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**Computational complexity of digraph decomposition and the congruence  
extension property for algebras**

by

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in partial fulfillment of the requirements for the degree of  
**DOCTOR OF PHILOSOPHY**

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## ABSTRACT

The strong direct product is one of the standard graph products. In 1992, Feigenbaum and Schäffer presented a polynomial-time algorithm to find the unique prime factorization of connected graphs under the strong direct product. In this paper, we show that weakly connected directed graphs have unique prime factorizations with respect to the strong direct product, and we give a polynomial-time algorithm to find the prime factorizations of such digraphs. This is an extension of Feigenbaum and Schäffer's work on factoring undirected graphs under the strong direct product and Imrich's work on factoring undirected graphs with respect to the weak direct product.

We also investigate the problem of determining whether an algebra has the congruence extension property. We prove that this problem is complete for polynomial time.



## CHAPTER 1. INTRODUCTION

Examining properties of graphs and algebraic structures often leads to questions about computational complexity. We can define a decision problem based on a property of an algebra or a class of algebras, with the goal of determining the complexity of the problem. In order for this to make sense, we assume our structures are finite. As an example, consider the following question: Given a finite algebra  $A$  of finite similarity type, does  $A$  have a proper subalgebra? In fact, this problem was shown to be complete for  $P$  by Bergman and Slutzki (2).

This area of computational complexity is of interest to algebraists because it gives them a sense of how hard it is to determine certain properties of algebras. It is also of interest to computer scientists because it gives them some natural mathematical examples of problems in the various complexity classes. This is especially true for some of the higher complexity classes, where there are not many examples available.

We consider two different problems in this paper. The first problem involves directed graphs. In graph theory, there are several different notions of graph products. Three of the standard ones are the Cartesian product, the weak direct product, and the strong direct product, which are formally defined in Chapter 2. Two fundamental questions arise from these notions of products: Given a graph, can it be represented as a nontrivial product of graphs, and how difficult is it to determine the factorization of a graph? For all three of these products, there are known polynomial-time algorithms to calculate the factorizations of connected graphs, with the added nonbipartite restriction for the weak product.

The definitions of graph products can be extended to directed graphs. In this paper we consider the complexity of factoring a weakly connected digraph with respect to the strong direct product. We present an algorithm to compute the prime factorization of a given di-

graph. In Theorem 3.7.3, we prove that the strong direct decomposition of such a digraph into prime factors is unique and that this decomposition can be found in polynomial time. Besides answering the existence question, our algorithm actually determines the unique factorization, if it exists.

The second problem we consider is based on the congruence extension property. An algebra  $\mathbf{A}$  has the congruence extension property if any congruence on any subalgebra of  $\mathbf{A}$  has an extension congruence on  $\mathbf{A}$ . For a formal definition, see Definition 4.0.1. For example, it can be shown that any Abelian group has the congruence extension property, but it is easy to find groups that do not have the congruence extension property. The group  $A_5$  of even permutations on five letters is one such group. We restrict the problem CEP to finite algebras of finite similarity type. Formally, it is defined as follows:

$$\text{CEP} = \{\mathbf{A} : \mathbf{A} \text{ has the congruence extension property}\}.$$

Given an algebra  $\mathbf{A}$ , the problem is to determine whether  $\mathbf{A} \in \text{CEP}$ . In Theorem 4.0.4, we prove that CEP is complete for polynomial time.

We begin with a summary of the relevant background material from graph theory, universal algebra, and complexity theory. Chapter 3 contains the results on digraph decomposition, and complexity of the congruence extension property problem is presented in Chapter 4. The final chapter includes a discussion of some related open problems.

## CHAPTER 2. BACKGROUND

To understand the digraph decomposition and congruence extension property problems, we first need to define some concepts from graph theory, universal algebra, and complexity theory. We present only the definitions needed to understand the results in this paper. For further definitions and details, the reader should consult (5; 11) for graph theory, (4; 14) for universal algebra, and (15; 17) for complexity theory.

### 2.1 Graph Theory Preliminaries

We define a *graph*  $G$  as a set  $V(G)$  of vertices together with an edge set  $E(G)$  of unordered pairs  $[x, y]$  of vertices of  $G$ . More precisely, this statement defines a *simple* graph  $G$  because the edge set contains no loops or multiple edges, where a *loop* is an edge  $[x, x]$  from a vertex to the same vertex. A simple graph is *finite* if its vertex set is finite. A *directed graph* or *digraph* is a graph in which the edges have an orientation. The directed edge from  $x$  to  $y$  is denoted  $x \rightarrow y$ , and we say that  $y$  is *adjacent* to  $x$ . For a digraph  $G$ , the graph  $U$  with  $V(U) = V(G)$  and edge set  $E(U) = \{[x, y] : x \rightarrow y \in E(G) \text{ or } y \rightarrow x \in E(G)\}$  is called the *underlying graph* of  $G$ . In this paper, we mainly consider finite simple digraphs, but we state the following definitions for both graphs and digraphs.

A *subgraph*  $H$  of  $G$  is a graph  $H$  for which  $V(H) \subseteq V(G)$  and  $E(H) \subseteq E(G)$ . If  $[x, y] \in E(G)$  implies that  $[x, y] \in E(H)$  for all pairs of vertices  $x$  and  $y$  of  $H$ , then  $H$  is called an *induced subgraph* of  $G$ . For  $H$  to be an *induced subdigraph*, we require that the edge orientation be preserved, so that  $x \rightarrow y \in E(G)$  implies  $x \rightarrow y \in E(H)$ . We say a sub(di)graph  $H$  of  $G$  *spans*  $G$  if  $V(H) = V(G)$ .

Graphs  $G$  and  $H$  are *isomorphic*, denoted  $G \cong H$ , if there exists a bijection  $\varphi$  from  $V(G)$

onto  $V(H)$  such that  $[x, y] \in E(G)$  if and only if  $[\varphi(x), \varphi(y)] \in E(H)$ . In the directed case, the orientation of edges must also be preserved by the mapping  $\varphi$ , so  $G \cong H$  if  $x \rightarrow y \in E(G)$  if and only if  $\varphi(x) \rightarrow \varphi(y) \in E(H)$ . Essentially, isomorphic (di)graphs are different (di)graphs with the same structure.

The *complete graph on  $n$  vertices*, denoted  $K_n$ , is the simple graph with all possible edges between vertices. In other words, for any two vertices  $x \neq y$ , there is an edge  $[x, y]$ . In the directed case, we define  $K_n$  to be the simple digraph for which  $x \rightarrow y$  and  $y \rightarrow x$  in  $K_n$  for any two vertices  $x \neq y$ .

A graph  $G$  is *connected* if for any two vertices  $x$  and  $y$  of  $G$ , there is a path from  $x$  to  $y$ . For a digraph  $G$ , if there is a directed path between any pair of vertices of  $G$ , then  $G$  is *connected*, and  $G$  is *weakly connected* if the underlying graph of  $G$  is connected. If a (di)graph is not connected, we say it is *disconnected*. In a disconnected (di)graph, the maximal connected sub(di)graphs are called *connected components*. The *weakly connected components* of a digraph are the connected components of its underlying graph.

The *open neighborhood* of a vertex  $x$  in a graph  $G$ , denoted  $N_G(x)$  or simply  $N(x)$ , is the set of all vertices of  $G$  which are adjacent to  $x$ . So,  $N(x) = \{y : [x, y] \in E(G)\}$ . The *closed neighborhood* of  $x$  also includes the vertex  $x$ . We write  $\overline{N}(x) = N(x) \cup \{x\}$ . Note that if loops are allowed, it is possible to have  $N(x) = \overline{N}(x)$ . In the directed case, there is more than one definition for the neighborhood of a vertex because of the orientation of the edges. For our purposes, the open neighborhood of a vertex  $x$  in a digraph  $G$  is the set of all vertices which are adjacent to  $x$ . So,  $N(x) = \{y : x \rightarrow y \in E(G)\}$ . Note that this set does not include the vertices to which  $x$  is adjacent. The closed neighborhood of  $x$  is defined as above. If  $\overline{N}(x) = \overline{N}(y)$ , we call  $x$  and  $y$  *interchangeable* vertices. Note that in a simple digraph we have  $\overline{N}(x) = \overline{N}(y)$  if and only if  $x = y$  or  $x \leftrightarrow y$  and for all  $z$  such that  $z \neq x$  and  $z \neq y$ ,  $x \rightarrow z$  if and only if  $y \rightarrow z$ .

There are four standard types of graph products. We define three of them here. The first is the most fundamental type, the Cartesian product. The *Cartesian product* of two graphs  $G_1$  and  $G_2$  is denoted by  $G_1 \square G_2$  and defined by

$$V(G_1 \square G_2) = V(G_1) \times V(G_2);$$

$$E(G_1 \square G_2) = \{[(x_1, x_2), (y_1, y_2)] : x_1 = y_1 \text{ and } [x_2, y_2] \in E(G_2) \text{ or} \\ [x_1, y_1] \in E(G_1) \text{ and } x_2 = y_2\}.$$

Note that in defining the vertex set,  $\times$  represents the standard Cartesian product of sets. The Cartesian product is commutative and associative and has the trivial simple graph  $K_1$  as a unit. The Cartesian product of two graphs is connected if and only if both factors are connected (11).

Figure 2.1 shows the Cartesian product of the complete graphs  $K_2$  and  $K_3$ . Note that there are three distinct copies of  $K_2$  and two distinct copies of  $K_3$  in the product graph.

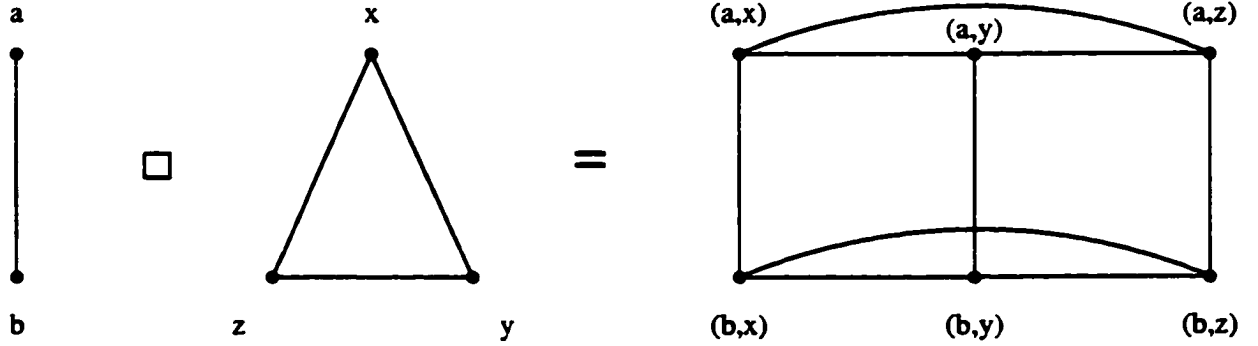


Figure 2.1 The Cartesian product  $K_2 \square K_3$

The *weak direct product* or *cardinal product* of  $G_1$  and  $G_2$ , denoted  $G_1 \times G_2$ , is defined by

$$V(G_1 \times G_2) = V(G_1) \times V(G_2);$$

$$E(G_1 \times G_2) = \{[(x_1, x_2), (y_1, y_2)] : [x_1, y_1] \in E(G_1) \text{ and } [x_2, y_2] \in E(G_2)\}.$$

The weak direct product is also commutative and associative. In the class of simple graphs it has no unit, but if loops are allowed, the one vertex graph with a loop is a unit. It is possible for the weak direct product of two graphs to be disconnected even if both factors are connected. For example, the product  $K_2 \times K_2$  is disconnected. However, it has been shown that the weak

direct product of two graphs is connected if and only if both factors are connected and at least one of the factors is nonbipartite (10).

Figure 2.2 shows the weak direct product of the complete graphs  $K_2$  and  $K_3$ . Note that the product graph is isomorphic to the cycle of length six.

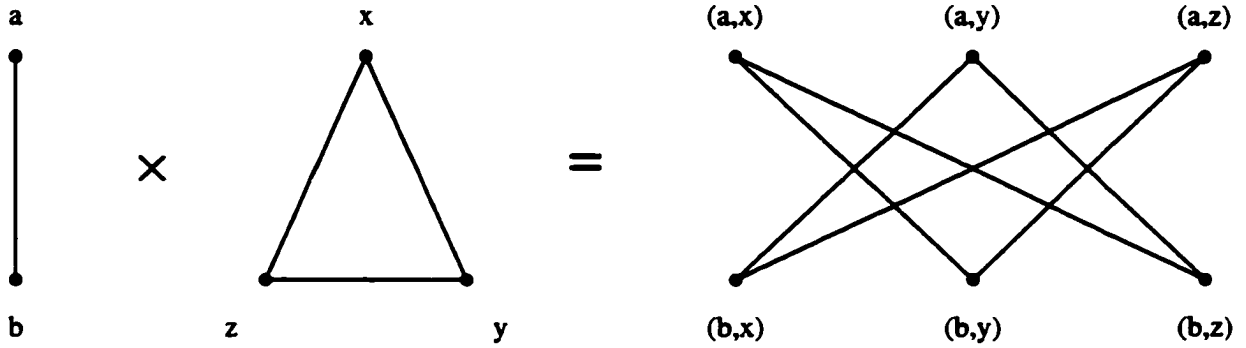


Figure 2.2 The weak direct product  $K_2 \times K_3$

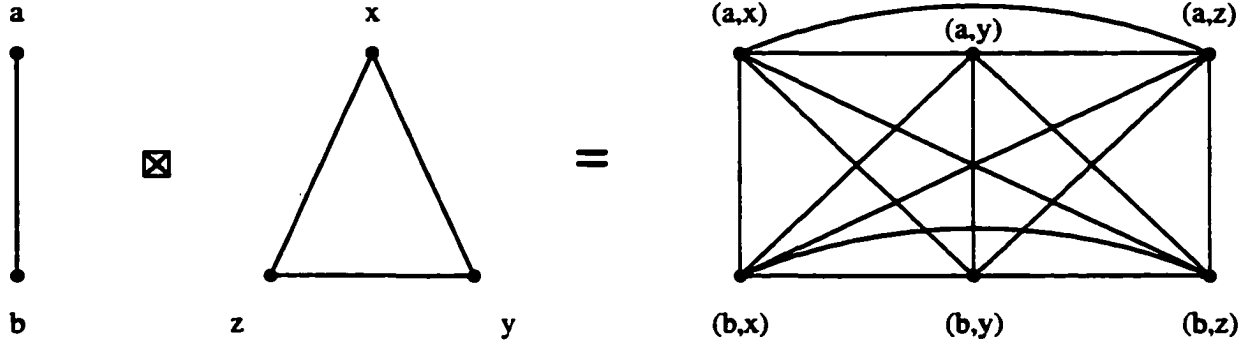
The *strong direct product*, or simply the *strong product*, of  $G_1$  and  $G_2$  is denoted by  $G_1 \boxtimes G_2$  and defined by

$$V(G_1 \boxtimes G_2) = V(G_1) \times V(G_2);$$

$$\begin{aligned} E(G_1 \boxtimes G_2) = \{[x_1, x_2], [y_1, y_2] : & x_1 = y_1 \text{ and } [x_2, y_2] \in E(G_2) \text{ or} \\ & [x_1, y_1] \in E(G_1) \text{ and } x_2 = y_2 \text{ or} \\ & [x_1, y_1] \in E(G_1) \text{ and } [x_2, y_2] \in E(G_2)\}. \end{aligned}$$

We could also write  $E(G_1 \boxtimes G_2) = E(G_1 \square G_2) \cup E(G_1 \times G_2)$ . The strong product is commutative and associative with  $K_1$  as a unit. The strong product of two graphs is connected if and only if both factors are connected (9). The notation for these three products comes from the product of an edge with itself and was introduced by Nešetřil.

Figure 2.3 shows the strong product of the complete graphs  $K_2$  and  $K_3$ . Note that the edge set is the union of the edges from the corresponding Cartesian and weak direct products.

Figure 2.3 The strong product  $K_2 \boxtimes K_3$ 

All three of these product definitions can be extended to digraphs, and we use the same notation. The vertex sets remain the same, with the edge sets defined in the following manner:

$$E(G_1 \square G_2) = \{(x_1, x_2) \rightarrow (y_1, y_2) : x_1 = y_1 \text{ and } x_2 \rightarrow y_2 \in E(G_2) \text{ or} \\ x_1 \rightarrow y_1 \in E(G_1) \text{ and } x_2 = y_2\};$$

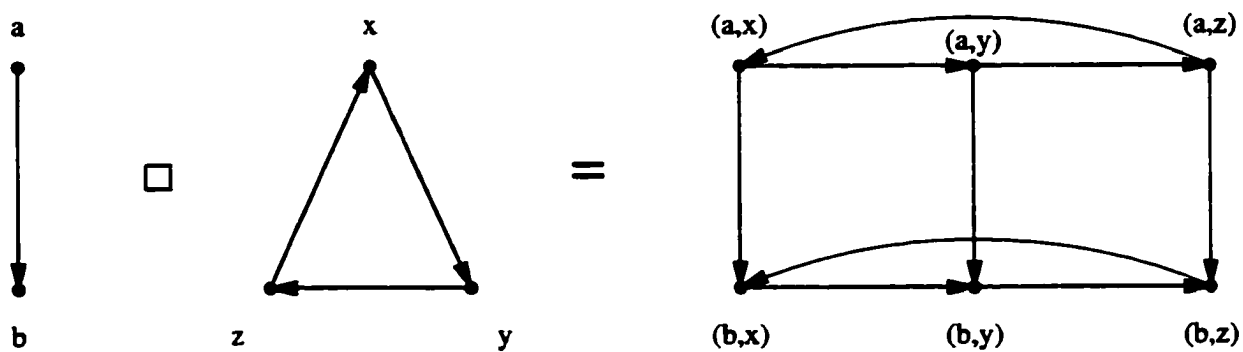
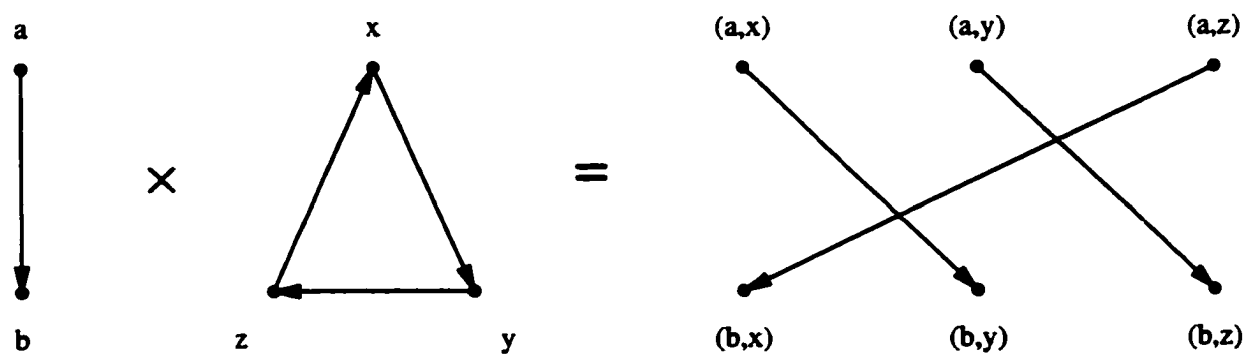
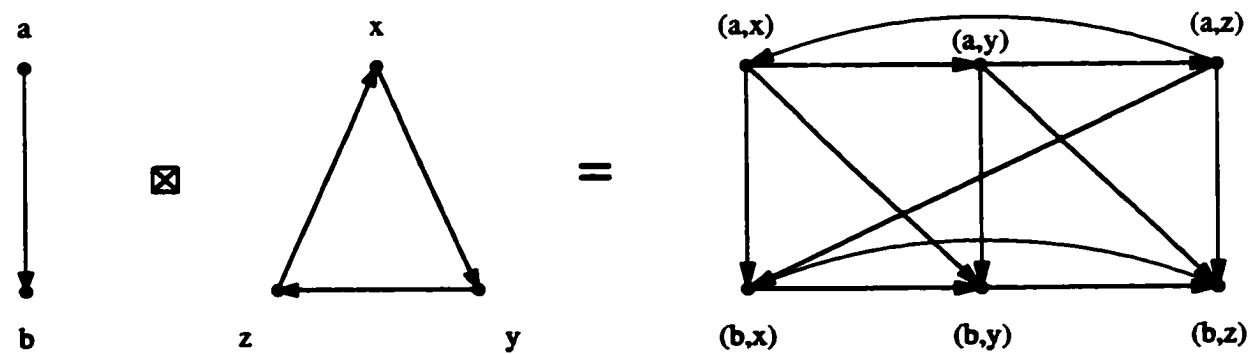
$$E(G_1 \times G_2) = \{(x_1, x_2) \rightarrow (y_1, y_2) : x_1 \rightarrow y_1 \in E(G_1) \text{ and } x_2 \rightarrow y_2 \in E(G_2)\};$$

$$E(G_1 \boxtimes G_2) = E(G_1 \square G_2) \cup E(G_1 \times G_2).$$

The products remain commutative and associative, and the Cartesian and strong products have  $K_1$  as a unit. If loops are allowed, the weak direct product has the one vertex graph with a loop as a unit.

Figures 2.4, 2.5, and 2.6 show the three products of the directed edge  $D$  with the directed triangle  $T$ , where  $E(D) = \{a \rightarrow b\}$  and  $E(T) = \{x \rightarrow y, y \rightarrow z, z \rightarrow x\}$ . The Cartesian product digraph has the Cartesian product graph  $K_2 \square K_3$  as its underlying graph. The weak direct product digraph is quite different from the undirected product, and it is isomorphic to the digraph with three disconnected directed edges. The strong product edge set is again the union of the Cartesian and weak directed edges from the other two product graphs.

A *prime* or *irreducible* (di)graph is one that cannot be expressed as the product of two

Figure 2.4 The Cartesian product  $D \square T$ Figure 2.5 The weak direct product  $D \times T$ Figure 2.6 The strong product  $D \boxtimes T$



nontrivial (di)graphs. Note that this definition of primality depends on the product type. For example, there exist (di)graphs which are irreducible with respect to the strong product but factorable under the Cartesian product. The cycle of length four is one such graph. It is true that most graphs are prime (9). Note that the complete (di)graph  $K_p$ , where  $p$  is a prime, is irreducible with respect to all three products. We are interested in knowing which product operators have the *unique prime factorization property*, which says that for every (di)graph  $G$ , there is a unique set of prime (di)graphs  $G_1, G_2, \dots, G_k$  such that  $G$  is the product of the  $G_i$ 's and  $G_i \neq K_1$  for all  $1 \leq i \leq k$ . Such a factorization is called a *unique prime factor decomposition* or a UPFD of the (di)graph  $G$ .

In this paper, we are mainly interested in the strong product of digraphs, so we introduce a few more definitions related to this product. Suppose a digraph  $G$  has been factored into  $k$  prime factors,  $G = G_1 \boxtimes G_2 \boxtimes \dots \boxtimes G_k$ . Then each vertex  $x$  has a coordinatization  $(x_1, x_2, \dots, x_k)$ . The number of coordinates of a vertex and the number of coordinates in which two vertices differ are independent of the representation of  $G$ , so every vertex on  $G$  has a *unique coordinatization*. We say that each factor  $G_i$  *divides*  $G$  or that  $G$  is *divisible* by  $G_i$  with respect to the strong product. To emphasize the dependence of divisibility on the type of product, we use  $\boxtimes$ -divisible to denote divisibility with respect to the strong product. An edge of  $G$  is called a *Cartesian edge* if the coordinates of its endpoints differ in exactly one component. Otherwise, it is called a *weak direct edge*. The *i*th *projection map*  $p_i : G \rightarrow G_i$  is defined by  $p_i(x_1, x_2, \dots, x_k) = x_i$ . The subdigraph induced by all vertices with coordinates  $(x_1, \dots, x_{i-1}, \cdot, x_{i+1}, \dots, x_k)$ , where the *i*th component ranges over all vertices of  $G_i$ , is called a *copy* of  $G_i$ . We denote by  $G_i^a$  the  $G_i$ -copy induced by the set  $\{x \in V(G) : x_j = a_j \text{ for all } j \neq i\}$ , where  $a = (a_1, \dots, a_k)$ . We could also write  $G_i^a = \{x \in V(G) : p_j(x) = a_j \text{ for } j \neq i\}$ . This definition of a copy of a factor also holds for the Cartesian and weak direct products. The closed neighborhood of a vertex  $x$  in  $G$  can be expressed as  $\overline{N}_G(x) = \overline{N}_{G_1}(x_1) \times \overline{N}_{G_2}(x_2) \times \dots \times \overline{N}_{G_k}(x_k)$ . We will write  $\overline{N}_i$  for  $\overline{N}_{G_i}$ .

## 2.2 Universal Algebra Preliminaries

For a set  $A$  and a nonnegative integer  $n$ ,  $A^n$  denotes the set of  $n$ -tuples of elements of  $A$ . An  $n$ -ary operation on  $A$  is a function  $f : A^n \rightarrow A$ . The integer  $n$  is called the *rank* or *arity* of  $f$ . If an operation  $f$  on  $A$  has rank 0, then  $f$  is called a *nullary* or *constant* operation. Because a nullary operation is determined by the value  $f(\emptyset) \in A$ , it is often thought of as an element of  $A$ .

An *algebra* is an ordered pair  $\mathbf{A} = \langle A, F \rangle$ , where  $A$  is a nonempty set and  $F$  is a set of operations on  $A$ . The set  $A$  is called the *universe* of  $\mathbf{A}$ , and  $F$  is the set of *basic* or *fundamental operations* of  $\mathbf{A}$ . An algebra  $\mathbf{A}$  is *finite* if  $|A|$  is finite, and  $\mathbf{A}$  is *trivial* if  $|A| = 1$ . If  $F$  is finite, then we say  $\mathbf{A}$  is of *finite similarity type*. If  $\mathbf{A} = \langle A, F \rangle$  and  $\mathbf{B} = \langle A, G \rangle$  with  $G \subseteq F$ , then we call the algebra  $\mathbf{B}$  a *reduct* of  $\mathbf{A}$ , and the algebra  $\mathbf{A}$  is called an *expansion* of  $\mathbf{B}$ .

A set  $B$  is a *subuniverse* of the algebra  $\mathbf{A}$  if  $B \subseteq A$  and if  $B$  is closed under the basic operations of  $\mathbf{A}$ . In particular, the *subuniverse of  $\mathbf{A}$  generated by  $X$* , denoted  $\text{Sg}^{\mathbf{A}}(X)$ , is the smallest subuniverse of  $\mathbf{A}$  which contains  $X$ . To be precise,

$$\text{Sg}^{\mathbf{A}}(X) = \bigcap \{B : X \subseteq B \text{ and } B \text{ is a subuniverse of } \mathbf{A}\}.$$

If  $X$  is empty, then  $\text{Sg}^{\mathbf{A}}(\emptyset) = \{c : c \text{ is a constant operation of } \mathbf{A}\}$ . Note that if  $\mathbf{A}$  has no constant operations, then  $\text{Sg}^{\mathbf{A}}(\emptyset) = \emptyset$ .  $\mathbf{B} = \langle B, G \rangle$  is a *subalgebra* of  $\mathbf{A}$ , denoted  $\mathbf{B} \leq \mathbf{A}$ , if  $B$  is a subuniverse of  $\mathbf{A}$  and the operations in  $G$  are the operations of  $F$  restricted to elements of  $B$ . We write  $G = F \upharpoonright_B$ . The empty set may be a subuniverse of  $\mathbf{A}$ , but it is never the universe of a subalgebra of  $\mathbf{A}$ .

Let  $\theta$  be an equivalence relation on  $A$ . We define  $\theta$  to be a *congruence* on  $\mathbf{A}$  if for all  $f \in F$  and for all pairs  $(a_i, b_i) \in \theta, i = 1, \dots, n$ ,

$$(f(a_1, \dots, a_n), f(b_1, \dots, b_n)) \in \theta,$$

where  $n$  is the rank of  $f$ . In general, if the above condition holds for an operation  $f$ , we say  $f$  *preserves*  $\theta$ . If every  $f$  in  $F$  preserves  $\theta$ , then we say the set  $F$  preserves  $\theta$ . The set of all congruences of an algebra  $\mathbf{A}$  is denoted  $\text{Con}(\mathbf{A})$ . The smallest element of  $\text{Con}(\mathbf{A})$  is the identity

relation  $\delta_A = \{(x, x) : x \in A\}$ , and the largest element is the relation  $A^2 = \{(x, y) : x, y \in A\}$ . For  $\nu \subseteq A \times A$ , the *congruence on  $A$  generated by  $\nu$* , denoted  $\text{Cg}^A(\nu)$ , is the smallest congruence on  $A$  which contains  $\nu$ . To be precise,

$$\text{Cg}^A(\nu) = \bigcap \{\theta \in \text{Con}(A) : \nu \subseteq \theta\}.$$

In particular,  $\text{Cg}^A(a, b) = \bigcap \{\theta \in \text{Con}(A) : (a, b) \in \theta\}$ . If a congruence  $\theta$  can be generated by a single pair of elements, then  $\theta$  is called a *principal congruence*. A nontrivial algebra  $A$  is said to be *simple* if  $\text{Con}(A) = \{\delta_A, A^2\}$ .

### 2.3 Complexity Theory Preliminaries

Most problems in computational complexity are defined in terms of languages, where a *language* is a set of finite strings over a fixed alphabet. For each language  $L$ , we can define a decision problem: Given a string  $x$ , is  $x$  in  $L$ ? The amount of time or space required to answer this question generally depends on the length of the input string  $x$ . If there is a polynomial  $p$  such that some deterministic Turing machine can decide whether an input string  $x$  of length  $n$  lies in a language  $L$  in time  $O(p(n))$ , then we say  $L$  is computable in *polynomial time*. Let  $\mathbf{P}$  denote the set of all languages computable in polynomial time.

We say  $L$  is computable in *nondeterministic log-space* if there is a nondeterministic Turing machine which can decide whether  $x$  lies in  $L$  in space  $O(\log n)$ . The set of all languages which are computable in nondeterministic log-space is denoted  $\mathbf{NL}$ . If  $L$  can be decided by a nondeterministic Turing machine in polynomial time, then we say  $L$  is computable in *nondeterministic polynomial time*. Let  $\mathbf{NP}$  denote the set of all such languages.  $\mathbf{NP}$  can also be defined as the class of languages for which a solution can be verified in polynomial time. It can be shown that  $\mathbf{NL} \subseteq \mathbf{P} \subseteq \mathbf{NP}$  (17). Although still unproven, it is believed that both of these inclusions are proper.

Given two problems  $A$  and  $B$ , we say that  $A$  is *log-space reducible* to  $B$  if there is a function  $f$ , which is computable in deterministic log-space, such that for every instance  $x$  of  $A$ ,  $x \in A$  if and only if  $f(x) \in B$ . We denote this by  $A \leq_{\log} B$ . If every member of  $\mathbf{P}$  is log-space reducible

to  $B$ , then  $B$  is said to be *hard for  $P$* .  $B$  is *complete for  $P$*  or  *$P$ -complete* if  $B$  is in  $P$  and is hard for  $P$ . Note that the relation  $\leq_{\log}$  is reflexive and transitive. It follows that if  $A$  is  $P$ -complete,  $A \leq_{\log} B$ , and  $B$  is in  $P$ , then  $B$  is  $P$ -complete. Also note that a problem  $A$  which is complete for  $P$  is at least as hard as every other problem in  $P$ . Thus, since  $NL \subseteq P$  and the inclusion is believed to be proper, it is unlikely that a  $P$ -complete problem  $A$  belongs to the class  $NL$ .

We would like to state our problems in terms of mathematical properties rather than formal languages. To do this, we need to assume some reasonable encoding of the instances of a problem into finite strings. All graphs and digraphs are assumed to be simple and finite. The vertices of a (di)graph can be assumed to be  $\{0, 1, \dots, n-1\}$ , and the edges can be represented by an adjacency matrix with indices  $\{0, 1, \dots, n-1\}$  and entries from  $\{0, 1\}$ . Thus, an input instance to the digraph decomposition problem has size at least  $n^2$ .

Similarly, we assume all algebras are finite and of finite similarity type. We can take the universe of an algebra to be  $\{0, 1, \dots, n-1\}$ . This set can be represented in the input by its cardinality, which requires  $\log n$  bits of storage. Each operation can be represented by a table of values. A  $k$ -ary operation will be represented as a  $k$ -dimensional array, with indices and entries coming from  $\{0, 1, \dots, n-1\}$ . Such an array takes space  $n^k \cdot \log n$  bits. Suppose  $A = \langle A, F \rangle$  is an algebra with  $|A| = n$  and  $|F| = q$ , and suppose that the maximum rank of any operation in  $F$  is  $r$ . Then as an input instance to CEP, the size of  $A$  is at least  $\max(n^r, nq)$ .

Following the conventions of Imrich (11), we use the random-access machine as our model of computation. We also take the running time of an algorithm to be equivalent to the number of steps in its execution.

## CHAPTER 3. DIGRAPH DECOMPOSITION

In this chapter we show that the prime factorization of weakly connected digraphs with respect to the strong product can be found in polynomial time. We also show that this factorization is unique. The general idea is to construct a Cartesian subdigraph which has a decomposition that is compatible with any strong decomposition of the original digraph. This Cartesian subdigraph can be factored under the Cartesian product using Feigenbaum's algorithm (8), and the factorization of the original digraph can be retrieved from this Cartesian decomposition. Unless stated otherwise, all digraphs in this chapter are assumed to be finite and simple. We begin with a discussion of some previous results regarding the complexity of graph decompositions.

### 3.1 Previous Results

There are many known results for decompositions of undirected graphs under the Cartesian, weak direct, and strong products. In 1960, Sabidussi showed that finite connected simple graphs have unique prime factor decompositions under the Cartesian product (16). This was perhaps the main introduction to the theory of graph multiplication. It was proven that connected simple graphs have unique prime factorizations under the strong product by Dörfler and Imrich in 1970 (7), and independently, by McKenzie in 1971 (13). McKenzie's work actually showed that nonbipartite connected graphs have unique factorizations with respect to the weak direct product in the class of undirected graphs with loops. By the definitions of the weak direct product and strong products, this implies the uniqueness result for the strong product.

Following the uniqueness results, the problem was to actually determine these prime fac-

tors. In particular, the complexity of these prime factorization problems was of interest. For the Cartesian product, Feigenbaum, Herschberger, and Schäffer presented a polynomial-time algorithm to find the unique factorization of connected simple graphs in 1985 (9). Their result utilized the towers of equivalence relations introduced by Sabidussi. Independently, Winkler presented a different polynomial-time algorithm in 1987, in which he regarded graphs as metric spaces (18). Their work inspired faster algorithms to be developed, and in 1992, Aurenhammer, Hagauer, and Imrich presented an algorithm which runs in  $O(m \log n)$  time, where  $m$  is the number of edges of the graph and  $n$  is the number of vertices (1). This is currently the fastest known algorithm for factoring graphs with respect to the Cartesian product.

Similar results were found for the strong and weak direct factorizations of graphs. In 1992, Feigenbaum and Schäffer proved that connected simple graphs can be factored with respect to the strong product in polynomial time (9). For the weak direct product, Imrich presented a polynomial-time algorithm to find the factorization of nonbipartite connected graphs in the class of undirected graphs with loops in 1998 (10).

Although there are many known results for the complexity of graph decompositions, not much has been done with the factorization of directed graphs. In 1986, Feigenbaum extended the Cartesian factorization results to the directed graph case, showing that weakly connected digraphs have unique prime factorizations that can be determined in polynomial time (8). This work utilized the Cartesian factorization of undirected graphs. For the other two products, no results have been published. The methods of this chapter closely follow the work done by Feigenbaum and Schäffer in factoring graphs with respect to the strong product (9) and Imrich's work in factoring graphs under the weak direct product (10).

### 3.2 The Relation $S$ and $S$ -thin Digraphs

Define a relation  $S$  on the vertex set of a digraph  $G$  as follows: For vertices  $u$  and  $v$  in  $V(G)$ ,  $uSv$  if and only if  $\overline{N}(u) = \overline{N}(v)$ . It is straightforward to check that  $S$  is an equivalence relation. Now define the digraph  $G/S$  as follows:

$$V(G/S) = \{D_i : D_i \text{ is an equivalence class of } S\};$$

$$E(G/S) = \{D_i \rightarrow D_j : i \neq j \text{ and there exist } u \in V(D_i) \text{ and } v \in V(D_j) \text{ such that } u \rightarrow v \in E(G)\}.$$

A digraph  $G$  is said to be  $S$ -thin if  $S = \delta_G = \{(x, x) : x \in V(G)\}$ . Clearly,  $G/S$  is  $S$ -thin. Note also that  $G$  is  $S$ -thin if and only if  $G$  has no interchangeable vertices. It can also be shown that if  $G = G_1 \boxtimes G_2$ , then  $G$  is  $S$ -thin if and only if  $G_1$  and  $G_2$  are  $S$ -thin.

**Lemma 3.2.1.** *Let  $G$  be a digraph with  $n$  vertices and  $m$  edges. Then  $G/S$  can be constructed in  $O(n^3)$  time.*

*Proof.* Let  $\{a, b\}$  be any pair of vertices in  $G$ . To check whether  $aSb$ , it suffices to check if  $a \rightarrow x$  and  $b \rightarrow x$  for all  $x \in V(G)$ . There are a total of  $n^2$  pairs  $\{a, b\}$  of vertices in  $G$ , and the adjacencies for each vertex can be checked in  $O(n)$  time. Thus, the total time to determine which pairs of vertices are equivalent under  $S$  is  $O(n^3)$ .

Constructing the equivalence classes of  $S$  is equivalent to finding the weakly connected components of the digraph  $G'$ , where  $V(G') = V(G)$  and  $a \rightarrow b$  in  $G'$  if  $aSb$ . The complexity of finding weakly connected components of a digraph is bounded by the number of edges, so the equivalence classes can be found in  $O(n^2)$  time.

Finally, to construct the digraph  $G/S$ , the adjacencies of the equivalence classes need to be checked. This amounts to checking edges, which can be done in  $O(m) < O(n^2)$  time. Therefore,  $G/S$  can be constructed in  $O(n^3)$  time.  $\square$

### 3.3 Complete Factors

The first step in decomposing a digraph into prime factors is to determine the largest complete factor. For our problem, a complete digraph is defined as a graph with all possible directed edges, so a digraph  $G$  is complete if for any pair of vertices,  $x \neq y$  in  $V(G)$ ,  $x \leftrightarrow y \in E(G)$ . To factor out the largest complete digraph with respect to the strong product, we follow the direction of Imrich in finding the largest complete graph factor with respect to the weak direct product (10).

**Lemma 3.3.1.**  $V((G \boxtimes H)/S) = \{U \times W : U \in V(G/S) \text{ and } W \in V(H/S)\}.$

*Proof.* Let  $U \in V(G/S)$  and  $W \in V(H/S)$ . First we show that the vertices in  $U \times W$  belong to the same equivalence class of  $V((G \boxtimes H)/S)$ . Let  $(u_1, w_1), (u_2, w_2) \in U \times W$ . Since  $U$  and  $W$  are equivalence classes of  $G/S$  and  $H/S$ , respectively, we have  $u_1 S u_2$  and  $w_1 S w_2$ . Then  $u_1 = u_2$  or  $u_1 \leftrightarrow u_2 \in E(G)$  and  $w_1 = w_2$  or  $w_1 \leftrightarrow w_2 \in E(H)$ . If  $(u_1, w_1) = (u_2, w_2)$ , then clearly  $(u_1, w_1) S (u_2, w_2)$ . If not, then by the definition of the strong product,  $(u_1, w_1) \leftrightarrow (u_2, w_2) \in E(G \boxtimes H)$ . It remains to be shown that for all  $(x, y) \in G \times H$ , with  $(x, y) \neq (u_1, w_1)$  and  $(x, y) \neq (u_2, w_2)$ ,  $(u_1, w_1) \rightarrow (x, y)$  if and only if  $(u_2, w_2) \rightarrow (x, y)$ .

Let  $(x, y) \in G \times H$  with  $(x, y) \neq (u_1, w_1)$  and  $(x, y) \neq (u_2, w_2)$ , and suppose  $(u_1, w_1) \rightarrow (x, y)$ . By the definition of the strong product, we have the following cases:

Case 1.  $u_1 = u_2, w_1 \leftrightarrow w_2$ :

Note that since  $w_1 S w_2$ ,  $w_1 \rightarrow y \in E(H)$  if and only if  $w_2 \rightarrow y \in E(H)$ .

- i. If  $u_1 = x$  and  $w_1 \rightarrow y$ , then  $u_2 = x$  and  $w_2 \rightarrow y$ .
- ii. If  $u_1 \rightarrow x$  and  $w_1 = y$ , then  $u_2 \rightarrow x$  and  $w_2 = y$ .
- iii. If  $u_1 \rightarrow x$  and  $w_1 \rightarrow y$ , then  $u_2 \rightarrow x$  and  $w_2 \rightarrow y$ .

Case 2.  $u_1 \leftrightarrow u_2, w_1 = w_2$ :

Note that since  $u_1 S u_2$ ,  $u_1 \rightarrow x \in E(G)$  if and only if  $u_2 \rightarrow x \in E(G)$ .

- i. If  $u_1 = x$  and  $w_1 \rightarrow y$ , then  $u_2 \rightarrow x$  and  $w_2 \rightarrow y$ .
- ii. If  $u_1 \rightarrow x$  and  $w_1 = y$ , then  $u_2 \rightarrow x$  and  $w_2 = y$ .
- iii. If  $u_1 \rightarrow x$  and  $w_1 \rightarrow y$ , then  $u_2 \rightarrow x$  and  $w_2 \rightarrow y$ .

Case 3.  $u_1 \leftrightarrow u_2, w_1 \leftrightarrow w_2$ :

- i. If  $u_1 = x$  and  $w_1 \rightarrow y$ , then  $u_2 \rightarrow x$  and  $w_2 \rightarrow y$ .
- ii. If  $u_1 \rightarrow x$  and  $w_1 = y$ , then  $u_2 \rightarrow x$  and  $w_2 = y$ .
- iii. If  $u_1 \rightarrow x$  and  $w_1 \rightarrow y$ , then  $u_2 \rightarrow x$  and  $w_2 \rightarrow y$ .

In all of the above cases, it follows that  $(u_2, w_2) \rightarrow (x, y)$  by the definition of the strong product. We have shown that if  $(u_1, w_1) \rightarrow (x, y)$ , then  $(u_2, w_2) \rightarrow (x, y)$ . By a symmetric argument the converse holds, so  $(u_1, w_1) S (u_2, w_2)$ .



It remains to be shown that  $U \times W$  is by itself an equivalence class of  $(G \boxtimes H)/S$ . Let  $(u, w) \in U \times W$ , and suppose that  $(a, b) \neq (u, w)$  belongs to the same equivalence class as the vertices in  $U \times W$ . We need to show that  $(a, b) \in U \times W$ . Note that since  $(a, b)S(u, w)$ , for every  $(x, y) \in U \times W$  with  $(x, y) \neq (a, b)$  and  $(x, y) \neq (u, w)$ , we have  $(a, b) \rightarrow (x, y)$  if and only if  $(u, w) \rightarrow (x, y)$ . Also, since  $(a, b) \neq (u, w)$  and  $(a, b)S(u, w)$ , we have  $(a, b) \leftrightarrow (u, w) \in E(G \boxtimes H)$ . Consider the following cases:

Case 1.  $a = u$  and  $b \leftrightarrow w$ :

Let  $y \in V(H)$  with  $y \neq b$  and  $y \neq w$ . Then

$$\begin{aligned} w \rightarrow y \in E(H) &\Leftrightarrow (u, w) \rightarrow (u, y) \in E(G \boxtimes H) \\ &\Leftrightarrow (a, b) \rightarrow (u, y) \in E(G \boxtimes H) \\ &\Leftrightarrow b \rightarrow y \in E(H), \text{ since } b \neq y. \end{aligned}$$

So  $bSw$ , and thus,  $b \in W$ .

Case 2.  $a \leftrightarrow u$  and  $b = w$ :

Let  $x \in V(G)$  with  $x \neq a$  and  $x \neq u$ . Then

$$\begin{aligned} u \rightarrow x \in E(G) &\Leftrightarrow (u, w) \rightarrow (x, w) \in E(G \boxtimes H) \\ &\Leftrightarrow (a, b) \rightarrow (x, w) \in E(G \boxtimes H) \\ &\Leftrightarrow a \rightarrow x \in E(G), \text{ since } a \neq x. \end{aligned}$$

So  $aSu$ , and thus,  $a \in U$ .

Case 3.  $a \leftrightarrow u$  and  $b \leftrightarrow w$ :

Let  $x \in V(G)$  with  $x \neq a$  and  $x \neq u$ . Then

$$\begin{aligned} u \rightarrow x \in E(G) &\Leftrightarrow (u, w) \rightarrow (x, w) \in E(G \boxtimes H), \\ &\Leftrightarrow (a, b) \rightarrow (x, w) \in E(G \boxtimes H) \\ &\Leftrightarrow a \rightarrow x \in E(G), \text{ since } a \neq x. \end{aligned}$$

So,  $aSu$ . By a symmetric argument we have  $bSw$ , and thus,  $(a, b) \in U \times W$ .

Therefore,  $U \times W$  is an equivalence class of  $S$ .  $\square$

**Proposition 3.3.2.** *Let  $G$  and  $H$  be digraphs. Then  $(G \boxtimes H)/S \cong G/S \boxtimes H/S$ .*

*Proof.* This statement follows from Lemma 3.3.1 and the definition of the strong product.  $\square$

**Lemma 3.3.3.** *Let  $G$  be a weakly connected digraph and let  $k > 1$  divide  $|D_i|$  for all  $D_i \in V(G/S)$ . Then there exists a digraph  $H$  such that  $G \cong K_k \boxtimes H$ . Conversely, if  $G \cong K_k \boxtimes H$  for some  $k > 1$ , then  $k$  divides  $|D_i|$  for all  $D_i \in V(G/S)$ .*

*Proof.* Let  $V(G/S) = \{D_i : i \in I\}$ , and let  $\{D'_i : i \in I\}$  be a family of disjoint sets with  $|D_i| = k|D'_i|$ . Define a digraph  $H$  as follows:

$$V(H) = \bigcup_{i \in I} D'_i;$$

$$E(H) = \{x \rightarrow y : x, y \in V(D'_i) \text{ or } x \in V(D'_i), y \in V(D'_j), \text{ and } D_i \rightarrow D_j \in E(G/S)\}.$$

Then  $G \cong K_k \boxtimes H$ .

For the converse, suppose that  $G \cong K_k \boxtimes H$  for some  $k > 1$ . Since  $V(K_k)$  is the only equivalence class of  $K_k/S$ , Lemma 3.3.1 implies that  $V(G/S) = \{V(K_k) \times W : W \in V(H/S)\}$ . Then it is clear that  $k$  divides  $|D_i|$  for any  $D_i \in V(G/S)$ .  $\square$

**Lemma 3.3.4.** *Let  $G \cong K_k \boxtimes H$  and  $G \cong K_k \boxtimes H'$ . Then  $H \cong H'$ .*

*Proof.* If  $G = K_k \boxtimes H$ , then  $G/S \cong K_k/S \boxtimes H/S \cong H/S$  by Proposition 3.3.2, since  $K_k/S$  is the unit digraph  $K_1$ . Similarly,  $G/S \cong H'/S$ . So there is an isomorphism  $\pi : H/S \cong H'/S$ . This isomorphism can be chosen so that  $|D_i| = |\pi(D_i)|$  for all  $D_i \in V(H/S)$ . Let  $\varphi_i : D_i \rightarrow \pi(D_i)$  be a bijection. Then  $\varphi : V(H) \rightarrow V(H')$  defined by  $\varphi \upharpoonright_{D_i} = \varphi_i$  gives an isomorphism  $H \cong H'$ .  $\square$

**Lemma 3.3.5.** *Let  $G$  be a weakly connected digraph with decompositions  $G = K_m \boxtimes H$  and  $G = K_n \boxtimes H'$ . If  $H$  and  $H'$  are not  $\boxtimes$ -divisible by  $K_k$  for any  $k > 1$ , then  $m = n$  and  $H \cong H'$ .*

*Proof.* Let  $d = \gcd(\{|D_i| : D_i \in V(G/S)\})$ . By Lemma 3.3.3,  $m$  divides  $d$ . Then  $\{\frac{1}{m}|D_i|\}$  represents the size of the equivalence classes of  $H/S$ . The greatest common divisor of  $\{\frac{1}{m}|D_i|\}$  must be 1, since  $H$  is not divisible by  $K_k$  for any  $k > 1$ . Therefore,  $m = d$ . By a symmetric argument,  $n = d$ , so  $m = n$ . Then by Lemma 3.3.4,  $H \cong H'$ .  $\square$

By Lemma 3.3.3, the largest complete factor of  $G$  can be determined by calculating the largest integer  $k$  such that  $k$  divides  $|D_i|$  for all  $D_i \in V(G/S)$ . Since  $S$  and  $G/S$  can be constructed in polynomial time and the greatest common divisor of  $\{|D_i| : D_i \in V(G/S)\}$  can be found in polynomial time using the Euclidean algorithm (5), the largest complete factor of  $G$  can also be determined in polynomial time. By Lemma 3.3.5, once the largest complete digraph is factored out of  $G$ , the remaining factor is uniquely determined.

### 3.4 Cartesian Edges and the Copy Consistency Property

Recall that an edge  $(x_1, x_2) \rightarrow (y_1, y_2)$  is *Cartesian* with respect to the decomposition  $G_1 \boxtimes G_2$  if either  $x_1 = y_1$  or  $x_2 = y_2$ . A set of edges satisfies the *copy consistency property* if for every factor  $G_i$ ,  $i = 1, 2$ , and every pair of adjacent vertices  $x_i \rightarrow y_i \in V(G_i)$ , the (copy of the) edge  $x_i \rightarrow y_i$  is marked in all copies of the factor  $G_i$  or in no copies of  $G_i$ . By associativity of the strong product, the copy consistency property extends to any finite number of factors of  $G$ . The lemmata in this section are the basis for the algorithm presented in Section 3.5. The goal is to mark enough Cartesian edges to span  $G$  while satisfying the copy consistency property.

**Lemma 3.4.1.** *Let  $G$  be a weakly connected, nontrivial,  $S$ -thin digraph with  $G = G_1 \boxtimes G_2$ . Let  $F$  be a copy consistent set of directed Cartesian edges of  $G$ , and let  $H$  be the digraph with  $V(H) = V(G)$  and  $E(H) = F$ .*

*For all  $x \in V(G)$ , let*

$$S(x) = \{y \in V(G) : \overline{N}(y) \subset \overline{N}(x)\},$$

$$P(x) = \{z \in V(G) : z \text{ is in the weakly connected component of } H \text{ which contains } x\},$$

$$R(x) = V(H) \setminus P(x), \text{ and}$$

$$\mathcal{J}(x) = \{\overline{N}(y) : y \in R(x) \cap S(x)\}.$$

*Mark  $x \rightarrow y$  if  $\overline{N}(y)$  is maximal in  $\mathcal{J}(x)$ . Then all marked edges are Cartesian and the set of all marked edges satisfies the copy consistency property.*

*Proof.* We begin by showing that every marked edge is Cartesian. Let  $x = (x_1, x_2)$  and  $y = (y_1, y_2)$ . Suppose  $x \rightarrow y$  is marked but not Cartesian. Then  $x_1 \neq y_1$  and  $x_2 \neq y_2$ . Let  $y' = (y_1, x_2)$  and  $y'' = (x_1, y_2)$ . If  $y'$  and  $y''$  are both in  $P(x)$ , then  $y \in P(x)$  by the copy consistency of  $F$ . So, without loss of generality, assume  $y' \notin P(x)$ .

If  $\overline{N}(y) \subset \overline{N}(x)$ , then  $\overline{N}_1(y_1) \subset \overline{N}_1(x_1)$ , since  $G_1$  is  $S$ -thin and  $x_1 \neq y_1$ . Then we have

$$\begin{aligned}\overline{N}(y') &= \overline{N}_1(y_1) \times \overline{N}_2(x_2) \\ &\subset \overline{N}_1(x_1) \times \overline{N}_2(x_2) \\ &= \overline{N}(x).\end{aligned}$$

So,  $y' \in R(x) \cap S(x)$ . Also,  $\overline{N}(y) \subset \overline{N}(x)$  implies  $\overline{N}_2(y_2) \subset \overline{N}_2(x_2)$  since  $G_2$  is  $S$ -thin and  $x_2 \neq y_2$ . Then

$$\begin{aligned}\overline{N}(y) &= \overline{N}_1(y_1) \times \overline{N}_2(y_2) \\ &\subset \overline{N}_1(y_1) \times \overline{N}_2(x_2) \\ &= \overline{N}(y').\end{aligned}$$

Since  $x \rightarrow y$  is marked,  $\overline{N}(y)$  must be maximal in  $\mathcal{J}(x)$ , but  $\overline{N}(y) \subset \overline{N}(y')$  contradicts the maximality of  $\overline{N}(y)$ . Therefore,  $x \rightarrow y$  is Cartesian.

Now we show that the set of all marked edges satisfies the copy consistency property. Suppose  $u \rightarrow v$  is marked. Without loss of generality, we can assume that  $u \rightarrow v$  is in a copy of  $G_1$ . Then  $u = (u_1, u_2)$  and  $v = (v_1, u_2)$ , and  $\overline{N}_1(v_1)$  is maximal in the set  $\{\overline{N}_1(w_1) : (w_1, u_2) \in R(u) \cap S(u)\}$ .

Consider another copy  $u' \rightarrow v'$  of this edge. Then  $u' = (u_1, u'_2)$  and  $v' = (v_1, u'_2)$ . Since  $v \in R(u)$ ,  $v' \in R(u')$  by the copy consistency of  $F$ . Because  $v \in S(u)$ , we also have  $v' \in S(u')$  by the following argument:

$$\begin{aligned}\overline{N}(v) \subset \overline{N}(u) &\Rightarrow \overline{N}_1(v_1) \times \overline{N}_2(u_2) \subset \overline{N}_1(u_1) \times \overline{N}_2(u_2) \\ &\Rightarrow \overline{N}_1(v_1) \subset \overline{N}_1(u_1) \\ &\Rightarrow \overline{N}_1(v_1) \times \overline{N}_2(u'_2) \subset \overline{N}_1(u_1) \times \overline{N}_2(u'_2) \\ &\Rightarrow \overline{N}(v') \subset \overline{N}(u').\end{aligned}$$

Thus,  $v' \in R(u') \cap S(u')$ , and  $u' \rightarrow v'$  is eligible to be marked.

Suppose there is a vertex  $v'' = (v''_1, v''_2) \in R(u') \cap S(u')$  that prevents  $u' \rightarrow v'$  from being marked. Such a  $v''$  would have to satisfy the condition  $\overline{N}(v') \subset \overline{N}(v'') \subset \overline{N}(u')$ , or equivalently,  $\overline{N}_1(v_1) \subset \overline{N}_1(v''_1) \subset \overline{N}_1(u_1)$ . This equivalence holds by the following argument:

$$\begin{aligned} \overline{N}_1(v_1) \times \overline{N}_2(u'_2) &\subset \overline{N}_1(v''_1) \times \overline{N}_2(v''_2) \subset \overline{N}_1(u_1) \times \overline{N}_2(u'_2) \\ &\Leftrightarrow \overline{N}_2(u'_2) = \overline{N}_2(v''_2) \\ &\Leftrightarrow u'_2 = v''_2, \text{ since } G_2 \text{ is } S\text{-thin.} \end{aligned}$$

The statement  $\overline{N}_1(v_1) \subset \overline{N}_1(v''_1) \subset \overline{N}_1(u_1)$  contradicts the maximality of  $\overline{N}_1(v_1)$ , unless  $(v''_1, u_2) \notin R(u) \cap S(u)$ . If that is the case, then either  $(v''_1, u_2) \notin R(u)$  or  $(v''_1, u_2) \notin S(u)$ .

First suppose  $(v''_1, u_2) \notin R(u)$ , so then  $(v''_1, u_2) \in P(u)$ . By the copy consistency of  $F$ , we have  $v'' = (v''_1, u'_2) \in P(u')$ . It follows that  $v'' \notin R(u') \cap S(u')$ , so  $v''$  cannot prevent  $u' \rightarrow v'$  from being marked.

Now suppose  $(v''_1, u_2) \notin S(u)$ . By the copy consistency of  $F$ , we have  $v'' \notin S(u')$ . Thus,  $v'' \notin R(u') \cap S(u')$ . Therefore, no such  $v''$  exists. So,  $u' \rightarrow v'$  is marked, and the set of marked edges is copy consistent.  $\square$

**Lemma 3.4.2.** *Assume the conditions of Lemma 3.4.1 hold with  $F$  closed under applications of Lemma 3.4.1, so that if  $\overline{N}(y) \subset \overline{N}(x)$ , then  $y \in P(x)$ . For all  $x \in V(G)$ , let  $Q(x) = \overline{N}(x) \cap R(x)$ , and for all  $y \in Q(x)$ , let  $I(x, y) = \overline{N}(x) \cap \overline{N}(y)$  and  $\mathcal{I}(x) = \{I(x, y) : y \in Q(x)\}$ .*

*Mark  $x \rightarrow y$  if*

- i.  $I(x, y)$  is strictly maximal in  $\mathcal{I}(x)$  or
- ii.  $I(x, y)$  is maximal in  $\mathcal{I}(x)$  and for all  $y' \in Q(x)$  such that  $I(x, y) = I(x, y')$ ,  $\overline{N}(y') \not\subset \overline{N}(y)$ .

*Then all marked pairs are Cartesian and the set of all marked edges satisfies the copy consistency property.*

*Proof.* We first prove that all marked pairs are Cartesian. Let  $x = (x_1, x_2)$  and  $y = (y_1, y_2)$ , and suppose  $x \rightarrow y$  is marked but not Cartesian. Then  $x_1 \neq y_1$  and  $x_2 \neq y_2$ . Let  $y' = (y_1, x_2)$  and  $y'' = (x_1, y_2)$ . By the copy consistency of  $F$ ,  $y \in P(x)$  if  $y', y'' \in P(x)$ , so assume  $y' \notin P(x)$ .

Let  $z \in I(x, y) = \overline{N}(x) \cap \overline{N}(y)$ . Then either  $z = x$  or  $x \rightarrow z$  and either  $z = y$  or  $y \rightarrow z$ . By the definition of the strong product, it follows that  $z \in \overline{N}(y')$ . Thus,  $z \in \overline{N}(x) \cap \overline{N}(y') = I(x, y')$ . So,  $I(x, y) \subseteq I(x, y')$ .

If  $I(x, y) \subsetneq I(x, y')$ , then  $x \rightarrow y'$  would be marked instead of  $x \rightarrow y$ . On the other hand, if  $I(x, y) = I(x, y')$ , then  $\overline{N}(y') \subset \overline{N}(y)$  by the following argument:

$$\begin{aligned}
\overline{N}(x) \cap \overline{N}(y) &= \overline{N}(x) \cap \overline{N}(y') \\
&\Rightarrow (\overline{N}_1(x_1) \times \overline{N}_2(x_2)) \cap (\overline{N}_1(y_1) \times \overline{N}_2(y_2)) \\
&= (\overline{N}_1(x_1) \times \overline{N}_2(x_2)) \cap (\overline{N}_1(y_1) \times \overline{N}_2(x_2)) \\
&\Rightarrow (\overline{N}_1(x_1) \cap \overline{N}_1(y_1)) \times (\overline{N}_2(x_2) \cap \overline{N}_2(y_2)) = (\overline{N}_1(x_1) \cap \overline{N}_1(y_1)) \times \overline{N}_2(x_2) \\
&\Rightarrow \overline{N}_2(x_2) \cap \overline{N}_2(y_2) = \overline{N}_2(x_2) \\
&\Rightarrow \overline{N}_2(x_2) \subseteq \overline{N}_2(y_2) \\
&\Rightarrow \overline{N}(y') = \overline{N}_1(y_1) \times \overline{N}_2(x_2) \subseteq \overline{N}_1(y_1) \times \overline{N}_2(y_2) = \overline{N}(y) \\
&\Rightarrow \overline{N}(y') \subset \overline{N}(y), \text{ since } y' \neq y \text{ and } G \text{ is } S\text{-thin.}
\end{aligned}$$

But since  $x \rightarrow y$  is marked, this contradicts the condition that if  $I(x, y) = I(x, y')$ , then  $\overline{N}(y') \not\subset \overline{N}(y)$ . Thus,  $x \rightarrow y$  is Cartesian.

Now we prove copy consistency. Suppose  $u \rightarrow v$  is marked and lies in a copy of  $G_1$ . Then  $u = (u_1, u_2)$  and  $v = (v_1, v_2)$ . Let  $u' \rightarrow v'$  be another copy of  $u \rightarrow v$ , so that  $u' = (u_1, u'_2)$  and  $v' = (v_1, v'_2)$ . Note that  $v' \in R(u') \cap S(u')$  by the same argument as in the proof of Lemma 3.4.1.

Suppose there is a  $v'' = (v'_1, v'_2)$  such that  $u' \rightarrow v''$  is chosen over  $u' \rightarrow v'$ . Then  $v'' \in R(u') \cap S(u')$  and either  $I(u', v') \subset I(u', v'')$ , or  $I(u', v') = I(u', v'')$  and for all  $z \in Q(u')$  such that  $I(u', v'') = I(u', z)$ ,  $\overline{N}(z) \not\subset \overline{N}(v'')$ .

First suppose that  $v''$  is in the same  $G_1$ -copy as  $u' \rightarrow v'$ , so then  $v'' = (v'_1, v'_2)$ . If  $I(u', v') \subset$

$I(u', v'')$ , then

$$\begin{aligned}
(\overline{N}_1(u_1) \cap \overline{N}_1(v_1)) \times \overline{N}_2(u'_2) &\subset (\overline{N}_1(u_1) \cap \overline{N}_1(v''_1)) \times \overline{N}_2(u'_2) \\
&\Rightarrow \overline{N}_1(u_1) \cap \overline{N}_1(v_1) \subset \overline{N}_1(u_1) \cap \overline{N}_1(v''_1) \\
&\Rightarrow (\overline{N}_1(u_1) \cap \overline{N}_1(v_1)) \times \overline{N}_2(u_2) \subset (\overline{N}_1(u_1) \cap \overline{N}_1(v''_1)) \times \overline{N}_2(u_2) \\
&\Rightarrow I(u, v) \subset I(u, (v''_1, u_2)).
\end{aligned}$$

Then  $u \rightarrow (v''_1, u_2)$  would be marked instead of  $u \rightarrow v$ .

If  $I(u', v') = I(u', v'')$ , then since  $u' \rightarrow v''$  is marked instead of  $u' \rightarrow v'$ , there exists a  $z' = (z_1, z_2) \in Q(u')$  such that  $z' \neq v'$ ,  $I(u', v') = I(u', z')$ , and  $\overline{N}(z') \subset \overline{N}(v')$ . Then

$$\begin{aligned}
I(u', v') = I(u', z') &\Rightarrow \overline{N}_2(u'_2) = \overline{N}_2(u'_2) \cap \overline{N}_2(z_2) \\
&\Rightarrow \overline{N}_2(u'_2) \subseteq \overline{N}_2(z_2).
\end{aligned}$$

We also have  $\overline{N}(z') \subset \overline{N}(v')$ , which implies that  $\overline{N}_2(z_2) \subseteq \overline{N}_2(u'_2)$ . Thus,  $\overline{N}_2(z_2) = \overline{N}_2(u'_2)$ , and since  $G_2$  is  $S$ -thin,  $z_2 = u'_2$ . Then we have  $z_1 \neq v_1$ .

Let  $z = (z_1, u_2)$ . Since  $\overline{N}(z') \subset \overline{N}(v')$  and  $G_1$  is  $S$ -thin, we have  $\overline{N}_1(z_1) \subset \overline{N}_1(v_1)$ . Also,

$$\begin{aligned}
z' \in Q(u') &\Rightarrow z' \in \overline{N}(u') \\
&\Rightarrow z_1 \in \overline{N}_1(u_1) \\
&\Rightarrow z \in \overline{N}(u).
\end{aligned}$$

If  $z \in P(u)$ , then  $z'$  would be in  $P(u')$  by the copy consistency of  $H$ . But,  $z' \in R(u')$ , so  $z \in R(u)$ . Thus,  $z \in Q(u)$ . Also,  $I(u, v') = I(u', z') \Rightarrow \overline{N}_1(u_1) \cap \overline{N}_1(v_1) = \overline{N}_1(u_1) \cap \overline{N}_1(z_1)$ .

Then

$$\begin{aligned}
I(u, v) &= (\overline{N}_1(u_1) \cap \overline{N}_1(v_1)) \times \overline{N}_2(u_2) \\
&= (\overline{N}_1(u_1) \cap \overline{N}_1(z_1)) \times \overline{N}_2(u_2) \\
&= I(u, z).
\end{aligned}$$

Also,  $\overline{N}(z) = \overline{N}_1(z_1) \times \overline{N}_2(u_2) \subset \overline{N}_1(v_1) \times \overline{N}_2(u_2) = \overline{N}(v)$ , which means that  $u \rightarrow v$  would not be marked.

Now suppose that  $v''$  is not in the same copy of  $G_1$  as  $u' \rightarrow v'$ , so then  $v''_2 \neq u'_2$ . Note that  $I(u', v') \subseteq I(u', v'')$  implies  $\overline{N}_2(u'_2) \subset \overline{N}_2(v''_2)$ , since  $G_2$  is  $S$ -thin.

Then  $\overline{N}(u') = \overline{N}_1(u_1) \times \overline{N}_2(u'_2) \subset \overline{N}_1(u_1) \times \overline{N}_2(v''_2) = \overline{N}(u_1, v''_2)$ . This implies that  $(u_1, v''_2) \in P(u')$  since  $F$  is closed under applications of Lemma 3.4.1. Since  $v'' \notin P(u')$ , we can assume  $v''_1 \neq u_1$ . Thus, we have

$$\begin{aligned} I(u', v'') &= (\overline{N}_1(u_1) \times \overline{N}_2(u'_2)) \cap (\overline{N}_1(v''_1) \times \overline{N}_2(v''_2)) \\ &= (\overline{N}_1(u_1) \cap \overline{N}_1(v''_1)) \times (\overline{N}_2(u'_2) \cap \overline{N}_2(v''_2)) \\ &= (\overline{N}_1(u_1) \cap \overline{N}_1(v''_1)) \times \overline{N}_2(u'_2), \text{ since } \overline{N}_2(u'_2) \subset \overline{N}_2(v''_2) \\ &= I(u', (v''_1, u'_2)). \end{aligned}$$

Also,  $\overline{N}(v''_1, u'_2) = \overline{N}_1(v''_1) \times \overline{N}_2(u'_2) \subset \overline{N}_1(v''_1) \times \overline{N}_2(v''_2) = \overline{N}(v'')$ , but this contradicts  $u' \rightarrow v''$  being marked unless  $(v''_1, u'_2) \in P(u')$ . Then by the copy consistency of  $F$ ,  $(u_1, v''_2), (v''_1, u'_2) \in P(u')$  implies that  $v'' \in P(u')$ , so no such  $v''$  exists. Therefore, the set of marked edges is copy consistent.  $\square$

### 3.5 Constructing the Cartesian Skeleton

The *Cartesian skeleton*  $H$  of a digraph  $G$  is the subdigraph containing the edges of  $G$  which must be Cartesian with respect to any decomposition of  $G$  under the strong direct product. To be precise, if  $H = H_1 \square H_2$  and  $G = G_1 \boxtimes G_2$ , then for every  $x \in V(G)$ ,  $V(H_i^x) = V(G_i^x)$ . In this section, we give an algorithm to construct the Cartesian skeleton of an  $S$ -thin digraph with no complete factors. This algorithm is modeled after the marking algorithms of Feigenbaum and Schäffer (9) and Imrich (10). Following Feigenbaum and Schäffer, all of the edges marked in the algorithm are indeed edges of the input graph  $G$ .

#### Algorithm 1. MARK( $G$ )

For each  $x \in V(G)$

$P(x) \leftarrow \{x\}$ .

Insert  $P(x)$  into  $\mathcal{P}$ .

$S(x) \leftarrow \{y : \overline{N}(y) \subset \overline{N}(x)\}$ .



**M1:** While there is an  $x \in V(G)$  such that  $R(x) \cap S(x) \neq \emptyset$

For each such  $x$

$\mathcal{J}(x) \leftarrow \{\overline{N}(y) : y \in R(x) \cap S(x)\}.$

If  $\overline{N}(y)$  is maximal in  $\mathcal{J}(x)$ , then mark  $x \rightarrow y$ .

If  $x \rightarrow y$  was marked, then replace  $P(x)$  and  $P(y)$  with  $P(x) \cup P(y)$  in  $\mathcal{P}$ .

End M1

**M2:** While  $|\mathcal{P}| > 1$

**M3:** For each  $x \in V(G)$

$Q(x) \leftarrow \overline{N}(x) \cap R(x).$

If  $Q(x) \neq \emptyset$ , then

For each  $y \in Q(x)$ ,  $I(x, y) \leftarrow \overline{N}(x) \cap \overline{N}(y).$

$\mathcal{I}(x) \leftarrow \{I(x, y) : y \in Q(x)\}.$

If  $I(x, y)$  is strictly maximal in  $\mathcal{I}(x)$ , then mark  $x \rightarrow y$ .

If  $I(x, y)$  is non-strictly maximal in  $\mathcal{I}(x)$  and for all  $y' \in Q(x)$

with  $I(x, y) = I(x, y')$ ,  $\overline{N}(y') \not\subset \overline{N}(y)$ , then mark  $x \rightarrow y$ .

If  $x \rightarrow y$  was marked, then replace  $P(x)$  and  $P(y)$  with  $P(x) \cup P(y)$  in  $\mathcal{P}$ .

End M3

End M2

Note that Lemma 3.4.1 shows the edges marked in loop M1 are Cartesian and the set of marked edges satisfies the copy consistency property. By Lemma 3.4.2, the edges marked in loop M2 are also Cartesian and the set of marked edges satisfies the copy consistency property.

**Lemma 3.5.1.** *All iterations of M1 and M2, except the ones in which the loops are terminated, reduce the size of  $\mathcal{P}$ .*

*Proof.* To show this for the loop M1, suppose there is an  $x \in V(G)$  such that  $R(x) \cap S(x) \neq \emptyset$ . At least one set in  $\mathcal{J}(x)$  must be maximal, so at least one edge  $x \rightarrow y$  is marked in this iteration. Since  $y \in R(x)$ ,  $y \notin P(x)$  at the beginning of the iteration, and then  $y \in P(x)$  at the end of the iteration. Thus, the size of  $\mathcal{P}$  is reduced.

For M2, suppose  $|\mathcal{P}| > 1$ . Since  $G$  is weakly connected, there is an  $x \in V(G)$  with at least one neighbor which is not in  $P(x)$ . So,  $Q(x) = \overline{N}(x) \cap R(x) \neq \emptyset$ . If  $\mathcal{I}(x)$  has a strictly maximal element  $I(x, y)$ , then  $x \rightarrow y$  is marked and the size of  $\mathcal{P}$  is reduced. Otherwise, if  $\mathcal{I}(x)$  has no strictly maximal element, then because  $G$  is  $S$ -thin, there is a  $y \in V(G)$  such that  $I(x, y)$  is maximal and  $y$  has a strictly minimal closed neighborhood. Then  $x \rightarrow y$  is marked, and the size of  $\mathcal{P}$  is reduced.  $\square$

Assuming  $|V(G)| = n$ , determining the closed neighborhood of a vertex by checking the adjacency matrix of  $G$  has complexity  $O(n)$ , and an edge can be marked in constant time (11). The partition can also be constructed in polynomial time (5). The operations of finding intersections of sets, checking set inclusions, and determining maximal subsets can all be done in polynomial time, so all of the operations inside the loops M1 and M2 can be completed in time polynomial in  $n$ . Since the size of  $\mathcal{P}$  is reduced for each iteration of M1 and M2, the time complexity of the entire algorithm is polynomial in  $n$ .

**Lemma 3.5.2.** *Let  $G$  be a weakly connected  $S$ -thin digraph. Then there exists a weakly connected digraph  $H$  defined on the same vertices of  $G$  whose edges are Cartesian and copy consistent with respect to any decomposition of  $G$  as a strong product.*

*Proof.* Let  $H$  be the digraph whose edge set consists of the edges marked in Algorithm 1. Since M2 terminates when  $|\mathcal{P}| = 1$ ,  $H$  is weakly connected.  $H$  is constructed without reference to any particular strong product decomposition of  $G$ , and the decomposition  $G = G_1 \boxtimes G_2$  in Lemma 3.4.1 and Lemma 3.4.2 was arbitrary. Thus, the edges of  $H$  are Cartesian and copy consistent with respect to any decomposition of  $G$  as a strong product.  $\square$

### 3.6 Unique Factorization of $S$ -thin Digraphs

In this section, we show that the strong product factorization of weakly connected, simple directed graphs is unique. We also show that this factorization can be computed in polynomial time.

Suppose digraph  $G$  has the factorization  $G = G_1 \boxtimes G_2 \boxtimes \cdots \boxtimes G_k$ , and let  $H$  be the digraph with  $V(H) = V(G)$  and  $E(H) = \text{MARK}(G)$ . Let  $H_i$  for  $i = 1, \dots, k$  be defined as follows:

$$V(H_i) = V(G_i);$$

$$E(H_i) = \{x_i \rightarrow y_i : (x_1, x_2, \dots, x_k) \rightarrow (y_1, y_2, \dots, y_k) \in E(H)\}.$$

Then  $H = H_1 \square H_2 \square \cdots \square H_k$ . From Feigenbaum, we know that  $H$  has a unique prime factor decomposition with respect to the Cartesian product (8). Let  $H = Q_1 \square Q_2 \square \cdots \square Q_m$  be this decomposition. We use  $\prod^\square$  to denote the Cartesian product. There exist disjoint sets  $I_1, I_2, \dots, I_k$  such that  $\bigcup_{i=1}^k I_i = \{1, 2, \dots, m\}$  and  $H_i = \prod_{j \in I_i}^\square Q_j$ , for  $i = 1, 2, \dots, k$ . We also have  $H_i^x = \left(\prod_{j \in I_i}^\square Q_j\right)^x$ , for all  $x \in V(G)$  and  $i = 1, 2, \dots, k$ , by the unique coordinatization.

**Lemma 3.6.1.** *Let  $G$  be a weakly connected  $S$ -thin digraph, and let  $A \boxtimes B$  and  $C \boxtimes D$  be two decompositions of  $G$ . Then there exists a decomposition  $A_C \boxtimes A_D \boxtimes B_C \boxtimes B_D$  of  $G$  such that  $A = A_C \boxtimes A_D$ ,  $B = B_C \boxtimes B_D$ ,  $C = A_C \boxtimes B_C$ , and  $D = A_D \boxtimes B_D$ .*

*Proof.* Let  $Q_1 \square Q_2 \square \cdots \square Q_k$  be the unique prime factor decomposition of the digraph  $H$  constructed by  $\text{MARK}(G)$ . Let  $I_A \subseteq \{1, 2, \dots, k\}$  with  $V(A) = V\left(\prod_{j \in I_A}^\square Q_j\right)$ , and let  $I_B, I_C$ , and  $I_D$  be defined analogously. Set  $H_{A,C} = \prod_{i \in I_A \cap I_C}^\square Q_i$ , and define  $H_{A,D}, H_{B,C}$ , and  $H_{B,D}$  similarly. Then  $H = H_{A,C} \square H_{A,D} \square H_{B,C} \square H_{B,D}$ . So, from now on, we will use only four coordinates  $(x_1, x_2, x_3, x_4)$  for every vertex  $x \in V(G)$ .

It is possible that not all of the four intersections  $I_A \cap I_C$ ,  $I_A \cap I_D$ ,  $I_B \cap I_C$ , and  $I_B \cap I_D$  are nonempty. Suppose, for example, that  $I_B \cap I_D = \emptyset$ . Then  $I_A \cap I_D \neq \emptyset$  and  $I_B \cap I_C \neq \emptyset$ . If  $I_A \cap I_C = \emptyset$ , then  $I_A = I_D$  and thus,  $I_B = I_C$ . But then there is nothing to prove, so we can assume that all but possibly  $I_B \cap I_D$  are nonempty. Then at least three of the four coordinates are nontrivial, but it is possible that all of the vertices have the same fourth coordinate.

Define  $A_C$  as  $p_1(G)$ , so that  $V(A_C) = V(H_{A,C})$  and  $x_1 \rightarrow y_1 \in E(A_C)$  if there are  $x = (x_1, x_2, x_3, x_4)$  and  $y = (y_1, y_2, y_3, y_4)$  in  $V(G)$  such that  $x \rightarrow y \in E(G)$ . Similarly, define  $A_D = p_2(G)$ ,  $B_C = p_3(G)$ , and  $B_D = p_4(G)$ . If all of the vertices of  $G$  have the same fourth

coordinate, then  $B_D = K_1$ , or in other words,  $B_D$  is the unit graph with respect to strong direct multiplication. For the remainder of the proof, it suffices to show that  $A = A_C \boxtimes A_D$ .

Let  $p_A$  denote the projection of  $G$  onto the vertex set of  $A$ , and define  $p_B$ ,  $p_C$ , and  $p_D$  in the same manner. Thus, we have

$$p_A(x_1, x_2, x_3, x_4) = (x_1, x_2, -, -),$$

$$p_B(x_1, x_2, x_3, x_4) = (-, -, x_3, x_4),$$

$$p_C(x_1, x_2, x_3, x_4) = (x_1, -, x_3, -),$$

$$p_D(x_1, x_2, x_3, x_4) = (-, x_2, -, x_4).$$

To prove  $A = A_C \boxtimes A_D$ , it suffices to show that  $p_A(x) \rightarrow p_A(y) \in E(A)$  if and only if  $p_1(x) \rightarrow p_1(y) \in E(A_C)$  and  $p_2(x) \rightarrow p_2(y) \in E(A_D)$ .

Suppose  $p_A(x) \rightarrow p_A(y) \in E(A)$ . Without loss of generality, we can assume  $x \rightarrow y \in E(G)$ . Then  $p_1(x) \rightarrow p_1(y) \in E(A_C)$  and  $p_2(x) \rightarrow p_2(y) \in E(A_D)$  by the definition of  $A_C$  and  $A_D$ .

For the other direction, suppose  $p_1(x) \rightarrow p_1(y) \in E(A_C)$  and  $p_2(x) \rightarrow p_2(y) \in E(A_D)$ . In other words,

$$(x_1, -, -, -) \rightarrow (y_1, -, -, -) \in E(A_C)$$

and

$$(-, x_2, -, -) \rightarrow (-, y_2, -, -) \in E(A_D).$$

Then there are vertices  $x' = (x_1, a'_2, a'_3, a'_4)$ ,  $y' = (y_1, b'_2, b'_3, b'_4)$ ,  $x'' = (a''_1, x_2, a''_3, a''_4)$ , and  $y'' = (b''_1, x_2, b''_3, b''_4)$  in  $G$  with  $x' \rightarrow y'$  and  $x'' \rightarrow y''$  in  $E(G)$ .

Thus,  $(x_1, -, a'_3, -) \rightarrow (y_1, -, b'_3, -) \in E(C)$  and  $(-, x_2, -, a''_4) \rightarrow (-, y_2, -, b''_4) \in E(D)$ . Since  $G = C \boxtimes D$ , we have  $(x_1, x_2, a'_3, a''_4) \rightarrow (y_1, y_2, b'_3, b''_4) \in E(G)$ . Therefore,  $(x_1, x_2, -, -) \rightarrow (y_1, y_2, -, -) \in E(A)$ , so  $p_A(x) \rightarrow p_A(y) \in E(A)$ .  $\square$

The decomposition  $A_C \boxtimes A_D \boxtimes B_C \boxtimes B_D$  in Lemma 3.6.1 is called a *common refinement* of the products  $A \boxtimes B$  and  $C \boxtimes D$ . We say the digraph  $G$  satisfies the *refinement property* if any two such factorizations of  $G$  have a common refinement.

**Lemma 3.6.2.** *Every weakly connected,  $S$ -thin digraph  $G$  has a unique prime factor decomposition with respect to the strong product.*

*Proof.* We proceed by induction on the number of vertices of  $G$ ,  $n = |V(G)|$ . For  $n = 1$ , clearly  $G$  has a UPFD. Suppose Lemma 3.6.2 holds for all digraphs with fewer than  $n$  vertices. Let  $G_1 \boxtimes G_2 \boxtimes \cdots \boxtimes G_r = Q_1 \boxtimes Q_2 \boxtimes \cdots \boxtimes Q_s$  be two prime factorizations of  $G$ . Then there exist digraphs  $B$  and  $D$  such that  $G \cong G_1 \boxtimes B \cong Q_1 \boxtimes D$ .

By Lemma 3.6.1, taking  $A \cong G_1$  and  $C \cong Q_1$ , we have  $G \cong A_C \boxtimes A_D \boxtimes B_C \boxtimes B_D$ , with  $G_1 \cong A_C \boxtimes A_D$ ,  $B \cong B_C \boxtimes B_D$ ,  $Q_1 \cong A_C \boxtimes B_C$ , and  $D \cong A_D \boxtimes B_D$ . Since  $G_1$  is prime, either  $G_1 \cong A_C$  or  $G_1 \cong A_D$ . First suppose  $G_1 \cong A_C$ . Then  $A_D \cong K_1$  and  $D \cong B_D$ . Since  $A_C$  is nontrivial and  $Q_1$  is prime,  $Q_1 \cong A_C \cong G_1$  and  $B_C \cong K_1$ . Then  $B \cong B_C \boxtimes B_D \cong B_D$ , so  $B \cong D$ . By the induction hypothesis, both  $B$  and  $D$  have unique prime factorizations, so  $r = s$  and  $G_i \cong Q_i$  for  $2 \leq i \leq r$ .

Now suppose  $G_1 \cong A_D$ . Then since  $G_1$  is prime,  $A_C \cong K_1$ , and thus,  $Q_1 \cong B_C$ . Also,

$$G_2 \boxtimes G_3 \boxtimes \cdots \boxtimes G_r \cong B \cong B_C \boxtimes B_D \cong Q_1 \boxtimes B_D$$

and

$$Q_2 \boxtimes Q_3 \boxtimes \cdots \boxtimes Q_s \cong D \cong A_D \boxtimes B_D \cong G_1 \boxtimes B_D.$$

By the induction hypothesis, both  $B$  and  $D$  have UPFD's, so without loss of generality, assume  $Q_1 \cong G_2$ . Then  $B_D \cong G_3 \boxtimes \cdots \boxtimes G_r$ , so  $D \cong G_1 \boxtimes B_D \cong G_1 \boxtimes G_3 \boxtimes \cdots \boxtimes G_r$ . Thus,

$$G \cong G_1 \boxtimes B \cong G_1 \boxtimes Q_1 \boxtimes B_D \cong Q_1 \boxtimes G_1 \boxtimes B_D \cong Q_1 \boxtimes D \cong G_2 \boxtimes D \cong G.$$

Therefore,  $G$  has a unique prime factor decomposition. □

**Lemma 3.6.3.** *The prime factor decomposition of weakly connected,  $S$ -thin digraphs with respect to the strong product can be found in polynomial time.*

*Proof.* Let  $G$  be a weakly connected  $S$ -thin digraph. The Cartesian skeleton  $H$  of  $G$  can be found in polynomial time using Algorithm 1. Also, the UPFD of  $H$ ,  $H_1 \square H_2 \square \cdots \square H_k$ ,

can be found in polynomial time using the Cartesian factorization for digraphs presented by Feigenbaum (8).

Let  $G = G_1 \boxtimes G_2 \boxtimes \cdots \boxtimes G_r$  be the UPFD of  $G$ . There exists a partition  $I_1, I_2, \dots, I_r$  of  $I = \{1, 2, \dots, k\}$  such that  $V(G_i^x) = V\left(\left(\prod_{j \in I_i}^\square H_j\right)^x\right)$  for all  $x \in V(G)$  and for  $1 \leq i \leq r$ . To find the partition, let  $J$  be any subset of  $I$ . Define digraphs  $A$  and  $B$  by the projections  $p_J(G)$  and  $p_{I \setminus J}(G)$  onto the vertex sets  $V\left(\prod_{i \in J}^\square H_i\right)$  and  $V\left(\prod_{i \in I \setminus J}^\square H_i\right)$ . If  $J = I_i$  for some  $i$  or if  $J$  is the union of some of the  $I_i$ 's, then  $G = A \boxtimes B$ . In general, since  $E(G) \subseteq E(A \boxtimes B)$ ,  $G = A \boxtimes B$  if and only if  $|E(G)| = |E(A \boxtimes B)|$ .

$H_i$  is nontrivial for all  $i$ , so  $k \leq \log_2 n$ . Therefore,  $I$  has at most  $2^{\log_2 n} = n$  subsets. Construction of  $A$  and  $B$  has complexity  $O(m \log n)$ , where  $m = |E(G)|$ . Thus, we can find a minimal subset  $J$  of  $I$  such that  $G = A \boxtimes B$  in polynomial time. Then  $A = G_i$  for some  $i$ , and  $B = \prod_{\substack{1 \leq j \leq r \\ j \neq i}} G_j$ . Repeating this procedure at most  $\log n$  times decomposes  $G$  into its prime factors. □

### 3.7 Factoring Weakly Connected Digraphs

Once we have the factorization of  $G/S$ , the factorization of  $G$  can be retrieved by examining the sizes of the equivalence classes of the factors of  $G/S$ .

**Lemma 3.7.1.** *Suppose a digraph  $G$  with no complete factors is a strong product graph  $G = G_1 \boxtimes G_2$ , and suppose the decomposition  $G/S = G_1/S \boxtimes G_2/S$  is known. Then  $G_1$  and  $G_2$  can be determined in polynomial time.*

*Proof.* Let  $x = (x_1, x_2) \in G_1/S \times G_2/S$ , and let  $|\overline{(x_1, x_2)}|$  be the size of the  $S$ -equivalence class of  $G$  that is mapped into  $x$  in  $V(G_1/S \boxtimes G_2/S)$ . Let  $|\overline{x_1}|$  be the size of the  $S$ -equivalence class of  $G_1$  that is mapped into  $x_1$  in  $V(G_1/S)$ , and  $|\overline{x_2}|$  be the size of the  $S$ -equivalence class of  $G_2$  that is mapped into  $x_2$  in  $V(G_2/S)$ . Then  $|\overline{(x_1, x_2)}| = |\overline{x_1}| \cdot |\overline{x_2}|$ . Since  $G$  is not  $\boxtimes$ -divisible by  $K_k$  for any  $k > 1$ ,  $\gcd\{|\overline{y}| : y \in V(G_2/S)\} = 1$ . Thus,

$$|\overline{x_1}| = \gcd\{|\overline{x_1}| \cdot |\overline{y}| : y \in V(G_2/S)\} = \gcd\left\{|\overline{(x_1, y)}| : y \in V(G_2/S)\right\}.$$

Similarly,

$$|\overline{x_2}| = \gcd\{|\overline{y}| \cdot |\overline{x_2}| : y \in V(G_1/S)\} = \gcd\left\{\left|\overline{(y, x_2)}\right| : y \in V(G_1/S)\right\}.$$

To determine  $G_1$ , replace each vertex  $x_1 \in V(G_1/S)$  with the complete graph  $K_{|\overline{x_1}|}$ . Note that if  $|\overline{x_1}| = 1$ , then the vertex  $x_1$  remains unchanged. Then if  $x_1 \rightarrow y$  or  $y \rightarrow x_1$  in  $G_1/S$ , add the corresponding edges  $z \rightarrow y$  or  $y \rightarrow z$  for all  $z \in K_{|\overline{x_1}|}$ . When this procedure is completed, the resulting digraph will be  $G_1$ . In the same manner,  $G_2$  can be determined.

To see that  $G_1$  and  $G_2$  can be determined in polynomial time, first note that the greatest common divisor of a set of size  $n$  can be computed in time polynomial in  $\log n$  (5). Then  $|\overline{x_1}|$  can be computed in time polynomial in  $\log |G_2/S|$ . Since  $|G_2/S| \leq |G_2|$ , clearly,  $|\overline{x_1}|$  can be computed in time polynomial in  $n = |V(G)|$ . The same holds for  $|\overline{x_2}|$ . Edges can be inserted in constant time (11). Thus, the digraphs  $G_1$  and  $G_2$  can be determined in polynomial time.  $\square$

**Lemma 3.7.2.** *Let  $G$  be a weakly connected digraph with no complete factors. Then  $G$  satisfies the refinement property. In other words, if  $A \boxtimes B$  and  $C \boxtimes D$  are two decompositions of  $G$  with respect to the strong product, for which  $A/S \boxtimes B/S$  and  $C/S \boxtimes D/S$  are distinct decompositions of  $G/S$ , then there exists a decomposition  $G = A_C \boxtimes A_D \boxtimes B_C \boxtimes B_D$  such that  $A = A_C \boxtimes A_D$ ,  $B = B_C \boxtimes B_D$ ,  $C = A_C \boxtimes B_C$ , and  $D = A_D \boxtimes B_D$ .*

*Proof.* By Lemma 3.6.1,  $G/S$  satisfies the refinement property, so  $A/S \boxtimes B/S$  and  $C/S \boxtimes D/S$  have a common refinement. Suppose  $A'_C \boxtimes A'_D \boxtimes B'_C \boxtimes B'_D$  is this refinement, where  $A/S = A'_C \boxtimes A'_D$ ,  $B/S = B'_C \boxtimes B'_D$ ,  $C/S = A'_C \boxtimes B'_C$ , and  $D/S = A'_D \boxtimes B'_D$ . Let  $(x, y, u, v)$  be the coordinatization corresponding to this decomposition. Then there exist functions  $a(x, y)$ ,  $b(u, v)$ ,  $c(x, u)$ , and  $d(y, v)$ , where  $a(x, y)$  is the size of the  $S$ -class of  $A$  mapped into the vertex  $(x, y) \in V(A/S)$ , and the other functions are defined in a similar manner.

We have  $a(x, y)b(u, v) = c(x, u)d(y, v)$ . We need to show there exist functions  $a_1(x)$ ,  $a_2(y)$ ,  $b_1(u)$ , and  $b_2(v)$  such that  $a(x, y) = a_1(x)a_2(y)$ ,  $b(u, v) = b_1(u)b_2(v)$ ,  $c(x, u) = a_1(x)b_1(u)$ , and  $d(y, v) = a_2(y)b_2(v)$ . Also, we need to show that  $\gcd\{a_1(x) : x \in V(A'_C)\} = 1$  and that analogous properties hold for  $a_2$ ,  $b_1$ , and  $b_2$ .

Since  $a(x, y)b(u, v) = c(x, u)d(y, v)$ , we have  $\frac{a(x, y)}{d(y, v)} = \frac{c(x, u)}{b(u, v)}$ , and both sides depend only on  $x$  and  $v$ . Then  $\frac{a(x, y)}{d(y, v)} = \frac{a(x, y_0)}{d(y_0, v)}$ , and thus,  $\frac{a(x, y)}{a(x, y_0)} = \frac{d(y, v)}{d(y_0, v)}$ . Note that both fractions depend only on  $y$  and  $y_0$ , so there is a function  $f(y, y_0) = \frac{d(y, v)}{d(y_0, v)}$  such that  $a(x, y) = a(x, y_0)f(y, y_0)$ . Since  $y_0$  was arbitrarily fixed, we can write  $a(x, y) = a_1(x)a_2(y)$ . In a similar manner, the functions  $b$ ,  $c$ , and  $d$  can be decomposed. Then

$$a_1(x)a_2(y)b_1(u)b_2(v) = c_1(x)c_2(u)d_1(y)d_2(v),$$

so there exist constants  $k_1, k_2, k_3, k_4$  such that  $k_1a_1(x) = c_1(x)$ ,  $k_2a_2(y) = d_1(y)$ ,  $k_3b_1(u) = c_2(u)$ ,  $k_4b_2(v) = d_2(v)$ , and  $k_1k_2k_3k_4 = 1$ .

Clearly,  $a_i, b_i, c_i, d_i$ ,  $i = 1, 2$ , can be chosen to be rational functions, but we would like them to be integer functions. Consider

$$\frac{\text{numerator}(a_1(x))}{\text{denominator}(a_1(x))} \cdot \frac{\text{numerator}(a_2(y))}{\text{denominator}(a_2(y))} = a_1(x) \cdot a_2(y) = a(x, y).$$

Assuming all fractions to be in lowest terms, since  $a(x, y)$  is an integer, the denominator of  $a_1(x)$  divides the numerator of  $a_2(y)$ , and the denominator of  $a_2(y)$  divides the numerator of  $a_1(x)$ . This is true for arbitrary  $x$  and  $y$ . Let  $n_1$  be the least common multiple of  $\{\text{denominator}(a_1(x))\}$  and  $n_2$  the least common multiple of  $\{\text{denominator}(a_2(y))\}$ . Then  $n_1$  divides the numerator of every  $a_2(y)$ , and  $n_2$  divides the numerator of every  $a_1(x)$ . So, we can write  $a_1(x) = \frac{a'_1(x)}{n_1}$  and  $a_2(y) = \frac{a'_2(y)}{n_2}$ . Then

$$\frac{a'_1(x)}{n_1} \cdot \frac{a'_2(y)}{n_2} = \frac{a'_1(x)}{n_2} \cdot \frac{a'_2(y)}{n_1} = a(x, y).$$

Replacing  $a_1(x)$  by  $\frac{a'_1(x)}{n_2}$  and  $a_2(y)$  by  $\frac{a'_2(y)}{n_1}$ , we have an integer factorization of  $a(x, y)$ . The same procedure can be done for the functions  $b, c$ , and  $d$ . Then  $k_i = 1$  for  $i = 1, 2, 3, 4$ .

Now consider the greatest common divisor. If  $\gcd\{a_1(x) : x \in V(A'_C)\} \neq 1$ , then  $\gcd\{(x, y) : (x, y) \in V(A)\} \neq 1$ , which implies that  $A$  has a complete factor. But  $A$  has no complete factors, so it must be the case that  $\gcd\{a_1(x) : x \in V(A'_C)\} = 1$ . A similar argument holds for  $a_2$ ,  $b_1$ , and  $b_2$ .  $\square$

We are now ready for the main result.



**Theorem 3.7.3.** *Let  $G$  be a weakly connected digraph. Then  $G$  has a unique prime factor decomposition with respect to the strong product. Moreover, this decomposition can be determined in polynomial time.*

*Proof.* Let  $G$  be a finite, weakly connected digraph. In Section 3.3, we showed how to find the largest complete factor  $K_k$  of  $G$ . This complete graph can be factored in time polynomial in  $k$  by finding the prime factorization  $p_1 p_2 \cdots p_t$  of  $k$ . Then we can express  $G$  as the product  $G = Q \boxtimes K_{p_1} \boxtimes K_{p_2} \boxtimes \cdots \boxtimes K_{p_t}$ , where the digraph  $Q$  has no complete factors. By Lemma 3.3.5,  $Q$  is uniquely determined.

It remains to be shown that such a digraph  $Q$  has a unique prime factorization. Suppose  $G_1 \boxtimes G_2 \boxtimes \cdots \boxtimes G_r$  is a prime factorization of  $Q$ . By Lemma 3.6.2,  $Q/S$  has a UPFD, so let  $Q/S = Q_1 \boxtimes Q_2 \boxtimes \cdots \boxtimes Q_k$  be this unique prime factorization. Then there is a partition  $\mathcal{I} = \{I_1, I_2, \dots, I_r\}$  of the index set  $I = \{1, 2, \dots, k\}$  such that  $G_i/S = \prod_{j \in I_i} Q_j$ .

Suppose  $G'_1 \boxtimes G'_2 \boxtimes \cdots \boxtimes G'_s$  is another prime factorization of  $Q$ . Similarly, there is a partition  $\mathcal{I}' = \{I'_1, I'_2, \dots, I'_s\}$  of  $I$  such that  $G'_i/S = \prod_{j \in I'_i} Q_j$ . If  $\mathcal{I}' \neq \mathcal{I}$ , then by Lemma 3.7.2 there would be a refinement of the product. Since all of the  $G_i$  and  $G'_i$  factors are prime, that is not possible. Thus, the prime factorization of  $Q$  is unique.

Now consider the complexity of finding the unique prime factor decomposition of  $G$ . The factorization is found by completing the following steps:

1. Determine  $S$  and  $G/S$ .
2. Write  $G$  as the product  $Q \boxtimes K_{p_1} \boxtimes K_{p_2} \boxtimes \cdots \boxtimes K_{p_t}$ , where  $Q$  has no complete factors.
3. Construct the Cartesian skeleton  $H$  of  $Q/S$  using Algorithm 1.
4. Factor  $H$  with respect to the Cartesian product.
5. Determine the prime factors of  $Q/S$ .
6. Determine the prime factors of  $Q$ .

Step 1 has complexity  $O(n^3)$  by Lemma 3.2.1. The second step was shown to have polynomial complexity in Section 3.3. By Lemma 3.6.3, steps 3-5 can be completed in polynomial

time. Finally, the last step can be completed by repeated applications of Lemma 3.7.1. To get the prime factors of  $Q$ , find all minimal subsets  $J$  of  $I = \{1, 2, \dots, k\}$  such that there are graphs  $A$  and  $B$  with  $G = A \boxtimes B$ ,  $A/S = \prod_{i \in J} Q_i$ , and  $B/S = \prod_{i \in I \setminus J} Q_i$ . Since  $J$  is minimal, by the refinement of Lemma 3.7.2,  $A$  must be prime.  $\square$

### 3.8 An Example

In this section, we present an example to visualize how the factoring algorithm works. Consider the digraph  $G$  in Figure 3.1. Note that  $G$  is  $S$ -thin and has no complete factors, so we begin by constructing the Cartesian skeleton  $H$  using Algorithm 1.

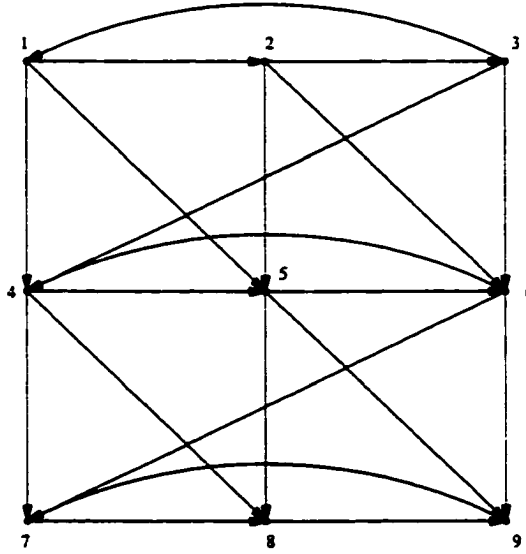


Figure 3.1 The digraph  $G$

We first determine the closed neighborhood of each vertex:

$$\begin{array}{lll}
 \overline{N}(1) = \{1, 2, 4, 5\} & \overline{N}(2) = \{2, 3, 5, 6\} & \overline{N}(3) = \{1, 3, 4, 6\} \\
 \overline{N}(4) = \{4, 5, 7, 8\} & \overline{N}(5) = \{5, 6, 8, 9\} & \overline{N}(6) = \{4, 6, 7, 9\} \\
 \overline{N}(7) = \{7, 8\} & \overline{N}(8) = \{8, 9\} & \overline{N}(9) = \{7, 9\}
 \end{array}$$

The partition  $\mathcal{P}$  is initialized as  $\{\{1\}, \{2\}, \{3\}, \{4\}, \{5\}, \{6\}, \{7\}, \{8\}, \{9\}\}$ , and the sets  $S(x)$  are constructed for each vertex  $x$ :

$$S(1) = S(2) = S(3) = S(7) = S(8) = S(9) = \emptyset$$

$$S(4) = \{7\} \quad S(5) = \{8\} \quad S(6) = \{9\}$$

In loop M1, the only nonempty sets  $\mathcal{J}(x)$  are  $\mathcal{J}(4) = \{\overline{N}(7)\}$ ,  $\mathcal{J}(5) = \{\overline{N}(8)\}$ , and  $\mathcal{J}(6) = \{\overline{N}(9)\}$ . So, the edges  $4 \rightarrow 7$ ,  $5 \rightarrow 8$ , and  $6 \rightarrow 9$  are marked. At the end of M1,  $\mathcal{P} = \{\{1\}, \{2\}, \{3\}, \{4, 7\}, \{5, 8\}, \{6, 9\}\}$ .

In loop M2, the sets  $Q(x)$  are constructed for each vertex  $x$ :

$$Q(1) = \{2, 4, 5\} \quad Q(2) = \{3, 5, 6\} \quad Q(3) = \{1, 4, 6\}$$

$$Q(4) = \{5, 8\} \quad Q(5) = \{6, 9\} \quad Q(6) = \{4, 7\}$$

$$Q(7) = \{8\} \quad Q(8) = \{9\} \quad Q(9) = \{7\}$$

The sets  $I(x, y)$  are also determined for each  $y \in Q(x)$ :

$$I(1, 2) = \{2, 5\} \quad I(1, 4) = \{4, 5\} \quad I(1, 5) = \{5\}$$

$$I(2, 3) = \{3, 6\} \quad I(2, 5) = \{5, 6\} \quad I(2, 6) = \{6\}$$

$$I(3, 1) = \{1, 4\} \quad I(3, 4) = \{4\} \quad I(3, 6) = \{4, 6\}$$

$$I(4, 5) = \{5, 8\} \quad I(4, 8) = \{8\} \quad I(5, 6) = \{6, 9\}$$

$$I(5, 9) = \{9\} \quad I(6, 4) = \{4, 7\} \quad I(6, 7) = \{7\}$$

$$I(7, 8) = \{8\} \quad I(8, 9) = \{9\} \quad I(9, 7) = \{7\}$$

Then by strict maximality, the following edges are marked:  $1 \rightarrow 2$ ,  $1 \rightarrow 4$ ,  $2 \rightarrow 3$ ,  $2 \rightarrow 5$ ,  $3 \rightarrow 1$ ,  $3 \rightarrow 6$ ,  $4 \rightarrow 5$ ,  $5 \rightarrow 6$ ,  $6 \rightarrow 4$ ,  $7 \rightarrow 8$ ,  $8 \rightarrow 9$ , and  $9 \rightarrow 7$ . At the end of the first iteration,  $\mathcal{P} = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ , so loop M2 is terminated.

Figure 3.2 shows the digraph  $H = \text{MARK}(G)$ . The solid edges were marked in loop M1 of the algorithm, and the dashed edges were marked in loop M2. Note that all of the edges are Cartesian and that  $H$  is a subdigraph of  $G$ .

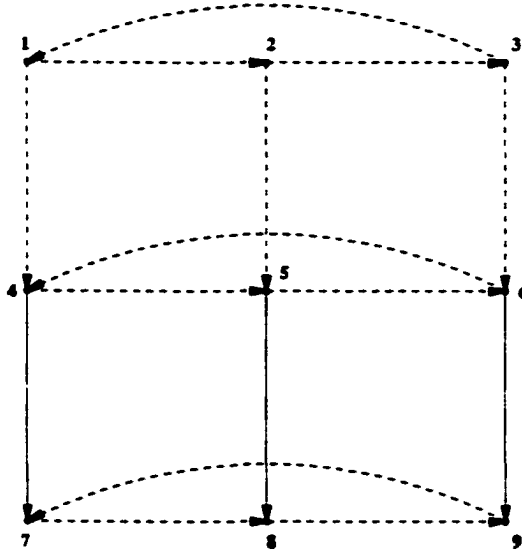
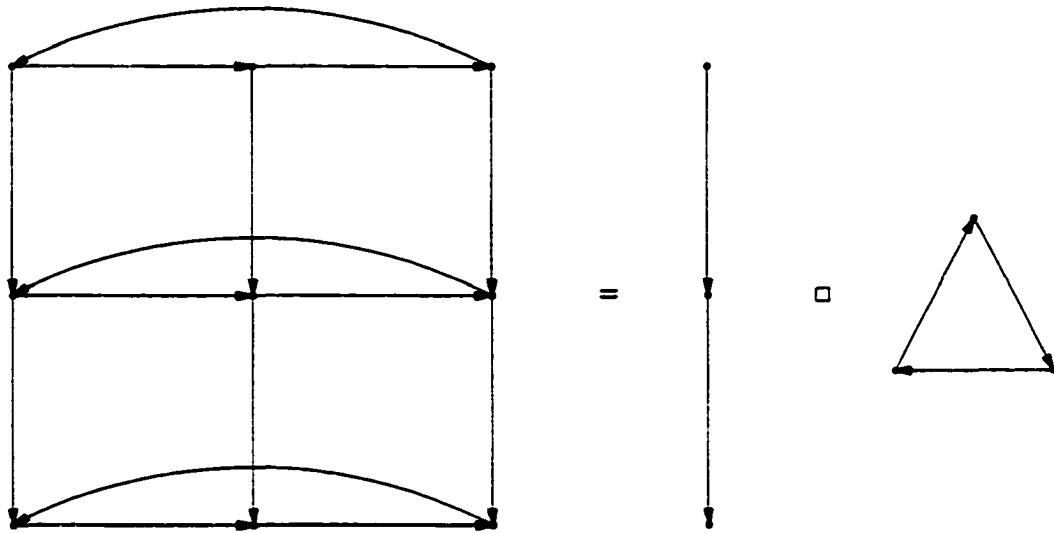
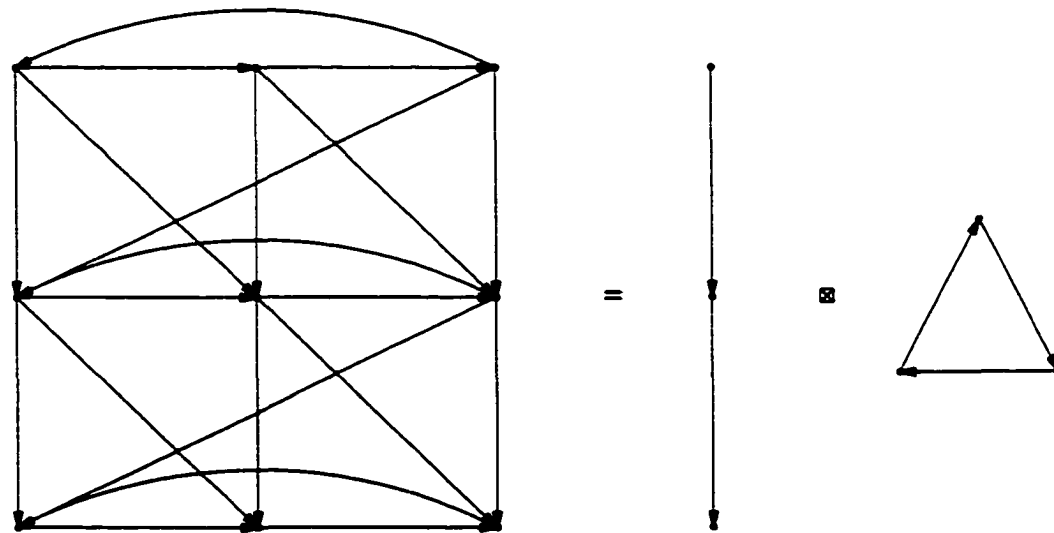


Figure 3.2 The digraph  $H = \text{MARK}(G)$

The digraph  $H$  is then factored with respect to the Cartesian product. Figure 3.3 shows this factorization. We can then retrieve the strong factorization of  $G$ , seen in Figure 3.4. In this example, the factors of  $H$  and  $G$  are exactly the same. This might not happen in general because a factor of  $G$  could be prime with respect to the strong product but reducible under the Cartesian product. In that case, two or more of the Cartesian factors of  $H$  will be combined into one factor of  $G$ . More generally,  $G$  itself could be prime with respect to the strong product even if  $H$  is reducible under the Cartesian product.

Figure 3.3 The Cartesian factorization of  $H$ Figure 3.4 The strong factorization of  $G$

## CHAPTER 4. THE CONGRUENCE EXTENSION PROPERTY

In this chapter, we consider the complexity of the problem of determining whether a finite algebra  $A$  of finite similarity type has the congruence extension property. Recall that the problem CEP is defined as follows:

$$\text{CEP} = \{A : A \text{ has the congruence extension property}\}.$$

Given an algebra  $A$ , the problem is to determine whether  $A \in \text{CEP}$ . We prove that CEP is complete for polynomial time.

**Definition 4.0.1.** An algebra  $A$  has the *congruence extension property* if for all  $B \leq A$  and for all  $\theta \in \text{Con}(B)$ , there exists a  $\bar{\theta} \in \text{Con}(A)$  such that  $\bar{\theta} \upharpoonright_B = \theta$ , where  $\bar{\theta} \upharpoonright_B := \bar{\theta} \cap B^2$ .

For groups, there is a one-to-one correspondence between congruences and normal subgroups. Let  $G$  be a group with a normal subgroup  $N$ . Then  $\theta_N = \{(a, b) \in G^2 : aN = bN\}$  is a congruence on  $G$ . Conversely, if  $\theta$  is a congruence on  $G$ , then  $N_\theta = e/\theta = \{g \in G : (g, e) \in \theta\}$  is a normal subgroup of  $G$ , where  $e$  is the identity of the group. Thus, for groups we can express the congruence extension property in terms of normal subgroups: A group  $G$  has the congruence extension property if for all  $H \leq G$  and for all  $N \trianglelefteq H$ , there exists an  $\bar{N} \trianglelefteq G$  such that  $\bar{N} \cap H = N$ .

For example, suppose  $G$  is an Abelian group, and let  $H \leq G$ . Then since  $G$  is Abelian,  $H \trianglelefteq G$ . Let  $N \trianglelefteq H$ . Then  $N \leq G$ , and since  $G$  is Abelian,  $N \trianglelefteq G$ . Take  $\bar{N} = N$ , and clearly,  $\bar{N} \cap H = N$ . Therefore, all Abelian groups have the congruence extension property. Also note that an algebra with no proper subalgebras trivially has the congruence extension property.

Perhaps the easiest example of an algebra which does not have the congruence extension property is a simple algebra  $A$  with a nonsimple subalgebra  $B$ . As a specific example, the group

$A_5$  of even permutations on five letters is simple, but the subgroup  $B$  of  $A_5$  with subuniverse  $B = \{(12)(34), (13)(25), (14)(35), (15)(24), (23)(45), (14325), (15234), (12453), (13524), (1)\}$  has a normal subgroup  $N$  with  $N = \{(14325), (15234), (12453), (13524), (1)\}$ . Therefore,  $A_5$  does not have the congruence extension property.

There are known complexity results for many algorithmic problems in algebra. In proving that the problem CEP is complete for polynomial time, we make use of two of these results. Define GEN-SUBALG to be the following problem:

$$\text{GEN-SUBALG} = \{\langle A, X, a \rangle : X \subseteq A, a \in A, \text{ and } a \in \text{Sg}^A(X)\}.$$

In (12) Jones and Laaser proved that GEN-SUBALG is complete for  $P$ .

Define the problem GEN-CON as follows:

$$\text{GEN-CON} = \{\langle A, \theta, a, b \rangle : a, b \in A, \theta \subseteq A^2, \text{ and } (a, b) \in \text{Cg}^A(\theta)\}.$$

In (3) Bergman and Slutzki proved that GEN-CON is complete for nondeterministic log-space. Recall from Chapter 2 that  $NL \subseteq P$ .

Our proof that CEP is in  $P$  uses a corollary to a theorem from Alan Day (6). Before stating the theorem, we need one more definition. An algebra  $A$  has the *principal congruence extension property* if for any subalgebra  $B \leq A$ , every principal congruence on  $B$  is the restriction of some congruence on  $A$ . We state Day's Theorem in terms of a single algebra, but note that it holds for an equational class.

**Day's Theorem.** *For an algebra  $A$ , the following are equivalent:*

1.  *$A$  satisfies the congruence extension property.*
2.  *$A$  satisfies the principal congruence extension property.*
3. *For all  $B \leq A$  and all  $a, b \in B$ ,  $\text{Cg}^B(a, b) = \text{Cg}^A(a, b) \upharpoonright_B$ .*

**Corollary 4.0.2.**  *$A$  satisfies the congruence extension property if and only if for all  $a, b, c, d \in A$ ,  $(c, d) \in \text{Cg}^A(a, b)$  iff  $(c, d) \in \text{Cg}^B(a, b)$ , where  $B$  is the subalgebra of  $A$  generated by  $\{a, b, c, d\}$ .*

*Proof.* We will show that the third condition of Day's Theorem is equivalent to the condition

$$\forall a, b, c, d \in A, (c, d) \in \text{Cg}^{\mathbf{A}}(a, b) \text{ iff } (c, d) \in \text{Cg}^{\mathbf{B}}(a, b). \quad (4.1)$$

Let  $a, b, c, d \in A$ . Define  $\mathbf{B}$  as the subalgebra of  $\mathbf{A}$  generated by  $\{a, b, c, d\}$ . Then since  $a, b \in B$  and  $\mathbf{B} \leq \mathbf{A}$ , by the third condition of Day's Theorem, we have  $\text{Cg}^{\mathbf{B}}(a, b) = \text{Cg}^{\mathbf{A}}(a, b) \upharpoonright_B$ . So,  $(c, d) \in \text{Cg}^{\mathbf{B}}(a, b)$  if and only if  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b) \upharpoonright_B$ . Since  $c, d \in B$ ,  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b) \upharpoonright_B$  if and only if  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b)$ . Therefore,  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b)$  if and only if  $(c, d) \in \text{Cg}^{\mathbf{B}}(a, b)$ .

For the other direction, suppose  $\mathbf{B} \leq \mathbf{A}$ , and let  $a, b \in B$ . Then we have  $\text{Cg}^{\mathbf{B}}(a, b) \subseteq \text{Cg}^{\mathbf{A}}(a, b) \upharpoonright_B$ , and we need to show the opposite inclusion. Suppose  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b) \upharpoonright_B$ . Then  $c$  and  $d$  must be elements of  $B$ . By (4.1),  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b)$  if and only if  $(c, d) \in \text{Cg}^{\mathbf{C}}(a, b)$ , where  $C = \text{Sg}^{\mathbf{A}}(a, b, c, d)$ . Since  $a, b, c, d \in B$ , we have  $\text{Sg}^{\mathbf{B}}(a, b, c, d) = \text{Sg}^{\mathbf{A}}(a, b, c, d) = C$ . Again by (4.1), we have  $(c, d) \in \text{Cg}^{\mathbf{B}}(a, b)$  if and only if  $(c, d) \in \text{Cg}^{\mathbf{C}}(a, b)$ . Also,  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b)$  if and only if  $(c, d) \in \text{Cg}^{\mathbf{A}}(a, b) \upharpoonright_B$  because  $c$  and  $d$  are elements of  $B$ . Thus,  $(c, d) \in \text{Cg}^{\mathbf{B}}(a, b)$ , so  $\text{Cg}^{\mathbf{A}}(a, b) \upharpoonright_B \subseteq \text{Cg}^{\mathbf{B}}(a, b)$ .  $\square$

**Theorem 4.0.3.**  $\text{CEP} \in \mathbf{P}$ .

*Proof.* From Corollary 4.0.2 we have the following equivalence:

$$\mathbf{A} \text{ has CEP iff for all } a, b, c, d \in A, (c, d) \in \text{Cg}^{\mathbf{B}}(a, b) \Leftrightarrow (c, d) \in \text{Cg}^{\mathbf{A}}(a, b),$$

where  $B = \text{Sg}^{\mathbf{A}}\{a, b, c, d\}$ . We present an algorithm to check this condition. Assume that  $\mathbf{A} = \langle A, F \rangle$ , with  $A = \{a_1, \dots, a_n\}$ .

**Algorithm 2.**  $\text{CEP}(\mathbf{A})$

$n \leftarrow |A|, B \leftarrow \emptyset$

for all  $(a_i, a_j, a_k, a_l) \in A^4$  do

for  $m = 1$  to  $n$  do

If  $\langle \mathbf{A}, (a_i, a_j, a_k, a_l), a_m \rangle \in \text{GEN-SUBALG}$ , then  $B \leftarrow B \cup \{a_m\}$ .

od

$\mathbf{B} \leftarrow \langle B, F \upharpoonright_B \rangle$

If  $\langle \mathbf{A}, (a_i, a_j), a_k, a_l \rangle \in \text{GEN-CON} \oplus \langle \mathbf{B}, (a_i, a_j), a_k, a_l \rangle \in \text{GEN-CON} = 1$ , then reject.



od

Accept

The symbol  $\oplus$  represents the exclusive or operation, so  $x \oplus y = 1$  if the truth value of  $x$  is not equal to the truth value of  $y$ . For all such quadruples  $\{a, b, c, d\} \subseteq A$ ,  $B$  is generated in polynomial time by checking whether  $\langle A, \{a, b, c, d\}, x \rangle \in \text{GEN-SUBALG}$  for all elements  $x \in A$ . The  $\Leftrightarrow$  equivalence is checked in nondeterministic log-space using GEN-CON with  $\theta = \{(a, b)\}$ .  $\square$

**Theorem 4.0.4.** *CEP is complete for P.*

*Proof.* To show that CEP is P-hard, we shall give a log-space reduction of GEN-SUBALG to CEP.

Let  $\langle A, X, a \rangle$  be an instance of GEN-SUBALG, where  $A = \langle A, F \rangle$ . If  $X = \emptyset$  and  $A$  has no nullary operations, then let  $A' = A_5$ . Otherwise, construct  $A'$  in the following manner.

Assuming that  $A \cap \{0, 1\} = \emptyset$ , let  $A' = A \cup \{0, 1\}$  be the universe of  $A'$ . Note that if  $A \cap \{0, 1\} \neq \emptyset$ , then we can replace 0 and 1 with two symbols which are not in  $A$ . For all  $b \in A \cup \{1\}$ , define an operation  $g_b$  as follows:

$$g_b(x) = \begin{cases} b & \text{if } x = a \\ x & \text{otherwise.} \end{cases}$$

If  $X \neq \emptyset$ , then there exists  $c_1 \in X$ . On the other hand, if  $X = \emptyset$ , then  $A$  has a nullary operation, say  $c_1$ . In both cases, define

$$h(x, y) = \begin{cases} c_1 & \text{if } x = 1 \text{ and } y = a \\ 0 & \text{otherwise.} \end{cases}$$

Now let  $A' = \langle A \cup \{0, 1\}, F \cup \{g_b : b \in A \cup \{1\}\} \cup \{h\} \cup \{c_i : c_i \in X\} \rangle$ , where the  $c_i$ 's are constant operations and for all  $f \in F$ ,  $f(x_1, \dots, x_k) = 0$  if  $\{x_1, \dots, x_k\} \cap \{0, 1\} \neq \emptyset$ .

For completeness, we need to check that  $\langle A, X, a \rangle \in \text{GEN-SUBALG} \Leftrightarrow A' \in \text{CEP}$ . Consider first the case where  $X = \emptyset$  and  $A$  has no nullary operations. Then clearly  $a \notin \text{Sg}^A(X) = \emptyset$ . Since  $A' = A_5$ ,  $A' \notin \text{CEP}$ , and the above equivalence holds.

For the remaining cases, we first show that  $\langle \mathbf{A}, X, a \rangle \in \text{GEN-SUBALG} \Rightarrow \mathbf{A}' \in \text{CEP}$ . Suppose  $\langle \mathbf{A}, X, a \rangle \in \text{GEN-SUBALG}$ , i.e.,  $a \in \text{Sg}^{\mathbf{A}}(X)$ . Let  $\mathbf{C} = \langle A, F \cup \{g_b : b \in A\} \rangle$ . If  $a \in \text{Sg}^{\mathbf{A}}(X)$  then  $a \in \text{Sg}^{\mathbf{C}}(X)$ , since  $\mathbf{C}$  is an expansion of  $\mathbf{A}$ . For every element  $b \in A$ ,  $b = g_b(a) \in \text{Sg}^{\mathbf{C}}(a)$ , and since  $a \in \text{Sg}^{\mathbf{C}}(X)$ , we have  $\text{Sg}^{\mathbf{C}}(a) \subseteq \text{Sg}^{\mathbf{C}}(X)$ . So,  $A \subseteq \text{Sg}^{\mathbf{C}}(X)$ . We also have  $\text{Sg}^{\mathbf{C}}(X) \subseteq A$ , since  $A$  is the universe of  $\mathbf{C}$ . Thus,  $\text{Sg}^{\mathbf{C}}(X) = A$ .

For all  $c_i \in X$ ,  $c_i$  is a constant symbol of  $\mathbf{A}'$  and  $\text{Sg}^{\mathbf{C}}(X) = A$ , so every subuniverse of  $\mathbf{A}'$  must contain  $A$ . Since  $a \in A$  and  $g_1$  is a basic operation of  $\mathbf{A}'$ , any subuniverse of  $\mathbf{A}'$  must contain  $g_1(a) = 1$ . Then  $h(1, 1) = 0$  must also be contained in any subuniverse of  $\mathbf{A}'$ . Therefore,  $A' = A \cup \{0, 1\}$  is the only subuniverse of  $\mathbf{A}'$ . In other words,  $\mathbf{A}'$  has no proper subalgebras.

It follows that  $\mathbf{A}' \in \text{CEP}$ , so we have shown that  $\langle \mathbf{A}, X, a \rangle \in \text{GEN-SUBALG} \Rightarrow \mathbf{A}' \in \text{CEP}$ . Now suppose  $a \notin \text{Sg}^{\mathbf{A}}(X)$ . We need to show that  $\mathbf{A}' \notin \text{CEP}$ .

Let  $B = \text{Sg}^{\mathbf{A}}(X) = \{b_1, b_2, \dots, b_m\}$ , and let  $\mathbf{B}'$  be the subalgebra of  $\mathbf{A}'$  with subuniverse  $B' = B \cup \{0, 1\}$ . It is straightforward to check that  $B'$  is a subuniverse of  $\mathbf{A}'$ . Let  $\theta = \{(0, 0), (0, 1), (1, 0), (1, 1)\} \cup 1_B$  so that  $\theta$  is the equivalence relation on  $B'$  with partition  $\{\{0, 1\}, \{b_1, \dots, b_m\}\}$ .

To prove  $\theta \in \text{Con}(\mathbf{B}')$ , we need to show that the basic operations of  $\mathbf{B}'$  preserve  $\theta$ . Since  $a$  is not an element of  $B'$ , for every  $b \in B \cup \{1\}$ ,  $g_b$  acts as the identity map on  $B'$ , and for all pairs  $x, y$  in  $B'$ ,  $h(x, y) = 0$ . So,  $\{g_b : b \in B \cup \{1\}\}$  and  $h$  preserve  $\theta$ . Clearly, the constant operations also preserve  $\theta$ .

Since  $B$  is a subuniverse of  $\mathbf{A}$ ,  $B$  is closed under all operations  $f$  in  $F$ . To show that  $F$  preserves  $\theta$ , first consider all pairs  $b_i, b_j \in B$ . By the definition of  $\theta$ ,  $(b_i, b_j) \in \theta$  for all  $1 \leq i, j \leq m$ . For  $x_i, y_i$  in  $B$ ,  $i = 1, \dots, k$ ,  $(f(x_1, \dots, x_k), f(y_1, \dots, y_k)) = (b_i, b_j)$  for some  $b_i, b_j \in B$ . If  $x_i$  and  $y_i$  are in  $\{0, 1\}$  for some  $1 \leq i \leq k$ , then  $(f(x_1, \dots, x_k), f(y_1, \dots, y_k)) = (0, 0)$ . Thus,  $F$  preserves  $\theta$ , and  $\theta$  is in  $\text{Con}(\mathbf{B}')$ .

It remains to be shown that  $\theta$  does not have an extension in  $\text{Con}(\mathbf{A}')$ . Let  $\alpha \in \text{Con}(\mathbf{A}')$ . If  $(0, 1) \notin \alpha$ , then  $\alpha \restriction_{B'} \neq \theta$  since  $(0, 1) \in \theta$ . On the other hand, if  $(0, 1) \in \alpha$ , then  $(h(0, a), h(1, a)) = (0, c_1) \in \alpha$ . But then  $\alpha \restriction_{B'} \neq \theta$ , since  $0$  and  $c_1$  are elements of  $B'$  but

$(0, c_1)$  is not in  $\theta$ .

We construct the output algebra  $\mathbf{A}'$  as the group  $\mathbf{A}_5$  or by adding operations to the input algebra  $\mathbf{A}$ . The operations are stored as tables, and each row of an operation table can be determined by one pass through the input. The space used in constructing the tables can also be reused, so the reduction can be computed in log-space. Therefore, CEP is  $\mathbf{P}$ -complete.  $\square$

## CHAPTER 5. OPEN PROBLEMS

There are many open problems in computational complexity, both in graph theory and universal algebra. We discuss a few that are related to results in this paper. In fact, exploring one of these open problems in algebra led to the digraph decomposition result presented in this paper. Specifically, that problem is determining whether an algebra is directly indecomposable, where an algebra is defined to be *directly indecomposable* if it is not isomorphic to a direct product of two nontrivial algebras. We formally define the problem DI as follows:

$$\text{DI} = \{A : A \text{ is directly indecomposable}\}.$$

There are often connections between problems in graph theory and problems in algebra. Clearly, the problem DI has some connections to the graph factorization problems, but a few complications arise. For instance, with algebras, there is only one standard product, but with graphs, there are several. The weak product seems to be the most connected to the direct product of algebras, and it also appears to be the most complicated of the graph products, as far as the factoring problem is concerned.

Both the Cartesian and the strong product results about graph factorizations have been extended to digraphs. However, the problem of decomposing digraphs with respect to the weak direct product is still open. According to Imrich (10), if all factors are connected, there is no obvious reason why the complexity of factoring digraphs under the weak product should be higher than the complexity of factoring undirected graphs with respect to the weak product. So, it appears there should be a polynomial-time algorithm to decompose digraphs with respect to the weak product. However, at this point, we have been unable to design such an algorithm.

For disconnected graphs or digraphs, the problem of finding the Cartesian decomposition is at least as hard as the graph isomorphism problem (8), which is known to be in NP (17). Since

the algorithms for factoring (di)graphs with respect to the strong and weak direct products utilize the Cartesian factoring algorithms, the complexity of factoring disconnected (di)graphs under either of these product also appears to be at least as hard as graph isomorphism. This suggests that the problem DI could be as hard as algebra isomorphism, which has the same complexity as graph isomorphism. In addition, for the weak direct product, there are no results regarding the factorization of bipartite graphs or digraphs.

Even though there are polynomial time algorithms for many of these decomposition problems, perhaps faster algorithms could be designed. Indeed, this is already the case for the Cartesian product of undirected graphs, in which the first algorithm presented has complexity  $O(n^{4.5})$ , and the most recent algorithm has complexity  $O(m \log n)$ , where  $m$  is the number of edges and  $n$  is the number of vertices of the graph. Also, there are no completeness results, so it could be possible for these problems to be in a lower complexity class such as **NL**.

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*Seeing the different cultures that my parents grew up in has been important for me because it has given me a better sense of who I am and where I came from. I don't live in a bubble where everything around me is the same. I live in the Midwest, that's where I grew up but I can go back to this very rural culture and see my roots. I find it really fascinating to go back and see that this is part of me also but it's so incredibly different from what I experience here.*

**Researcher:** How important is extended family in your life?

**Daughter:** Spending time with them is more important as I get older, or maybe I'm just noticing it more. I missed Christmas with my Grandparents one year because I was sick and it was a definite gap.

**Daughter:** *I kind of get the feeling with my dad's family that we are kind of the outsiders. He has two siblings and they have both stayed in the same town with their parents all their lives and their kids are there too. They are always together. And so when we come in it is kind of, not tense, but I feel different from them. They don't understand why I left the state to go to college. We have different value systems. My cousin, who is two years older than I am just got married this month and I get the feeling that was a more accepted thing to do than to go to school.*

*But then on my mom's side of the family, we usually have two extended vacations with them a year. They send their kids everywhere to school and our families have a lot of similar experiences. Then when we are with them, I feel like what we do in our lives is accepted. [Italics for emphasis]*

In families where there were differences in life-style, in values, and in culture, daughters noted the tensions; and parents made decisions to parent differently.

**Father:** The basic principle that guided my fathering was not to be the kind of father my dad was. I love my father dearly, and he is a great guy, but he was always the type who was quick to let me know where I didn't measure up. And I knew I didn't want that to happen to my kids.

What is essential and speaks to the structure of father support in these families is the fact that fathers do not automatically take the voice of their parents and apply it to the situations they have with their own daughters. Without making an issue of it, these fathers listen to their own voices as they parent their daughters as individuals with peculiar needs that they are interested in meeting.

Doherty, Kouneski and Erikson (1998) reviewed the literature on fathering, the main premise being that fathering is uniquely sensitive to contextual influences, both interpersonal and environmental influences. They discussed fathering as a multilateral relationship, in addition to a one-to-one relationship.



A range of influences—including mothers' expectations and behaviors, the quality of the coparental relationship, economic factors, institutional practices, and employment opportunities—all have potentially powerful effects on fathering. When these influences are not supportive of the father-child bond, a man may need a high level identification with the father role, strong commitment, and good parenting skills to remain a responsible father to his children. . . .As for the father's experience in his own family of origin, some research suggests that the father's relationship with his own father may be a factor—either through identifying with his father or compensating for his father's lapses—in contribution to his own role identification, sense of commitment, and self-efficacy (p. 289).

In extended families where shared values were the norm it appeared that energy was directed toward encouraging and loving each other, toward relaxing and enjoying time together. The daughters saw these families as an extension of their own nuclear family and derived support from their extended family and from the stories they told. Maintaining connection with their extended family was important enough to these fathers that even though they were hundreds of miles away from each other while their children were growing up, they made commitments of time and money to ensure the family bonds remained strong for their daughters.

In families where shared bonds between the generations were not the norm, fathers, mothers, and daughters in the research triad were aware of specific differences and had specific reasons to value their differences. In some cases they declined to spend time together, and the fathers thoughtfully and deliberately chose the type of fathering behaviors they would practice that was different from the way they were fathered.

*Sibling Relationships.* Siblings, there were no twins in the study, but there were brothers and sisters with similar genetic backgrounds, who grew up in the same house with the same parents, whose genetics and environment are similar but differences exist for other reasons. What were their relationships like? The sibling relationships weren't perfect. Only one family had a single child, the

other seven families had from two to three children, and in those families each parent indicated the importance of addressing the individual needs of each child. Harmony between siblings was a general theme in four of the families, three of the families spoke about various levels of disharmony between the siblings. Fathers were reluctant to discuss their situations with their sons.

**Researcher:** What is the relationship like between your daughter and son? Have you been able to parent them the same? Or have their needs been different?

**Father:** We had our son when our daughter was five years old, he hit the ground running and he hasn't stopped. He has been so different from her that we had to go to counseling to figure out how to parent him. Things are better now, but it has not been easy.

**Mother:** I think her giftedness has been a little bit of an issue with him. I think he's growing out of that a little more. He's 12 going on 13 now. He had trouble in school, could not read. We just really had a heck of a time getting him to read. He doesn't like to read which is so different in our family. It is just odd for us. He has grown up the same way his sister did and he continues to like me to read to him. He probably would not admit that at his age to his friends!

We tried very hard as soon as he was in school not to make a big deal of her scholastic ability. We were always very proud of her and we would tell her that but we didn't make a huge deal of it because we didn't want him to feel like he wasn't doing what he should be doing in school. When he was in the third or fourth grade, occasionally he would say things like, 'Well, we're different, I'm a good athlete and she's a good student.' You could tell he was working through all that and realizing he probably was not going to be the same student that she was but he had abilities that she did not. Although she has been a dancer since she was little she is not athletic at all. First it did not ever appeal to her to run or to play in an organized sport, but secondly she would not be any good at it.

Her brother has been more of a difficult child. However, is that in comparison to how she was? I mean is he really a difficult child or was it that she just never gave us a moment of worry and so we are comparing them? When he was in fourth grade, he was hard for us to handle. We just really did not know where to go with him and so my husband and I went to a counseling session and asked, 'Does he need counseling? Do we need counseling? What do we do with this kid?' He never went to a counselor. He never knew we were going to a counselor and all of a sudden, gee, he was a better kid! Hmm, look at this picture! So it was the way we were parenting. We were parenting him the same way we did her and it just didn't work. They were two terribly different people and once we understood that I think things have eased up a whole lot more and he's doing fine. He will never be an incredibly good student but at least he is trying harder and that is what we wanted him to do.

**Mother:** They were not close earlier. Actually one summer when they were both in elementary I thought they hated each other, and I remember telling my friend how awful it was and how much they hated each other and she just laughed at me and she said my memory was really bad but there had to be a time when I hated my sister. I really cannot remember hating my sister and I don't know that they hated each other, it just seemed like they did.

Now that she is home this summer I can hear them actually commiserating about things, like my habits. "Is she going to do so and so?" I think that is a good sign. I can tell

they are talking about me. It is not something they would prefer I hear, and if I said, "Pardon," they would say, "Oh, we weren't talking to you." So I really think that is a good sign because then at some point they don't have that generation in-between them and then they're together.

But now that they are older he goes to her for certain kinds of advice; advice about school, clothes, things that he would do that are appropriate or inappropriate, and he'd ask her about Spanish. He calls her at college to ask her about Spanish because that is something he can't ask any of us about. He started taking Spanish after she left for college and now they'll say some Spanish to each other so we don't understand, so that's kind of nice.

**Researcher:** What is your relationship like with your brother?

**Daughter:** It is not the best. We don't get along very well, just because we are very different. His strength is athletics, he doesn't like school very well he doesn't care that much, and we don't have a lot in common. So that makes it harder. We kind of pick on each other all the time. It is tiring. He likes to beat on me and I don't want to hurt him so I don't hit him back. But we actually get long a lot better since I have not been home. We talk on the phone and e-mail, that is much better than my being there all the time.

I think he thinks that that I am not really as good as he is because I don't do the things that he likes to do. He says to people, "My sister's smart, and that's about it." So I don't know that he--like my parents say, he just pesters me to get my attention. But to me it just seems like he wants to make me mad. Like I said, I think he likes it better when I'm not at home. He needs a lot of attention, and so I think he likes it better when there is nobody else there to get my parents attention.

I don't like how he treats my parents. He is not very respectful and he says stuff to them I would never even think of saying, and he doesn't like to help out or do anything. So I get mad at him for being that way and then he probably resents me for looking good. I mean, I would resent me for doing that. I don't know, I just think it is better when I'm not there. We do better with a long distance relationship.

*Friendship Relations.* Within the cultural context the effect of personal relationships with friends has to be considered an important supportive influence of a gifted daughter. Intergenerational differences (Giarruso, et al., 1995) were noted again when friendship were discussed as an intervening condition of support. The energy and passion weighed on the side of the daughters when talking about their friends while the parents seemed to relax as though friendships were no longer a parent issue. Once children are adult college students making their own life choices the concerns about friends become a thing of the past, especially since these girls had stable friendships over-time.

Friendship stability seemed to have been facilitated in part by parental choices to live in the same homes and school districts, maintain jobs within the same companies over their daughters' lifetime. Daughters had maintained some of the same friends since they entered school; with the first

changes in friendship groups being noted during middle school. When the girls left home to go to colleges and universities, some early friendship ties remained, but new friends reflected new interests and seemed to meet more particular needs of the girls than friends from earlier life.

Mayseless, Wiseman, and Hai (1998) reported similar findings to those in this study when they examined differences in autonomy and relatedness in adolescents' relationships with parents and their association with a same gender friend. They compared scores from the Relationship with Father/Mother Questionnaire and the Sharabany Intimacy Scale for 205 Israeli adolescents, 105 males and 100 females in two age groups, 9<sup>th</sup> grade and 12<sup>th</sup> grade. Older adolescents reported more autonomy in their relationships with parents than younger adolescents did. They reported adolescents with close, warm relationships with both parents to have more autonomy and less supervision in friendship matters. The adolescents in their study demonstrated the ability to develop and maintain strong friendships, personal maturity and autonomy while maintaining emotional closeness with their parents.

The discussion of friends includes parents' perceptions of friends and daughters' discussions of friend influence and of her observations of her parents' perceptions of her friends. Again, a note about grounded theory research, one voice may speak for many. Adequate voices will be presented to give a full range of responses.

**Father:** I think she has had good friends throughout her life. She has a fairly stable group of friends that has evolved over time but there are some pieces of that group who are amazingly steady. One of her good friends who was at our house over the fourth of July was a pre-school classmate in daycare, they have known each other since they were each about 18 months old. They are the same age. They go to different universities now but they still maintain contact with each other. They still see each other when they are back in town, exchange birthday presents and things like that. And so, one friendship is at least 18 years old for her. Her lasting friendships seem to have started from when she was in the fourth grade and we changed from one school to another within town. She made some friends there who are still friends. The others seem to be high school classmates and now that she is two years out of high school she still sees these people on a regular basis.

**Researcher:** Why do you think they are friends?

**Father:** Common experiences I suppose, as much as anything. Her good friend of 18 years, also has parents who are both university professors, they shared an interest in dance, that was a common interest for them for a long time. Ultimately I guess, they just get along together. For what ever reasons some personalities mesh and some don't. I don't think there is anything special that they have done to maintain friendships. I think it just happened because they wanted, they all agreed they wanted it that.

**Researcher:** Tell me about her friends and why you think they are friends.

**Father:** In the longest running friendship, the dance classes were the shared event that drew them together. The dance recitals which are a right of passage where you put on a costume and dance in front of 2,000 people and you make it through that experience okay. It is a team kind of a thing, you know, in an odd little way, although you dance alone, you are up there with others and so the shared experience of 'look at this trial that we passed through and we did very well, and next year we're going to be in the next class' and so forth.

She has a wide range of friends scholastic ability wise. One of the things that does define her group of friends is that they are not uniformly high achievers. They are all capable, they all do good work. Some of them were with her in the talented and gifted program and others weren't. Some of them are very successful right now in college and others haven't been. So within this group of friends that seem to show up every time she is back in town, there is a wide range of interests and abilities but yet they still all hang out together.

**Researcher:** Do you like her friends?

**Father:** Yes. Eventually I have even grown to like all of the boy friends she has had over the years. Some of them didn't seem quite right at first, but all of them have turned out to be decent guys who have socially redeeming qualities about them that I could end up appreciating, so yes, I do like her friends.

**Father:** Through middle school, most of her friends were the same ones she had had in grade school and a lot of them were either from dance classes, or math classes and things like that. They were in that interest group.

**Father:** In high school I always felt fortunate that she had good friends. Her high school peers changed quite a bit from what she had had in middle school and it was because she drifted into, I think clique is probably a bad term for this, but she drifted into a group who shared more peculiar interests. Because of her interest in the arts, she gravitated into a world new to her, here were artists and writers who talked about philosophical and emotional things where all of her other friends always talked about math formulas and dance steps.

So in what is probably a gross over simplification there was a change in her peer group that brought her new interests. Many of those friends that she made in high school are still with her now. I think they have all been positive people in her life. It is a real diverse group as far as performance is concerned, as the outside world would measure performance, grades, and jobs, even going to college or not going to college. So she has had a diverse group of friends; I don't think they have ever treated her differently because of any earlier acceleration that she had. But, they have had an influence and I feel it has always been positive.

The father was very perceptive of his daughters' changes in interests and it is reflected in the

daughter's comments about her friends.

**Daughter:** Maybe I would have stayed interested in science and math had I been closer with groups of people that were science and math oriented. I mean, certainly I had friends in high school that were on a straight-track toward a Comp-Sci. major or Engineering, even in 10th grade. But I didn't sit around and talk to my friends about math, I don't know how many people do. I mean I certainly knew people that I would sit and watch as they talked about computers. My friends and I wouldn't do that.

We talked about other things, about other people around us. I'm sure we talked about things we were all interested in. Like last night we were talking about racial relations. That is something that I had not delved into and somebody turned me on to a new book that I'm going to go and read just because it was an interesting conversation about something that he happens to know more about and got me interested in. That is a very direct influence of others.

It was interesting to "listen" to fathers and mothers discuss their daughters' friendships. The fathers had a lot of information about the friendships, the kinds of things they did together, but mothers seemed to have more insight into why things were. Both fathers and mothers were uncertain, "I think . . ." there was not voiced certainty about the friendships, but neither was there concern. Although fathers and mothers of six of the girls discussed the idea that their daughters had not had long-term romantic relationships in their lives, two of the girls were living with their boyfriends in college.

**Researcher:** Tell me about her friends and why you think they are friends.

**Father:** I think she and her college friends all have similar interests, I think they are all equally bright. They have a social relationship but it is with each other and not in the dating and go finds guys, that kind of thing. I think they all read a lot, I think they are all very goal oriented and they have pretty good ideas as to where they want to be down the line and right now there is no time for that distraction.

**Researcher:** Tell me about her friends and why you think they are friends.

**Mother:** I think they are all very bright. Essentially none of them has been very involved with boys or men. I would say by all standards that they do not date much. When they go out with guys, they just go out like a group of good friends. They essentially have not had romantic relationships. I don't exactly know how they feel about that but our daughter had a romantic relationship her freshman year, a short one, and it was really her first one. I think she feels like that's something that would have been good to have done but it would have had a cost, and the cost was greater than the benefit.

The cost would be that she would separate herself from a lot of other people because it would become a one-on-one relationship. And she might get so serious that it would

become the focus of her life and she doesn't want to have to move along with another person on the track at all. I think she still doesn't want to say, "I'll meet you at 6:15 for dinner," because she might grab a bag lunch or she might not go to dinner or she might get a better offer from a friend. I think she's looking for a sort of a low level of independence. I think she wants to be able to call up her friend from high school when she comes home and feel that that would be okay. There is not a romantic kind of relationship, she doesn't want to be tied to somebody. We've never said, "Don't do that," but I think it's sort of understood that it can be a hindrance too early.

**Researcher:** Tell me about her friends and why you think they are friends.

**Mother:** She has a group of close friends who basically have a lot of things in common. They are all sort of fun loving. Some of them are friends because of common interests, others it is history. They have been friends for ever and ever. And when they come back together they have enough in common that they still have a really good time together. I think she has developed newer friendships that are really more interest based. Now that she is older she knows a little bit more about what she likes, but she is pretty wide open in her friendships as far as different kinds of people. I think she really enjoys people for different reasons. She is not very outgoing but once she knows people, she can mix pretty well with any type of group. But her long term friends, I can think of one whom she has known since she was 18 months old, because they met in daycare. They go to different schools but they still communicate with one another. All of her friends tend to congregate at our house and it is something that we just love. Even now that they are college students and go their separate directions, when they are home on breaks, they end up at our house in the kitchen and we're eating ice cream out of the same container, with spoons, or wandering in and out watching movies. I like her friends very much, so, it is really very pleasant for us in that regard.

**Researcher:** Tell me about her friends and why you think they are friends.

**Mother:** She and her closest male friend, I think both have this idealist view of the world. They don't want to buy things from China, they want to be vegetarians, and they are into human rights and all those ideological sorts of things that really brings them together. They have a very strong sense of fairness towards people and feel strongly about environmentally sound practices. But when I think about her girlfriends, it is really hard to say. What are all those things that bring them together. In some ways they are very different. One of her close friends, someone who was born on the same day as she was, have been friends for ever and ever, but she is very much into sororities and those social things, which she totally isn't. So it is hard to see why they are friends, but they have such fun together. I really haven't thought about it. I think they have interests that are similar but I don't know what they are. Her friends are not all the same intellectual capacity, that sounds a little strange, but they haven't been exceptional students. One of them I think probably never will graduate from college, she can't focus academically, but she blends in with this group just fine. They have a great time. So they range again, different interests.

**Researcher:** Tell me about her friends and why you think they are friends.

**Mother:** She has a few friends who have carried over from high school to college. None of her really close friends went to college where she does. So for her to see her closest friends they all have to come back home. When she is here she will talk about them and do things but

I would have to say that I think probably that her best friend is a friend she met at college, it is not clear. I would say her best friend from high school is maybe her second best friend now. So there have been new friends, particularly one friend that seems very close. They seem to be just soul mates. They are both very mild and I think they both have self-insight. The minute our daughter went to college she talked about this one person. I think one of her big concerns about going to college was that everyone would be too much the same. Her concern was based on the fact that living in a university town has allowed her a lot of cultural diversity in her friends. And there's just a smattering of that at the college she attends. There is more of a traditional student and more of a religious tradition, and that's not a bias, it is true. But right away she met this girl in her hall, she looked like everybody else but she and Julie found each other and they started talking. The very first week she was telling me about this girl, that this girl had the same concerns she had that that everyone would be the same. Now this student left school because of depression and might not be coming back. I really hope she does because that's been somewhat difficult for her lose her best friend her sophomore year all the way to the west coast.

Most fathers were aware of a difficult time in their daughter's friendships during middle school that leveled out by high school. This seems to have been a typical adjustment in this population.

These girls maintained their friendships over a long period of time, many shared similar interests, and intellectual ability, but not all. Because discussing friends was a topic of a more intimate nature the daughters went into more detail about their friendships than either their fathers or mothers did. Typically parents were more aware of the details of friendship during their daughter's childhood and early youth than they were of college friends.

Father: She does have a group of close friends now. That group has become larger than it was when she was here in elementary school and high school. The elementary school was a little tough in terms of finding kids that matched her in terms of her interests and so on. It is a very small school and that was a tough time for her.

Father: She had a couple of fairly close friends but they were not quite interested in all the same things she was interested in. It was a little better in high school. She had some close friends in high school and she's really expanded that more now that she's in college. Part of it was her first dorm experience.

When she went away to college, there were two things I think that were very useful. One, at the University they had a program was kind of like a little college within the University. So rather than the typical University experience where you go to a bunch of different classes typically very large classes in the beginning and not necessarily the same kids in each class. In this particular program, they took a group of about 80 students. The students went from class to class to class together. They did this for the first couple of years so she had some opportunities to be with the same set of kids the whole time. She also lived in a dorm at the University which was a foreign language house which tended to have a very



diverse group of people interested in languages. She's always been interested in lots of different things and these were very broad-minded individuals who were interested in other cultures, obviously. So, she met a lot of people early on in college who just seemed to share her interests. So she has a good set of friends, a lot of whom are going abroad this summer. Next year she'll be away in Europe.

**Father:** I think she and her friends are just a smart bunch of girls. Also in high school I think she sought out students who had similar interests to hers, not debutantes or anything. I think the people she has associated with through high school on probably reinforced her own interests in science. Her friends are just inherently all smart kids with parents who reinforced that. They have the desire to do well, to excel at least intellectually.

**Father:** I like her friends. I feel very fortunate that she has had the group of friends that she has had. But again, it all comes back to that they are all very bright, they are all very independent, not the ones that are influenced by the crowd, so to speak. They have their own values and they have been very good sticking to those values. Where a lot of parents have to worry about, 'are they going to get led into things that they don't want to be in?' We have never had those kinds of issues to worry about. They are fun kids, all very considerate of other people, just a good bunch of kids.

**Father:** My impression is that she's very much her own person. I don't see her necessarily falling in with a crowd and adopting whatever the crowd is doing. I think she is interested in doing things and finds a group of people that are also interested in doing that. I don't see her following certain fads except for coloring her hair I guess! It's some shades of red and streaky kinds of things but nothing too unusual! I don't think she's been strongly influenced by her peers. I think they've allowed her to develop without defining her in some way.

**Researcher:** What do your parents think of your friends?

**Daughter:** My parents like all my friends that I know of. My house was the house of choice when we got together. My best friend says my Mom is like her second mom. My mom can talk to her and learn more than she tells her own mother. If she would get to my house and I was late she would visit with my Mom till I got home. My parents always knew who my friends were and they knew what we were like so they didn't worry about us, though all parents worry I think. But when they know whom you are out with and what you are doing... I think I got more independence. They knew my friends and what I was doing and they never questioned me.

**Researcher:** Do you have a group of close friends?

**Daughter:** Yes, the friends I had in high school are still my closest friends. My 3 closest friends are from back home, we have been separated for 2 years since high school. My best friend I have known since I was 3 years old. She lives two doors away, over the years we had some class schedules that didn't match and our homework didn't match. But in high school we always had the same homeroom and we reconnected. We are like sisters. I don't have a sister and she doesn't either. I'm a people person and want someone to hang out with in the evenings or to go to a party with or to play games with, I miss her.

Last year my brother had a friend over and my best friend and I played 'Pictionary' with them. We beat those two boys so bad!!! We could draw something that looked nothing

like it was supposed to and we knew what the other was thinking. She drew a circle with a squiggly line running from top to bottom and I shouted 'Earthquake'! And the boys would yell 'What'?!

**Daughter:** We were all pretty good students, with GPA's of 3.5 and above. We were in honors classes together. We had similar interests in track and cross-country. Other kids were more into drinking. We were good kids and wanted to have good clean fun. It's hard to describe how you become good friends, it just happens and you are.

**Researcher:** Why do you think you're friends?

**Daughter:** For the high school friend, we'd gone to elementary school together all of our lives and then we only got to be really close friends when we were in fifth grade and on. I don't remember exactly how we started being close friends but we have similar personalities, similar temperaments, and even then we were able to connect easily. *I think the interesting thing about that relationship is that as we went through middle school and high school we didn't always have the same larger group of friends. I think we each went our own way but then we always came back to each other as the ultimate home base.* [Italics for emphasis]

I met my best friend in college the very first weekend I was in there. She came to my room. We were listening to music and talking about the colleges we had applied to, and we found out that we had applied to a lot of the same colleges and had looked at a lot of the same things in a college and that we had selected our college for some of the same reasons! I made the comment that she seemed more natural or down to earth than a lot of the people I had met so far at college, she was flattered by that and I think that just got us going because we connected from then on. *I think the most important thing about a friend is somebody who likes to think seriously about things and who is interested in exploring and thinking about life in the same way you are.* [Italics for emphasis] My parents know most of my friends and for the most part I think they like them.

**Researcher:** Why do you think you are friends?

**Daughter:** Well, my college friends are my friends for the usual reasons. *Because of our personalities, and because we have fun together. We all have a good sense of humor and we don't annoy one another most of the time! We don't have the same professional goals but we are probably similar in the amount of time we spend studying.* [Italics for emphasis] My parents don't really know my friends. It is mostly my decision about who my friends are and I've never really introduced them to my parents. My next door neighbor is my friend and they knew her.

**Researcher:** Why do you think they're your friends?

**Daughter:** Because we love to discuss stuff and argue about things, sort of help each other on homework. Go out together, have fun together, share same views. I actually have one friend who works for my Mom. We got along almost immediately. I met her in my English class and then she sat down by me in chemistry class, and I just liked the way she did things. Then we started talking, we talked about morals and that kind of thing. *I found out she's like me. She doesn't want to be involved in alcohol and she doesn't want to party like people do. She wants to study and get really good grades because* [Italics for emphasis] she wants to go into veterinary medicine.

**Researcher:** What influence do you think your peers have had on you?

**Daughter:** Maybe I'm more *extroverted* because of them. Especially when I'm around them. After a year at college I'm more comfortable around people.

**Daughter:** I'm sure my friends *have influenced my social style*. Just the fact that I made friends with these people several years ago, well before I went to college and had to make different social choices like, 'Are we going to go to the bar?' 'Are we going to rent a movie?' I'm sure they had an influence on my decision that 'No, let's make something to eat and hang out.'

### *Causal Conditions Fostering Support*

Causal conditions fostering support emerged from the data as a category which ultimately led to the central phenomenon of father support. The subcategories which emerged as causal conditions were (a) value placed on daughter, (b) communication between father and daughter, and (c) managing life problems of illness and depression.

#### *Value placed on daughter*

The first causal condition fostering support is value placed on daughter. One of the strongest impressions the fathers gave during their interviews was an over all sense of how important their daughters were to them. The fathers seemed to be whole-heartedly interested in them, and exhibited a sense of parental pride when talking about their daughters:

**Father:** I will never forget, it is indelibly etched in my mind when I found out that we were going to be parents. It may have been a bigger moment for me than it was for my wife. I don't know. I was elated. It was like...wow! I had been a smoker up until that point, then I quit because I didn't think that was healthy for our child. It influenced a lot of things that I did. I started to see the world differently at that point and certainly after the kids were here. Knowing we were going to have a baby hit me with a lot of responsibility that I hadn't felt before.

**Father:** I felt when she was born that was the best thing that ever happened to me. I still think the same way and she is my joy in life. My wife is my lover and I love her. I hope she loves me too, but the joy of my life is my daughter. I love my other children too, but since she is my first child she is the beginning of my joy.

**Father:** There is sort of interesting aspect in that all my children were born by Cesarean section and my wife was bugging the heck out of the doctor to let husbands in the delivery room. At the time our first son was born they did not allow husbands in the delivery room so I had to stand outside the door and look in. I was allowed to go in the delivery room when our second son was born and nurses hovered over me making sure I didn't faint or anything!

Having seen that once I knew that after the baby was born all they did in the operating room was sew for what seemed like an hour. So, when our daughter was born I went right away to the nursery. I got to hold her right away, that was really neat. So, she was special from the beginning.

Father: I've never felt that being a Father to someone like my daughter was particularly onerous at all. It has always seemed like a privilege and *I have always thought that it was the single most important thing that I would ever do*—I hope that message came through to her at all stages in her life, and to some degree I think it has.

And the mothers voiced a recognition of their husband's devotion and interest in their daughter and in the things she delighted in the following scenario expresses the intent:

Mother: While her Dad was working on his Ph.D. and living in Iowa City for a little over three years I single parented them with him coming home on the weekends. Whenever she was in any activity even if it was in the middle of the week he drove back to attend. He would drive from Iowa City and go to whatever it was and sometimes drive back that night. He wanted her to know that she was important to him and one of the ways he showed her was by coming to her performances.

Mother: Of course, I was very thrilled when I was pregnant with her. I was almost 30 when she was born. We had finished our PhDs, and it took us awhile to conceive, so I was very, very excited. She was the first grandchild on both sides of the family and this was a really big deal. I'm not sure I cared whether she was a girl or a boy and I didn't know then like they do now, but I was very thrilled to have a girl because I grew up with sisters and we were very, very close. When she was little I still remember she was always writing me little notes, you know, 'I love you mommy,' and we did a lot of things together. Then when her brother was born when she was about 2½. I think that was somewhat hard for her but she didn't appear to be jealous. She was a happy child.

And while the fathers' voices were speaking with the distance of a generation between them and through the differences related to gender and parental authority, their daughters heard their words and recognized a component of unconditional love and acceptance from their fathers.

Daughter: My sister and I gave every indication to my father that we were both going to go into the sciences, medicine or math. He thought those were really great professions for us. Now that we are going different ways I think he still gets a lot of pleasure out of us. I think some of that pleasure rests in us being successful no matter what we do. So, his satisfaction might not depend completely on the branch of study we pursue, but more along the lines of ability and that we keep trying to be the best in whatever it is that we do. I want to say that it feels good to know that he thinks I can do anything, that I can do anything well.

Daughter: Just before I left for college Dad sat me down and talked to me about how grades are important but they are not the only thing that is important in life. He told me that A's are not all there is to college, he said it is important to go out and have fun, make friends. He said that if I'm always doing schoolwork and don't take breaks, I'll burn out. He said a 4.0 GPA is

not a necessary thing. When I was going into college he didn't want me to kill myself for grades. He didn't want me to feel pressure especially in college where an A- goes against your GPA. In high school an A- still equaled 4.00, but in college an A- equals 3.7.

**Researcher:** How did you feel after he said these things?

**Daughter:** I was a little shocked but I had mostly pushed myself to get 4.0 in high school. So I knew it would still be something I would push myself for. But I knew if I didn't succeed at the highest standard, he would still love me.

**Daughter's Journal:** Overall, I think that my Dad is proud of me and of the way that I continue to work. The only thing that comes to mind that he actively tries to improve is my assertiveness. He wants me to be more direct with people and stand up for myself. That's hard for me and he doesn't really understand why. But I want to say that I thank God that I was blessed with a father like mine, where my personal strengths were encouraged and my weaknesses were not thrown back in my face. My father accepts me for who I am and I realize what a gift that is.

One daughter realized how similar their goals were when she responded to the question, "how would you feel if your father was disappointed in you?"

**Daughter:** If he was disappointed? I think if I were to choose a path in life that were to disappoint him but it made me happy, I think I'd be upset, but I can't see that happening because most of my goals are things that my dad is okay with, and are clear with him. If I was unhappy with my life he'd be disappointed in me, and I think I'd already be unhappy because that would mean something was a mess.

*Communication between father and daughter/between mother and daughter:*

The second causal condition that fosters support has to do with communication. While one father was especially fluent in his interviews, he recognized that conversations with his daughter were "fairly superficial." This was the sentiment of the other fathers. Overall, the interviews were thick with information and a lot of information was transmitted when fathers and daughters spoke about the supportive nature of the relationships that existed over the life-time of the daughter. But when the question was communication, what they talked about together in the course of the daughters lifetime and in the "here and now," the interactions show the ever-changing reality that occurs in the process of growth and development. At the time of the interviews the daughters were young women, having lived near their colleges for one to two years, still financially dependent on their fathers but moving away rapidly and developing circles of friends outside of the familiar circle. Fathers and daughters

independently verbalized an appreciation of closeness in the past and an awareness of present distance with a wish for an emotional closeness that superceded their relationship during childhood.

**Father:** Well, I think we talk about most things. *If there is one thing that describes what we do talk about, we talk about things fairly superficially* [Italics for emphasis]. We talk about world politics and we talk about local politics and we talk about how the universities are being mismanaged and we talk about our work a lot. She talks about what she does at her work in the bookstore and what she has read that might apply to work I do—how the corn bore technology has changed in the last five years, so I think we talk a lot about the stuff we do and about other personal kinds of interest. We talk about taxes and money.

One of things that I noticed in my upbringing is we were borderline poor and I never knew it as a kid. We just didn't talk about money. Whatever the farm financial situation was it was good enough because we all stayed alive and we always ate. But I never knew as a kid how we were doing as a family. I think we did some of that with our daughter. Lately we have worked on our income taxes together because I figure *that is something that she is going to have to know how to do*. I felt that using our income taxes as an example was how she would learn to do her own. We have talked about money.

The big things you are suppose to talk to your kids about, drugs and sex, I don't think we ever talked in depth, but I think we talked enough to know that she understood both of those and the troubles that you could get into. I don't know how you could be a kid and not know those messages now. It just seems like there is so much information available, in the health education classes and so forth. I never felt like we really sat down and did a birds and bees talk, but I guess one of the things that I notice when we do talk is that subjects tend to be fairly short, and then we are on to something else. We really don't spend a lot of time dwelling on any one thing. We don't beat any topic to death. "This was neat," and "That was okay," and "What else is going on?" kinds of things.

**Daughter:** Dad and I talk about "Well what is going on in classes?" and "How are you doing?" and more general stuff. We'll talk about new scientific discoveries or something like that.

**Daughter:** I talk to Dad about Pre-med. for now. I guess we talk about it because it is something I can do and it doesn't seem like a job I would mind. I would be respected and I could earn enough money to be comfortable. I would be helping someone out. It is important to feel good about the work you do as well as having a job.

**Daughter:** I give him a general overview of what I'm doing and how I'm feeling. I say things like "Oh I'm stressed," or "Things are going well." I give him a general idea of how classes are going. His responses (if I'm stressed) will be? "Are you getting enough rest?" "Are you eating your fruit?" "Are you eating fruit every day?" "Do you drink milk?" He worries about that, about my food and whether or not I drink enough milk.

We fill each other in about events that have happened. The category of things I'd talk to him about are, what is going on at work and I also describe the people I know here.

It is the same with Mom only she is more open. When I went off to college she gave me a big spiel about things like being careful, and don't do anything stupid. If you do and you get in trouble don't be afraid to call home. It's better to call and let us know. Watch out for people. You think you know them but you don't. Don't have guys in your room with your door locked behind you. Mom and I cover issues I won't talk with my Dad about.

**Daughter:** School related things. If I'm having trouble and need emotional support I call. When almost anything goes wrong I call. I call if things go wrong around the apartment, if anything is going wrong in athletics, if things go wrong with my car, I talk to Dad about that. One day I had trouble and went to talk with him. You see I have really flat arches and my feet really hurt, I told him about that. And one time I was really down and went to him. My goal in track was to beat my last time; I tried really hard to do that. My hardest meet occurred two weeks after a girlfriend died. I struggled through so hard, it was the worst time I'd ever had. When I went to dad about it he said, "At least you finished. You went to practice after you had been off, and you were dealing with the stress of loss. You still pushed yourself and finished the race." I could understand. I had been doing pretty well, I had missed one week of practice. It was hard after my girlfriend passed away to get back into a routine. It was a setback. He showed me the truth about what was going on in my life right then and helped me put things in perspective.

**Daughter:** He might mention, "I have a meeting . . . church council meeting, or I have a meeting at work". Spontaneous cliché's but he doesn't really say much about himself personally. I talk to him about sports. I was really athletic when I was young and we both like tennis a lot so we keep up on that and talk about who's doing well and what is going on in that sport; and basketball, we talk about those kinds of things. We talk about my classes and how they are going, but it is more of a checkpoint to see if I am staying on top my studies, making sure I am getting things done and not procrastinating.

We don't talk about anything personal. My father talks with me about preparation kinds of things. He is helping me work out this semester taking music lessons on the East coast. He talks to me a lot about my orchestra director which is kind of strange. I'm really close to my orchestra director. My dad finds him very amusing. He is this crazy New York man, very unconventional. It is great. He has played a big part of my life at college so far. But my father and I don't talk about my instrument or my lessons or that kind of thing. We talk about orchestra and how my conductor helps me figure out the things I should be doing to get ready for graduate school, but we don't talk about anything personal.

**Daughter:** I tried to talk, sometimes it's weird, it's strange in the car, I'll be riding home with him in the car and it'll be dead silent. I'll start trying to get a conversation, and my dad will be reluctant to have a conversation you know. It's like he's too shy because I'm the only one in the car, mom's not in the car to back him up or something.

**Daughter:** Well, sometimes I'd ask him like what he did at work today. I always ask my mom the same thing and my mom goes on and on and on, talks forever, but my dad says a few words and then he'll stop. Then you have to ask another question. I try to make it feel like a conversation.

Scenarios similar to the following one repeated with four of the girls, verbalizing the desire to have a closer relationship with their fathers and stating ways they attempt to make it happen:

**Daughter:** I wish my dad would have had a lot more contact with me when I was a girl at home instead of with my brothers. I'm sort of jealous of my brothers, they'd be there and he'd talk to them all the time. Now I see it changing. My brothers come home from college and yes, he talks to them for a little while, but I'm the one that sticks around and still talks to him.

He's figured that one out. I ask him questions when everyone else has left the room. Even when he's doing the dishes I stay and ask him questions. I mean my brother goes upstairs immediately after dinner and writes to his girlfriend or something. I stay downstairs, I have a boyfriend and I could be talking to him on the phone or writing him a letter but I want to talk to my dad instead.

**Researcher:** Why do you think that he didn't talk with you when you were at home?

**Daughter:** Probably because I was a teenager and I wanted to do my girl things and hang out with mom. Actually when I was a teenager I'd go up to my mom's room and my mom would be dressing or doing something upstairs and I'd sit on her bed and talk to her for a long time. Even when I was a kid, I actually remember there was a storm outside and I didn't like it, so I ran and slept in their bed with them.

I'm in engineering you know, it's like "Dad talk to me. Give me some good equations or something to think about." I try to ask him for guidance a lot. I mean, like saying, "What did you take when you were an undergrad dad?" or "What kind of calculus, did you continue calculus?" then he'll tell me what he took.

I wish that we had a closer relationship, a closer and more open relationship, and I don't know how that could be changed. I don't know entirely how that came about. I don't know if it's because he stepped back more from me or if it's because he saw me going closer to my mom and felt like he didn't have a place anymore. I'm not sure, but I wish it were closer.

Six of the mothers and daughters spoke of their close relationships, the daughter's responses about their relationships with their mothers were almost identical. And a daughter finally revealed topics she talks about with her parents and why, things she calls "parentally appropriate topics."

**Researcher:** What kinds of things have you talked about with your daughter:

**Mother:** I say that's hard to answer now in some ways. She's very self-contained so getting a lot of really deep stuff is hard. I really have to work at that. I mean she talks but it's often more in a superficial way. So what do we talk about? We talk about practical issues, her going away, what are we going to do? How are we going to manage coming to visit? You know there's a lot of just conversation. When she's concerned about something she will talk to me, but it's hard to get her to talk a lot about her real deep feelings. She does sometimes but it's not something that's easy for her to tell anybody I think although she has close friends but I'm not sure how much she does that with them either.

**Daughter:** My mom is really my confidante. She's the person I can tell just about anything to probably more even than a close friend. My dad is my father, he's always the cheer squad, he's always there to cheer me on and he's proud of whatever I've done, but there's not the same depth in the relationship.

My mom is probably my best friend in the whole world. I don't know what I would do without her. She's the person I look to for guidance, for reinforcement, if I have doubts about something that I'm going to do, I run it by her. She's my sounding board, you know, anything that's on my mind, anything that's been frustrating me I take to her. But it's not all roses with my mom either.



**Researcher:** What don't you talk about?

**Father:** I guess we never really talked about sex with our daughter other than the mechanics of it and "don't do it" sorts of things. But since she has gone away to college, it is never anything that has come up since. Ignorance is bliss, I guess, in that regard.

She shares an apartment with a guy now, and has since she moved to the university. He's an okay guy. It has worked out well. They seem to be good for each other. They do have something better together, but we never spent a lot of time talking about that. When she was making her arrangements for the university and we were talking about money, I thought she needed the dorm life because it had worked so well for me. And so I put some financial bribery behind my opinion that she should try to live in the dorm and not entangle herself in a relationship. My bribery did not work. She went ahead and moved in with the guy anyway in spite of the bribe and it has worked beautifully. So she understood herself better than I did in that regard because I was trying to get her to do what had worked well for me and she is doing what works well for her in spite of my financial efforts otherwise.

It was difficult initially. It wasn't so much "Hi, I want to talk to you about this," it's "Hi, here is what I have decided to do, can I borrow the truck to move next week?" "Oh, are you sure?" "Yes." And sort of a brief look at, "You understand how much money it takes to run an apartment" and "Do you think your ready for that?" "Yes, yes and yes." She had made up her mind and had leased the apartment before she told us. At that point it was, either rant and rail against the moon, or get ready to go move her furniture. I said, "Let me know if I can ever help," and she said, "Yes, I need you to help me move next week." And I said "Okay, I can do that." And then we went on from there.

**Mother:** She and I talk about almost everything, all the time, we always have, but one thing she won't talk to me about, and I'm sure she doesn't talk to her Father about, is sex. Our relationship is so close, I can't understand why she won't open up about that topic, but she adamantly refuses.

**Mother:** She's pretty reticent to talk, (pause) she hasn't really had a serious boyfriend and I know that she's concerned about that. She's worried that she won't find anybody but it's not something that is easy for her to talk about. So I try to ask those kinds of questions when she mentions males but I sense that I shouldn't pursue it too much because she doesn't really want to say a lot about that. In some ways she's like her parents in that neither one of us had a lot of relationships before we got married, through high school or college either, and I see that with my son so it is kind of interesting to wonder how does this get repeated? She's always had male friends but they seemed to always be just friends, even at the college level she has male friends, but she wasn't a girl with boyfriends or dating very much at all. I know that bothers her so she won't talk about it very much.

She has expressed to me that she wonders if she's going to find anybody, and I think at her age that's how I felt and it really wasn't until later in college that I even started to have young men interested in me. My husband and I met in graduate school and actually most of the people we know with long-term happy marriages really didn't get together until late college or graduate school.

**Daughter:** I talk to them about parentally appropriate topics. I don't talk to them about sex and boys and my social life. They are mine, I never talk to them about those things, because I want, I need a space that is my own.

**Daughter:** I don't talk to him about social things, I skip over those things. I won't talk to him about relationships. I talk to My Mom, Dad doesn't want to hear about it and Mom does. I don't talk about the typical things college kids don't want to! Like drinking. I don't do it much but I don't tell them at all.

**Daughter:** I don't usually talk about the classes, I don't discuss classes, I talk with my advisor, my curriculum is pretty much set. I don't talk to him about boy or friend issues. I usually go to Mom about that. I feel more comfortable to talk to Mom when I'm looking for the female perspective. If I need the male perspective we'll go together to talk to him.

The issue of being shy about boys and dating was more common among the girls than I think they realized. While all of the girls have long-term friendship groups that include young men, five of the eight girls discussed concerns about not having dated and wondering who to talk with about these issues, following are two interactions about that topic where the girls have siblings who may, or may not, act as confidantes!

**Daughter:** You know I think I am still shy about boys and my brother is still really shy about girls. He's 17 and he's never had a real girlfriend. I was talking to my mom about it once and we were wondering if it was genetic, or is it something else. My mom didn't really have any serious boyfriends until she was in college and met my dad, and my dad was kind of the same way. I don't think it was because they were silent, they have never been particularly repressive about sex and boys or anything. I don't know if it's just a personality thing or because you need a lot of self-confidence around the opposite sex I think. I've never been self-conscious though around guys as friends. I always had lots of guy friends, and I never really felt shy around them talking about intellectual things; I never felt the need to feel stupid or anything. I think at least for me and my brother as well that we both have very high standards. I think that might come from being smart because you have high standards for yourself, and you don't want to settle for less than the best. I don't know if that's something I got from my parents or if it goes with being smart. I think that makes it hard when you want the best for yourself and sometimes you have to compromise. Obviously you're not going to find the world's most perfect male, especially in high school, you're going to have to compromise if you want to some sort of social life because there's only so many people in high school.

I don't know. I haven't talked to my brother too much about it. I will talk to my mom, I think she will tell me, my brother hasn't quite gotten over the dumb sister thing yet so he's probably not going to talk to me too seriously for awhile.

**Daughter:** It's funny we don't talk about dating even to our Mother. We don't mention it in our family. It's funny because my Dad says my sister and I shouldn't date now, we shouldn't even date in undergraduate school. He says we still we have to study but, when he talks about our future he speaks of our being married and having kids. My sister asks, "Well when is this going to happen, we're not dating." So often he speaks of how we are going to be married but he's missing something in between! All our friends know it is the same with their dads. They don't think their dads will ever approve of anyone for them.

My sister and I really didn't date in high school. According to my Dad that was good because boys just mess up your interest in academics and your time to study. He would say we were too young, that we didn't need to worry about boys now. He would say that now is the time for you, you need to accomplish all you can. He will say we are not studying that we need to be developing ourselves in other areas, areas like volunteer work or something. He will say we have friends and family, and that dating is a different kind of relationship that we don't need to have right now. My friends and I have discussed this and we know that it is going to be really hard to find someone that our Fathers approve of.

### *Managing Life Problems of Illness and Depression*

**Daughter:** Yeah. Yeah, It was hard being 16 and receiving a terminal medical diagnosis. I wasn't dealing with the same issues as most of my friends and I would get really impatient with their flighty worries or whatever and of course, they really didn't know what was going on. I didn't really talk to them about it. But I felt like I was 35, you know. I didn't connect with a lot of people my own age. I still don't.

Medical problems are difficult at any age, maybe they are compounded at a time in a person's life when they are supposed to be able to try on independence and manage their lives with less interference. The knotty problem of diagnosed depression reared its head in three of the eight families in this study and became yet another arena in which father support became an issue. The problems of depression that three of the girls in this study suffered with were issues that some of their mothers and grandparents had also dealt with.

J. T. Webb (1999) discussed the issue of depression in gifted females at a talented and gifted conference. He spoke of the problem of depression as more than a passing issue; he spoke of its familial connections, and of its possible relation to the emotional intensity and perfectionism of gifted girls. Whenever it is a problem, it is a serious problem that deserves serious and determined long-term attention.

During one of the interview sessions a daughter was discussing her relationship with her father over her lifetime when she began talking about a time in her life when her grades started dropping and she lost her interest in studying. Because her situation was similar to the other two girls I will present her comments.

**Researcher:** What happened to change your interest in your schoolwork?

**Daughter:** No. It wasn't exciting for me anymore. Calculus I was fun, I had a good teacher and the problems were interesting. But calculus II was just (pause) it was a big bite. I was a senior in high school and taking calc II at the university. It was a struggle with Mathematica. It was a lot of work that I just wasn't ready to put in. Mathematica is a computer program where you tell it to integrate something and as long as you know what it does with that command, it will produce an answer that means something. The language there is tricky, it is trick to understand what it is doing.

**Researcher:** What was happening in your life?

**Daughter:** You know I had always been in the Honor's program, there was a good group of people and I was enjoying the classes and I still liked the readings but I was struggling a lot with writing. At age 15 they diagnosed me with depression. I think that was a big part of it. But whatever I was doing, I was reading things and when asked to process them, my reaction was "I have nothing to say." So my grades just went downhill fast. Stuff wasn't incredibly challenging; especially in the 9th and 10th grade when I was a 4.0 student who wrote her English papers in Science and did her Science homework in English. After that more work was expected but for whatever reasons, whatever mental blocks, I wasn't doing it any more.

I still struggle with confidence when I'm writing papers. I am a perfectionist. I think it is actually something that I got at least in part from my Dad. But, if my thesis isn't phrased quite right, I'll play solitaire until I'm ready to try and rework it. Or if I'm not getting a transition between paragraphs, I'll have the same block. I'm actually writing now, which shows significant improvement in desire and will to even be involved in that sort of school work.

Sometimes I was feeling depressed. I was still fairly active in all I was doing. I was doing Theater and Odyssey of the Mind. I didn't do Odyssey of the Mind my senior year, but every year up till then. Science Olympiad I did through Sophomore year, really I stopped doing that, not because I necessarily lost interest but the people I knew were all dropping out of it. The coach had made things a lot stricter and the environment felt like it changed. I wasn't enjoying it any more. So, yeah, I was still active. I still had interests, had friends.

**Researcher:** How old were you?

**Daughter:** I was 16 going on 17.

The interview I had with her father discussing how he helped her in issues related to her depression:

**Father:** I think we felt that our daughter's self esteem was slipping. I don't know what age it was, but it was in that fourth through sixth grade period that we were aware from the world around us and the messages that were coming in, that this is something girls do; that they retract about that age. We could see it happening with her. We tried to talk her through that period and tried to reinforce herself-esteem. And then along comes depression and wiped out whatever teaching and talking we had done. The support we gave was pretty much out the window by the time she got into high school and hit those depressive periods. So I think there is a difference. Self-esteem is one of those things that is, I guess, a value, that I worked on probably continuously that "Gee I really need to complement her on this." "I need to give her some positive message."

**Researcher:** Can you talk more about it?

**Father:** Yes, I can talk about it now. It was very hard, it was much more difficult at the time. I want to say it was the Junior year of high school or maybe early Senior year that her not wanting to start things was getting worse and it was pressing her night owl tendencies later and later into the night. Often times it would be 11 P.M. and she was still not started on something. You would call it writers block. She needed an essay on something and she just hadn't been able to get it started. Or she had started it three times and crumpled it up and now was just sitting there staring at the computer screen. There was a fairly dramatic escalation in that kind of behavior until one night she threw something down the steps and when it hit the brick floor at the bottom I woke up to see what was going on. She was pretty stressed out to the point that we were scared by what we saw. She said things like "I can't take it."

That was when we started taking her to the clinic. They diagnosed her with depression and told us who to see. So we started seeing the female doctor they recommended and hopefully did all the right things after that. In hindsight, there were earlier signs; some of that perfectionist procrastination, 'I can't do this good enough to suit myself' that we probably should have diagnosed much sooner than we did. I don't know, I guess I have a certain cynicism toward the medical community, but I don't know that even if we had taken her as a high school freshman, they would have recognized her symptoms.

What we took to the doctor was our daughter during her junior and senior years, who was pretty unwilling to accept help and was especially unwilling to do the practice that it took to get better. She sort of bounced on and off of medication and in and out of counseling and right through that time period and there was a certain helplessness over that that I felt. I wanted to say to her, "Look, I just, I want to push you through this process and you'll come out on the other end and you'll be so much better." "Don't you see how much better you'll be if you just follow the doctor?" "No! they don't know what they are talking about and I don't want to take the medicine and I don't like the sweater that the guy is wearing on the front cover of the book." These all sound like petty excuses but these were the kinds of reasons why she rejected and rebelled against what she really needed; which was clear to us. "We're the outside experts." "We know what we are doing." "We know what you need." But it took her pretty close to failure to turn that corner and come back up and say, "Yes, I do need post-it notes around my room." "I'm a nice person." "Have you done your exercises today?" "Have you filled in the workbook?" She finally got around to doing even that.

Well, back to the point of the depression, yes, we knew when the catastrophe hit and as soon as we moved to solve the catastrophe we could look back and say "Gee you know for two years she has been doing these things that we thought were laziness or mood swings" There was a two-year period where we watched this coming and we didn't know what we were watching.

**Researcher:** What was happening in her life?

**Father:** She was unwilling to start work, there was a real unwillingness to start the unpleasant. I would tell her "Look you have to do this, it is an assignment." That was pretty close to when she bottomed out, she didn't bottom out until she got to college, but the stress of high school was really making her depression worse and she just wouldn't start things that were unpleasant for her. She still did very well on the things she liked.

**Researcher:** Has there been a pattern of depression in either of yours or your wife's family?

**Father:** Yes, in my wife's family. Her father, our daughter's grandfather, had clinical depression in the mid 1970's which was before I knew him. I had led a sheltered life. I didn't know that there were people who went through this. He was on lithium and electro-shock therapy. Seriously depressed in the mid to late 70's and early 80's. And my wife has had depression on and off and has been to counselors for it and has used various medications through her adult life too. It wasn't until she was an adult that it showed up in my wife, and it wasn't until late in his adult life that it showed up in her father. But our daughter got it as a junior in high school.

**Researcher:** And what was your relationship like during that time?

**Father:** She lived at home so we saw her there and we ate together and did those kinds of things. Things were, I would say, normal for us during that period. She had a series of jobs and did quite well. Right now she works in the book store at the university. She comes home and talks about how things are at "her bookstore." She cares very deeply about things that she gets into. In that year, one of the first jobs she did was to count plants per plot for another professor in my department. She would come home and tell me how things had been in "her lab" that day, and here she is the hourly employee working for the graduate students who are working for the major professor! She is cleaning this place and organizing it like it is "her lab." I think part of that, bringing order and a sense of possession is what works for her. "Look, I can be in charge of this and I can do these things and talk this out." "This is where I'm going."

She wanted to diversify her life experiences. I don't know where that came from exactly, but she quit the university and she worked at the hospital in the laundry, hauling around tubs of wet laundry for washing machines that hold 200 pounds at a time. It was quite physical and it started at 6 AM in the morning. She worked with a team of adults who were all in their 30's to 60's. It was great. It worked out just right for her. She was up at 6 AM and down there. She showed great responsibility and motivation and came home enthused. She would tell me about how they can iron sheets on a machine that is the size of our living room.

I think at the beginning of that period things were a little strained because of what she was going through, she was still working her way out of depression and then she was staying out on Thursday, Friday, Saturday night until 4 AM in the morning. We didn't approve of that, and she knew we didn't approve, but she didn't care enough to change it. Those are the times that you say, "Gee, that's when all the bad stuff happens out in the streets." "Are you sure that you are okay?" She kept saying, "These are not bad people," "You have to trust me on this," "You sent me off to college and allowed me to make those decisions, you should allow me to make those decisions now." "Well, are you sure? I don't like this." She says "Okay," and then went off to do that again. By the time she went back to college, we were talking a lot more about some of the old things we used to do, "How's this machine work?" and "What kind of plant is that again?" the kinds of small things we talked about before.

**Mother:** I do worry about her emotionally, because I have seen what happens with depression. She has some very strong feelings about that too in that it is a problem that runs in my family. It is my grandmother before me, my father, and me, and now her. I haven't talked to her about this recently, she thinks it is a personal weakness, that she ought to be able to rise above and so getting her to take any medication was difficult. She resisted therapy so they gave her a workbook to work through about how to do the inner talk to yourself, commit yourself, feel more positive all the time. I think that has made a difference. As far as I know,

she refuses to take any medication. There is a seasonal aspect to the depression. And recently, with the help of her boyfriend, I got her to agree to use a special light during the fall and winter to help her. But beyond that, I worry that at some point she will refuse to take the medication and that the biochemical imbalance will take her the other direction and she'll spiral down and have a bad situation. I used to worry about her in high school, because she had an episode then too where I really was concerned about suicide. She never said anything, but so many high school kids do that, and that fear was in the back of my mind all the time.

### *Phenomenon of Father Support*

The phenomenon of father support is based on its three subcategories: (a) Father's Perception of daughter's Giftedness, (b) Father's Attitudes about Family Time, and (c) Father's Values.

Rash (1998, July/August) discussed the need for parents to be aware of the characteristics of gifted children that differ from those of same-age normal children. Earlier than other children, gifted children sometimes walk, talk, and understand. They may display motor abilities beyond what is normally accepted for a child at an early age. They frequently use more words, display a greater attention span, use more complex sentence structure, and exhibit speedier learning. They may also have a more intense need for books, use toys and tools in a larger variety of ways and with more complexity. They are sometimes able to decipher codes, patterns, and puzzles, create to play activities, some demonstrate deeper understanding of questions and answers from grown-ups. Some gifted children exhibit an early interest in time, use abstract reasoning, have a sharp sense of humor, show extraordinary alertness, have an insatiable curiosity, are more comfortable in the company of adults, ask a barrage of questions, have intense activity levels, need less sleep, have excellent memories, and suffer from asynchronous development.

### *Father's Perception of Daughter's Giftedness*

**Researcher:** Talk about the time when you first realized your daughter was gifted.

**Father:** It seems that she was laughing, smiling almost as soon as she came home from the hospital. She seemed to start talking almost effortlessly and had a lot to say... (pause) She walked early, she talked early and she seemed to understand, at least she would concentrate on my face for a long time and listen intently to what I had to say. She loved books.

**Father:** I don't know when you know these kinds of things in pre-schoolers; in the three to five year old range she picked up stories very well. She was a night owl, probably almost

from birth, especially in the ages of three through five. She would not go to bed at 7:30 or 8 o'clock or even 9 o'clock like her friends were although, by about 9 o'clock we would force her to stay in her room. And at the age of three she would be sitting in there flipping the pages, reciting the books that we had read to her. I don't believe that she was reading the words. I think she was telling the story over again. That may have been an indication, but I don't have enough experience to know if that is normal or not. By kindergarten, she tested into an all day experimental kindergarten class, and so by age five we were told by others who had some sort of quantitative measurement that she was fitting the definition of giftedness. I don't have a good answer to the question, because, since that is something that is outside my experience and everybody thinks their own kids are bright and grandparents all think their grandkids are bright, I guess I would say I really didn't know until she was tested for the school program in kindergarten.

**Father:** I think I had glimmers of her ability at various stages. She has always been interested in books. The first interest that anyone showed outside of her mother and I being exceptionally proud and willing to take all the credit for the fact that she was somewhat precocious, was a study conducted when she was in preschool. She had an evaluation and they told us, 'You have a bright kid here.' That was very rewarding, but we knew it all along! That they noticed only mattered because of what she was offered, an opportunity to be challenged at her level of ability. Part of the advantage of living in a town like this was that she knew there were kids brighter than she was, and so she learned how to work really hard. One of things that I am most proud of, as I look at her, is she didn't rest on the natural abilities, but she has her mother's work ethic. She put in the hours and did her homework, she did all the things that needed to be done and the rewards came.

**Father:** They were all bright, they all did things together. I remember walking through the kitchen when they were working on something together at the kitchen table and they were discussing gigabytes. I walked through the kitchen then back again because I wondered if they were discussing it intelligently. They were. She was five years old and she was right in there talking about these advanced things.

**Father:** Well, it's an interesting thing! (Laughs) I mean, my wife and I both have doctorates and we work at the university and my father also works at a university and my wife's father is a physician and so we didn't think that our daughter was anything special, really. I mean, she was just a kid that we had that seemed to be able to do a lot of different things. I guess it wasn't until people did some testing or we were around other more "average kids," that it was clear she was a little ahead of the other ones. But again, I mean both my wife and myself growing up were not all that different than she was and I don't think either of us really thought of ourselves as exceptional. I don't think our daughter has really ever thought of herself as exceptional. This is the way we are and we have certain abilities to do certain kinds of things and it just makes it possible for us, for her to take advantage of certain opportunities and learn things quickly and enjoy the world that's out there.

**Researcher:** When you realized that she had high ability, did it make a difference in the way you parented?

**Father:** Well the school told us the results of those tests. I am sure there are things that we did that we wouldn't have done otherwise, but they were no big deal. There wasn't any special, 'Hold it! Stop! We are doing it wrong, now we have to go this other direction!' It was more



along the lines of, 'Well, that's cool, now we have to buy chapter books sooner than we would have otherwise.' So all we did was step through the milestones a little sooner. But it is not because we discarded what we were doing was wrong and we needed to start something else. It was just we were always going to do these things, the question was when would we begin. We were always going to buy books, and we were always going to transfer from crayons to colored pencils, it was just, 'Oh, now is the time to do that' and 'She seems to be asking for this,' or 'She seems to be ready for that,' So, 'Okay, let's do that.'

**Researcher:** Talk about the time when you first realized your daughter was gifted.

**Mother:** All of this may sound egotistical, but as a parent I expected that she would be gifted. I always thought I was gifted because I was always in accelerated sections when I was in school. My husband is very bright so I didn't expect that we would have a child who wasn't academically very capable. Let me say that I don't know about "gifted," but I think "academically very capable" is where I just expected her to be, and she didn't surprise me at all. She learned to talk very early, and she had a very big vocabulary.

I remember the first day we took her to daycare, they wrote a note that said, "You need to work on her vocabulary." The note was in front of me and I said, "What, what do you mean? This child talks all the time and she uses words and complicated phrases and that I don't see in other little kids." I asked them about it, and she said, "Oh, no, it is just that she is so vocal that we feel that is an area where we can excel her further; move her along the tracks." They noticed! I think from then on she just picked everything up very quickly.

I remember when she was about 2<sup>nd</sup> or 3<sup>rd</sup> grade, we were home for a vacation and she was talking to her uncle during the dinner table at her great-grandparent's house and, he made some crack about something and she said, "Well did you mean that literally or figuratively?" Everybody's mouth dropped open that she not only used the expression but she used it correctly. She knew what it meant. This is what I mean about her early grammar.

**Mother:** I probably didn't pick it up as early as I could have because I was so busy in my life, my own hectic chaos; but I'd say I probably picked it up around two, two and a half years of age. When we would read bedtime stories, she would pick up if I would miss a page or she would tell me what was ahead in the next page. At first I thought she was reading and my oldest daughter would say 'No mom, come on, she has just memorized it.' This started when she was about two and a half, but by three and a half it became real clear that she was reading on her own. So I say that kind of evolved through that time period when she could talk a little more.

**Mother:** Actually we did not know because she was my first child. One day I was walking. I was pregnant with my second one, she was only eighteen months old and she was sitting in the stroller and reading the car licenses—the numbers and the letters and everything—and then somebody walked by me asked, "Is she reading?" I said, "I think so." I know she read all the licenses. They said, "Oh boy, I think she is very gifted" because probably that lady was working in child development or something and she told me, "Why don't you take her down to child development so they can test her?" I said, "I don't know. I don't see anything different." Because that was my first child I did not know what age the kids should start reading.

I remember the first gift that she got that was a book and I read it first, maybe two or three times and later on she knew everything from every page before I read. She would say,

“Show me the picture and show me the word,” and say, “This is the picture and this is the word.” She knew all of them.

**Mother:** Oh she had a tremendous vocabulary, she liked learning. We both come from very, I would say, sort of academic, intellectual families so that’s what’s always been valued in our families. So I imagine we probably expected to see that in our kids. But I remember making a list of words that she knew at some very early age and it was huge, and you know, she spoke in a very sort of sophisticated way at a very early age so it was quite obvious.

**Mother:** I really don’t know when I thought she was gifted. I probably always thought she was! She had a large vocabulary early. I know at 19 months she was in the hundreds of words. She’s always been very good verbally and now her higher scores are on the verbal as opposed to the math. She writes real well, that’s her area.

Early on she was really precocious, she loved to dress herself when she was real young, maybe between two and three, she would take purple and hot pink and orange and then she would want a bow in her hair. She was much more flamboyant than now. She isn’t flamboyant now. She was so flamboyant, she would hop up on a stool and sing and dance and carry a tune, really sing with a lot of range, and she was very verbal.

I always thought she was real sensitive. I have pictures of her very early wrapped up in an afghan like a mummy looking out the window with just her face showing. She would say “moo moo.” She already wanted to see the moon. She and her Daddy would go out and watch the moon at night. They were the moon watchers. She used to love going out in the backyard and playing with the cat in the grass and not wanting the grass cut. She always liked things natural because the cat liked tall grass. When the apple tree fell down, she did not want it cut because it protected the cat. She was probably three, just really little because I have pictures of her sitting eating an apple off the old apple tree and sitting in that tall grass and wanting that grass to be tall.

**Mother:** I can’t remember when I realized she was gifted. I have always believed she was bright, but how would you know for sure? At first it would probably be a desire, you have a child and you look at them and you say, ‘This is a gifted child?’ That is pretty unclear, right? However, I think if you do not think you are going to have a gifted child you won’t. I think those early times you have to think you’re going to rear them for giftedness otherwise you don’t. For example if somebody said, ‘This child has potential for an IQ of 50,’ you’ll probably do something different then if they said this child has a potential for an IQ of 160. I remember when she was real little her father would say, “She is going to be the first female President of the United States.” We wouldn’t say she was *gifted* [emphasis hers], I don’t think as much as we’d say, “she’s bright.” She did whatever she sets forth to do, and she always seemed to know what she liked.

**Researcher:** How did you feel when you realized she was gifted?

**Mother:** It scared me a little actually. It scared me because I wanted to make sure we did what we should do for her. She was never to the point where I thought, “Oh, my word. She’s this genius.” It was never to that extent. It was just more of fear that we were in the right school system that we were doing the things that we should be doing to make sure she was up to potential, other than that I don’t know. I think every parent wants the best, the best teachers, the best schools and the best ways to help their kids be successful.

**Daughter:** I'm wondering how much my dad found out about my being gifted, I mean, I'm sure he was told. My parents made comments to me that they knew I was what they called a "frighteningly bright kid," and they challenged me. I remember while we were standing on the patio Dad would ask me, "Sam, what's the square root of 64?" I was five years old, "What's the square root of 81?" And you know I'd always know the answer was either eight or nine so I would keep guessing! They kept challenging me to read and encouraged me to go to the Super Summer program here in town. I think that is probably what it was, they just kept challenging me to move ahead.

**Daughter's Journal:** When I was growing up my Dad never called me "gifted." In fact, my Dad never really made much of a big deal about my intellectual abilities. My good schoolwork was simply a given, not something to be constantly fawned over. In fact, it was much more likely for my mother to be the one to tell me I was "smart" than for my Dad. Only recently have I begun to receive praise from him about my schoolwork. He told me "You write very well. You should be proud of yourself." And that's the way it's always been with my Dad and me. He still wants me to know that it's more important to be proud of my own accomplishments and work to make myself happy than it is to do things only for other people.

Maxwell (1998, February) found that parents of highly gifted children remember noticing signs of intense awareness almost from birth. Their babies are seen to be extremely alert, with a penetrating gaze, they smile early, and show early recognition of caregivers. The probing, active self of such children appears to relate early to a recognized other and presses to refine its interactive tools. They sit, walk and develop large vocabularies at an early age. Many parents report that they never talked baby talk with their children and were surprised how early it was possible to have a real conversation with them.

When speaking of the early development of gifted children, Koht (1971, 1977) indicated that there is a difference in their development. They observe the behaviors of others and model them amazingly well, but they model selective behaviors and they do so with a bit of an attitude as if to say that this was not just copying behavior, it is a thought out behavior. When they are young they are more dependent on their parents for love and nurturance than they are for directions. An early and continuous cry is "I can do it myself."

#### *Fathers and Family Time*

Lamb, Pleck, Charnov, and Levine (1985) attest that the very basis of fathering is his "presence" in the child's life. Snarey (1993) found fathers support of social-emotional development;

intellectual-academic development, and physical-athletic development during childhood and adolescence to be important in the lives of their children. It is important to note several things when looking at the Snarey (1993) research in comparison with the present research: fathers in both studies were born during the same baby boom era during the late 40's and early 50's; the Snarey (1993) fathers were less educated than fathers in the present study, and children of the Snarey (1993) fathers were born into their families earlier than children in the present study. Snarey (1993) used quantitative, self-report data to investigate supportive fathering practices in one group of 240 fathers; and a finding that seems important indicated that overall father support was given similarly to sons and daughters alike. While terminology differed in each study the meaning of some terms were interchangeable and both studies identified nearly mirror images of fathers' paternal generativity in support of social-emotional development; intellectual-academic development, and physical-athletic development during childhood and adolescence. Additionally, findings in his study indicated that intellectual-academic father support was given more in the adolescent decade than in other decades of the children's lives. While the distribution of support over the various decades of a daughter's life was not measured in the present study, characteristics of support were similar in both studies: providing materials, playing with their babies, reading to their young children, taking them to libraries, consulting (advocating?) with their teachers, providing extra-curricular lessons, and enrolling in special courses.

"Family time" was the first "in vivo" code (Strauss & Corbin, 1990) to emerge during the interviews. When fathers began to speak of family time they seemed to relax and their thoughts began to flow more naturally as though they were speaking in an arena of comfort. They talked about the importance of spending time with their daughters; they talked about how they made special allowances in their jobs for the stated purpose of spending time with their families. The fathers valued time with their families and spoke of it as something that they planned for and would not miss out on. They talked about the specific things they did with their daughters and they also talked about "time";

of “being there”, “being in the same room”, “listening to family stories of activities”, these somewhat passive relationships on the father’s parts; as being valued by both father and daughter. These statements by the fathers and the fact that family time actually occurred—regularly, over the lifetime of the daughters seemed to give life/meaning/vitality/credibility to their earlier statements that “I believed raising my daughter was the most important thing I would ever do.” Although parents do not seem to dominate the conversation during family time, they are present in the family unit, listening, and interacting with their children. What are the long-term consequences of this time together? This concept seemed to set the background for the supportive fathering practices espoused by these fathers and it provided room for the achievement of their goals of spending time with their daughters.

Although reading to children has been widely acknowledged as supportive of intellectual development, the importance of family time has not been as widely reported. In this study, both reading and the value placed on family time as well as the consistency and quality of time that family members spent together were noted to be intervening conditions fostering support within the relationship between the fathers and daughters.

Two fathers discussed their views of the importance of spending time with their daughters:

Father: Thinking about my relationship with my daughter over her lifetime, *I realize how I valued the time we spent together* (Pause, he seemed animated when he began speaking again). When she started school I initiated family time at our house and we made it a rule for everyone to be home by 4:30 PM. Being in academia made that possible for me. Every day as far as possible we were home in time to do some house or yard work together, I wanted them to feel that they were an important of making the household work. Then we made the meal and we had family dinner together. We wouldn’t always work together but if they were working I was there and I could help if they needed it. Dinner together was an essential part of that time. During the meal we just talked about the things that came up during our day, but we were together and we had that time to see the kids and to hear from them. We tried to listen to them, to hear about their day, we thought that was important. Then after dinner everyone had different things to do. When the kids were older the time varied and sometimes they had to go back to school for practice sessions. Sometimes we played games if they didn’t have homework or books.

Father: I’ve tried to set regular times aside to be with each child on a regular basis, one on one, without other friends or family around. Fortunately, that continues. When my kids come home, even our son, when he comes in later, or I come in later, we usually hook up for a few minutes to catch up on the day, on what’s happening. I don’t believe much in the concept of

“quality time.” I don’t think you can short change time. *All time you spend is important, even when it’s doing mundane chores.* Spending “significant” time is important, whether you think it’s quality time or not. *Spending time with a child raises their self worth, it helps them understand how valuable they are.* [Italics for emphasis, mine].

I asked other fathers about the time they spent with their children.

**Father:** Briefly in the morning, and if we were there, it would probably be a majority of the evening that we would have all been together, as in the same place at the same time, maybe not closely interacting during this time, but evening would have been the bulk of time we spent together.

Six of the fathers spoke of similar kinds of regular family activities during the evening time spent together.

**Father:** Well we were still reading to her, probably through age four and five. We read all kinds of books. She read a lot of the picture books that you would expect for infants and very quickly moved on into stories. We would read to her and tell her at 9 PM, ‘No, you have to go to sleep.’ When she was still in her crib, which had to have been when she was only two years old, we would hear her flipping the pages, reading the book to herself and reciting what we had just read to her out of that book. These were books with lots of pictures and three lines of text at the bottom of each page. She has reminded me that when she was about five we started reading James Thurber. I tried to find the short James Thurber stories because it was just something I enjoyed at that point in my life. I think during pre-school we also probably read to her small amounts from the newspaper and from magazines, saying ‘This is what we are doing’, and ‘Listen to this.’

**Researcher:** Family time was expanded as the daughter grew:

**Father:** Well, covering that range of time I guess the usual. The reading, the storytelling when she was quite young. She was in a few early classes, a music class, a tumbling class, took dance lessons once a week, so to and from classes and lessons beginning pre-school age. Later on it was more not reading to her, but being in the same room, one of us reading the paper, the other two of them were reading novels for instance. Since I don’t read a lot of novels, I would probably be reading the newspapers and magazines. Some TV, but it was there and we did some of that occasionally. Later on, activities together, softball. I was the coach of her softball team, for example. And trips, we are 630 miles from all of our relatives, and a lot of what would be called family vacation time would always be spent driving on the same piece of highway, going to the same place to visit family. So a lot of road time and early on, two trips a year to Ohio to visit grandparents, aunts and uncles, cousins and so forth. So, I guess, remarkably the usual kinds of things.

**Mother:** Dinner conversations are so important. We value the time we spend there because over time we have discussed the issues of life. It doesn’t seem to ever be planned, but she reads a lot, my husband reads a huge amount and I read too, and somebody will bring something up. Oh, our son doesn’t read much at all because he always doing golf or sports but, he might bring up something that happened on the golf course like, ‘You know what happened today? and that might lead to, ‘Oh, my! So what happened?’ ‘Well, what did you

think about that? Did that bother you or what did you say? How did you...’ I think it’s because there’s a stream of questions that comes out, not like a judgment, but always, I want to know how they felt about being in that situation. That seems real important. “How did you feel about that?” And then their father might say, ‘I read an interesting article in the “Economist” about so and so and this is what happened.’ Or he might say, ‘Did you see where so and so did this or...?’ Just something like that, then out of that grows a conversation. When we see each other at the end of day if we just talk about the day, something emotional usually comes up either happy or sad. Because if you talk very much to people and you are open, you get into feelings right away. There’s nothing you do that’s isn’t feelings. So the conversation might be, ‘Well, how’s your paper coming?’ Then our daughter would say, ‘Well, I changed what I was doing and...’ So we talk about the time constraints and her worries or something like that.

**Daughter:** Dad worked to make it home for suppers together and to help around the house. He would go in to work early before I got up and make it a point to be home by 4:30 PM to spend the evening with us. He was rarely gone to work on weekends. Evenings were always the same, we ate together at the table and not in front of the TV. Friday nights we got movies and ate pizza together. When I was little my brother and I would jump in bed with Mom in the mornings, and we’d play with Dad in the evenings; kid games like Memory, Chutes and Ladders, Candyland, and family puzzles. When we were older Mom and I read, we all did a lot of reading. Dad told us that as a child he didn’t have very much responsibility and realized that wasn’t a good thing. So he wanted us to have some responsibility around the house, like cooking and cleaning. He saw to it, but he’d also stay in the kitchen with us while we did the work.

**Daughter:** *We commuted to work with our parents every day of the week.* They drove us to school in the van and we had to wait until they were finished with work to go home in the evening, *but once we got home we had family dinners every night where everybody had to sit down at the table. That was our main family time.* [Italics for emphasis, mine.]

In this family commute time was not considered “family time”, it was time to wake up in the morning and unwind from the day, but evening, dinnertime was time for family interaction.

**Researcher:** Did you like that?

**Daughter:** Yeah, *That’s the main thing I miss from being home* (Sigh). [Italics for emphasis, hers]

**Researcher:** What kinds of things did you talk about during your family dinners?

**Daughter:** Sometimes it would be science stuff, or mom would be saying something about her work. I don’t remember my dad talking a lot about his work, I don’t think he thought that we were so interested in it. Sometimes I’d ask my dad about what he was doing or something like that. He didn’t talk that much about work, he would talk about other things. They both do important work, Dad is an engineer and Mom is a chemist who works in a lab. That is cool. Sometimes they’d tell us stories, like my Dad would tell good stories from graduate school, (pause—laugh the crazy things he did when he was a kid. We always, all three of us kids liked those stories. He’d show us something neat with magnets and other things sometimes.

**Daughter:** I haven't been home for an extended period of time since I graduated from high school. Time at home during winter and summer breaks were *just normal*. He asked how was it going? How many classes was I going to take? Dinner table conversation was normal. We told if something interesting happened during the day, we weren't big dinner table talkers. No big philosophical discussions, sometimes the TV was on till everyone sat down, we left it on sometimes. We talked about current events; if a politician was on that was so stupid we talked about them and some about politics. We talked about day to day things. Interesting events. It was mostly the kids who talked.

**Daughter:** When I was little I was at day care in the morning until the bus picked me up for school, which was not very long, and then again in the afternoon from 3 to 5. Then evenings and weekends were "Parent time."

**Daughter:** When you think about time we spent together, when we were little he told stories. They sounded like fables. They were stories about animals. In hindsight they were Asian fables, common stories that he heard as a child. I can remember him telling us stories when I was in preschool and he told stories to us until I was in about the 3<sup>rd</sup> or 4<sup>th</sup> grade. I had a room with my sister and he would come in after I was too old for stories, she'd ask for a story and I'd get another one! (groan and a laugh!)

#### *Father Values*

Individual differences of opinion between fathers and mothers were noted in the current study in the subcategory of father values. Fathers stated that they held certain values as very important in their lives, yet they were reluctant to stress those values by teaching them directly to their daughters. In many situations these fathers spoke of teaching values to their daughters by example rather than by word of mouth and they used words and phrases such as: intuit, by osmosis, through observation, through modeling, etc., to explain how they had transmitted their values to their daughters. Mothers, on the other hand, had definite opinions about the values they wanted their daughters to know and they were emphatic about the importance of transmitting those values and felt they would more likely be adopted through discussion and reasoning.

Walker and Taylor (1991), conducted a 2-year longitudinal study with 63 family triads (mother, father, and child) with children younger than those in the present study, in grades 1, 4, 7, 10, to predict moral development and reasoning over time. Their most significant finding was that parent discussion style and level of moral reasoning were predictive of children's moral reasoning



development over the two-year period; when parents discussed moral issues that were real, children were more likely to internalize those discussions.

**Researcher:** What values were important for you to pass along to your daughter?

**Father:** Things like going to church even if that's not exactly what you want to do at the time because you are tired. Things like showing that you love your kids' mother. Taking an active role in their lives like coaching softball, those kinds of things. Showing them it's important to be involved with your family and with your kids. It's just living a good example.

**Father:** Well, certainly the big ones. I don't recall ever saying to myself, or deliberating planning and saying, "Gee you know, this is a value that I hold dear, therefore I must impart it to the next generation." Teaching values is something I hear a lot about, but I never really thought that is what I was doing, but I did. I think it's clear that I did. I don't recall that I ever said to myself, "Today I'm going to teach a value, therefore we'll do this." I think values training is one of those things that is just woven into the fabric of life and it hopefully, it seems rather seamless. I don't think values are something that you pull off and say, "Today we're going to talk about thou shalt not steal, and you are not supposed to kill people."

At her pre-school we made sure that we knew the teachers. We volunteered for the clean-up, fix-up day kind of activities. So, she probably saw from us that volunteerism is part of what we do in life. I never thought of it as teaching a value but we were always involved in everything she did, whether it was dance class, we knew the people at the dance center, we met those people, we knew who they were. So without ever having said "This is values training," I think it happened, and it just happened because of who we are. We didn't change because we had a daughter and we certainly didn't change our values teaching because the school had identified her as accelerated in any way. This is just who we were and what we did and she came along with us because she was there.

One of the values that sort of shaped our lives in an obvious way is that we are vegetarians. I think of vegetarians as kinder, gentler people, that there is this extension of what is right in our relationship with other people that extends to animals. We don't kill them because we don't want them dead. We have four cats in the house because animals are an important part of us, especially companion animals. We do all that we can for those cats as we would do for other members of the family. So I think there are values of vegetarianism that are in her, "be kind, be gentle, don't kill, don't cause pain." Now, it is obvious that meat-eating families come up with those same values so I don't think we are different in that regard, but somehow, that's how I see those values transmitted.

**Father about his daughter's values:** One of the values is she takes pride in what she does. She has a job in a bookstore where she is a cashier; she is on the bottom of the totem pole, yet she talks about *her* book store [he laughed]. "At my bookstore today," such and such happened and she really has a pride in ownership toward things. She did the same thing in the laboratory where she worked on campus, "In my lab today we did this." Well she was the hourly student who was working for graduate students who were working for a professor! So again she was at the bottom of the totem pole, but she was exerting some feeling that "this is good," "this is mine, I'm doing the right stuff here." She knows she has to work for things. I think she is honest and caring and those are values that I am glad to see in her at this point in time.

**Mother about her daughter's values:** Our daughter is very responsible. She always has been

she has always worked. We've never told her to get a job. Her college is costing us almost nothing yet she works to make extra money, so she's a hard worker. She takes 18 credits, has a part-time job, cooks dinner for her friends and gets it all done. She is a very capable kind of person. She has talked about like maybe going into the Peace Corps so you know, she thinks about helping others which I'm pleased to see. So, yes, I would say that whatever has been important to us seems to be important to her at this point in her life anyway. Involvement in the religious community which is important to us, I think she values that. You know you're not going to do so much when you're in college but from things that she's said I know that it is important to her in the future.

**Researcher:** What values were important for you to pass along to your daughter?

**Mother:** I grew up in a home where things were just taken for granted. My folks did not drink. You were not supposed to drink, that was just something you did not do. You did not smoke, you did not swear. I probably heard my Dad say two cuss words my whole life. I grew up with those values. You went to church every week. You tried to do the right thing.

The value that is different for our daughter from the way my parents raised me is valuing people of different races. This is derived from the cultural influences she has had that I did not have. My parents lived in the same small town almost all their lives except for the time that my Dad was in World War II; there is not a lot of cultural diversity in a town of that size. I feel lucky that the kids have grown up with kids who are different nationalities because I did not have that opportunity and I think that was a loss for me. My parents didn't understand people of other cultures and would sometimes say unkind things. I would tell my children that my parents did not understand but that we did, that we have the opportunity to have friends of many different nationalities and that race is just not an issue. It's a non-issue because you don't even think about it. I think that was easier for our kids.

**Researcher:** What values were important for you to pass along to your daughter?

**Mother:** Now that's she's almost 20, I see her reflecting back in large measures what I thought I've put in just moderate measures because I didn't want to be too pushy. I am always interested in what she will now have decided are major values.

When we were first married we would kind of laugh about it but then we talked. I felt strongly that I wanted my kids to have a formal mold of my church. I wanted them to have everything it offered. I wanted them to have it just as it came, exactly as it came from that denomination. I don't mean that was right or wrong but I wanted them to have a mainline church like I had, then they could decide later if they didn't want it. I didn't want them to have nothing because what could they choose if they had nothing?

I just saw a book in my basement the other night called *How to Teach Values to Children* and I don't remember reading that. I think I just bought it and lost it but I think you do it again by talking to them. I think you tell them what you believe about something.

When I think of honesty, I don't always go by the letter of the law. I remember saying things to her like, "Well, you have to decide what is the right thing to say. Yes, I did say that to Grandpa." I'll say, "I don't really consider that a lie because Grandpa worries a lot. He worries about money, he worries about travel," and I'll say, "I'm just going to tell it sort of like this for a little while so he doesn't worry too much."

When she was in high school and asked me to talk to a teacher, I'd say, "I won't say anything to my friends about calling the teacher," and she'd say "Good, I don't want to hear anything." I thought that was important because I know that kind of feedback isn't very

popular, but I would call for her own good, she knew that and she wanted me to call.

I think she has a real deep sense of spirituality. It has really taken with her not to be materialistic, to save things, to take care of the environment and to pay attention to other people.

**Mother:** I always feel it's really important to tell kids what you're thinking because how do they ever learn if you don't tell them what you're thinking? So much of our lives are spent in thought. If you as a parent don't say your thoughts aloud, if you don't tell them what you are thinking, you don't know what messages they hear. You may not think they listen, but they do. They certainly don't cover it all at church and they don't cover it all at school. Besides that, they cover diversity and I have to tell them what I think and it's not straight-forward, it's always moderated. There's always the exception well this, but that, but this, but that, but then when you do it this way and then because of that we do this but then there's so and so and we have to think about that and I always bring up the complexity. Issues are always much more complex than an institution teaches, either church or school or anywhere. We have our table discussions about why something is right or wrong, or what is right, what is wrong? I mean issues come up all the time in the news that are excellent for table discussion.

**A daughter about her father's values:** I think he knew how to instill the right morals, and what morals he wanted for his children, and sort of the way he wanted his children to act. I think what he had in mind was probably to be honest, not to lie or cheat people, steal, or things like that. Treat other people with respect. I think he didn't want us to get involved with the wrong group of people. I've never heard him say any of this stuff, I usually hear things through my mom, so it's kind of strange. My mom will say what my dad has told her. It's different, sometimes I wish my dad could be direct with me.

**Daughter:** I think he was never conscious about teaching us morals or values, for example, *he wanted us to be really close. He would bring pencils and say, if you have one pencil you can break it easily. If you have a bunch of pencils they won't break so easily.* Maybe that is why I am so close to my brother and sisters [Italics for emphasis].

Late grade school/early middle school as a pre-teen I guess I started thinking of him as too overprotecting. I talked about wearing make-up and dating. He'd say "*School is not a fashion show.*"

I thought it wasn't fair I couldn't date. I had a friend who was also Asian. She couldn't date. I thought, "Oh that's why I can't date because I am of the same nationality." I wasn't real social so it was a moot point but the rules were in place if the issue ever came up.

Religion is not very important to our family. I guess values like honesty; do the right thing; a work ethic; importance of family; concern for your family. *They teach these things by demonstration, just doing them through their own actions. I think definitely there was some preaching, 'like this is what you should do' but there wasn't any hypocrisy.*

*He tried to instill in us the work ethic. He came home at five P.M. I always knew that was where he was. He would still have things to do in the evening, he always kept busy.*

**Daughter:** I try not to be a bad person, I do the "legal" stuff. I try to be fairly honest, trustworthy, pay my debts back fast. I don't try to impose my values on others, don't try to communicate them to others, just live them.

I'm involved in volunteering time at the Crisis Hotline during the school year; I think that shows my value of caring for others. I started out in the environmental club because I had enjoyed that in high school, but here at college it was so partisan and founded on big intellectual debates instead of direct effects and local effects like the crisis hotline. In high

intellectual debates instead of direct effects and local effects like the crisis hotline. In high school we'd talk to farmers whose houses were next to a hog lot, not to partisan groups, we'd talk about actual physical issues and actually try to find [emphasis, hers] a solution to issues related to hog confinement. Working on the Crisis Hotline I learn a lot about an issue, I learn, and not just do it.

Daughter: We went to church all the time as a family. He encouraged us to go to church and he encouraged the values of church.

Daughter: My friend and I were talking about how we never used alcohol or drugs and wondered why? Was abstinence something we learned about and valued?! Now she has been my friend since 7th grade, the first year we were in Odyssey of the Mind together, we were talking about how our peers in school, in grades both above and below us, were drinking alcohol and doing drugs, and we were saying "Why did we never?" "We never even thought about it." Jenna, Christy, Eleanora, [pseudonyms] all of my tight friends, it didn't occur to any of us as something to do. I don't know why that was? Maybe we had better things to do, maybe we weren't offered access, but it wasn't something that we sought. We didn't try to get a hold of alcohol or anything. We weren't like "Oh I've got to experiment with this" or "See who I can get to buy me something." I don't think that there was anybody in Odyssey of the Mind or Science Olympiad who did. I was in a couple of other activities where people were into drinking or drugs; there were athletes who were, people in choir were smoking, people in theater were smoking, drinking whatever. So it was no specific activity or thought. Maybe it was a social group thing. We didn't want it. We didn't think about it. We just didn't.

Support for the idea of discussing values early in the life of a gifted child is the strength and stability of interests over time that Lubinski, Schmidt, & Benbow (1996) identified in their analysis of 203 intellectually gifted adolescents. Values addressed in their study expanded from the social and religious values discussed in the current research, to theoretical, economic, aesthetic and political values assessed by the "Study of Values" (p. 444). Their findings supported the idea that assessments during early adolescence are somewhat related to education and vocational preferences in adulthood. And that individual differences in preferences of the intellectually gifted adult are related to values assessed in early adolescence.

### *Context Fostering Support*

#### *Intergenerational relationships across the life-span*

It is within the context of the girl's lifetime that support is discussed and the intergenerational differences relating to the awareness of that support are apparent. There are not many reasons a 19-21-year-old girl would have to make time to recall her relationship with her father over her lifetime,

so it was interesting to see with what surprise the girls realized the support their fathers had been for them. Most of these girls were getting ready to spend a year or more abroad and by the end of the interviews they all said they were glad for a reason to recall a relationship they had begun to take for granted.

Fathers recalled the early years with their daughters in great detail and they related how the relationship changed as the daughters' grew. During their growing-up years the daughters were busy just doing that, growing up! They enjoyed their fathers in many and varied activities throughout their childhoods and then about middle school they begin to stretch away into their own worlds and figuratively they left their fathers' behind, because literally they still lived at home in close proximity to their Dad's. By the time the girls reached middle school they seemed to be less aware of their fathers except as their fathers were present to help them with various projects. The girls were fairly mature before they began to appreciate their fathers differently, to see him as a person and to re-evaluate the supportive nature of the role he had played in their lives.

Fathers, on the other hand had grown up a generation ahead of their daughters, and as parents they were looking out for their daughters, they were trying to provide for them and guard them every step of the journey to adulthood. These daughters were very bright, capable, and strong-willed girls. As their fathers provided the structure and provisions for their journey through life, the daughters were reaching toward autonomy. They needed their fathers but their needs changed as they grew and their lives changed.

When discussing issues of childrearing, the fathers' contribution to their development is often ignored (Lamb, 1975). Youngsblade and Belsky (1995) discussed the importance of father influence in their children's lives when their research indicated that father relationships with their children were better predictors for friendship relations later in life than mother relationships. Rather than sit on the sidelines or serve as babysitters, men are being urged to participate in the lives of their children, from conception on; and apparently, increasing numbers of men are reaching out for more supportive

relationships with their children. The emerging view on fathering comes from the idea that men are able and willing to participate in the broad spectrum of parenting behaviors in addition, findings show that parents and children are better off when men take active roles in raising their children (Shulman & Seiffge, 1997).

**Researcher:** Have you always taken an active part in parenting your daughter?

**Father:** Yes.

**Researcher:** When you say parenting your daughter, what kind of things do you think of?

**Father:** Well, I think of the physical things like getting up with her in that newborn age when she was crying at night. We would switch off on that. When she was ill and needed to go to the doctor, half the time I would take her and half the time my wife would take her. For a time in her life the active parenting consisted of sitting up with her when she was sick or driving her to dance class if I had the afternoon off. Correcting behavior, what little we ever did along the lines of "Don't do that again" or "Stand up straight" kinds of instructions were just some of the ways I guided her. I think the answer to the question was yes, I was involved.

Note the generational difference in the time frame in which daughters become important to their fathers.

**Father:** Well I was very excited when she born. I mean I was from a big family and I was the oldest child so I spent a lot of time with younger siblings and I really enjoyed playing with them. I've always really enjoyed playing with kids so I was very excited when she was born. I felt really good about the whole experience. I was really looking forward to it.

When she was a newborn my wife was teaching in the same building I had my office in so we had a little playpen set up in my office and our baby would stay there and then my wife would go down and teach her class. She was teaching a couple days a week for three hours at a time so she would teach for awhile and then give the students a break and come up and nurse the baby and then go back down. So, it was fun having the baby in the office because she was a very good baby and I could play with her and talk to her and so on.

I do a lot of field studies so when she was a little girl she would come out with me in the field. She would come out to the prairie and walk around with me and look at stuff. I tried to get her interested in the natural world. Actually, both my wife and I are naturalists, bird watchers, and all that sort of thing. We always thought, "Oh, this will be great, we'll take our kids out bird watching with us," but they never really had as much interest in it as we did. That was okay, we didn't push it. I remember her coming out in the field with me at different points and helping me like carrying notebooks. I'm trying to think of all these years in elementary school. Then the kids go away to school and you don't see them as much as you did. They're kind of there when you get home from work and then they go to bed. I mean I did a lot of reading to her so we always had some time around bedtime when we'd get together and read something. She'd read something to me or I'd read something to her.

**Father:** Early on I would say that what I did as a father was pretty unspectacular. Pre-birth

and new born, it was all physical in terms of "What does she need?" "What are we doing to meet her needs?" "Is she eating enough?" "Is she growing?" "Are we making the doctor's appointments?" "Have we remembered the immunizations?" And just a lot of making sure things got done right for her.

Through pre-school she was in a daycare program, and a lot of the relationship was "This will be okay" kinds of things that I would tell her, these were the things that she would seem to need from me. Of course, we would ask about the day and try to extract from her what was going on and how she was doing, but I don't think this was an unusual concern. But our concern was "Are we doing the right thing?" "Is the day care the right one for her?" "Is the system all right." She went to one of those cooperative day care centers. We started through the day care system with the expectation that we really would spend a lot of time there. You came in and dropped your kid off and checked with the teacher at the end of the day. When they needed a new climber built for the front yard we showed up on Saturday and built it. That all fit into my relationship with her surroundings, but those are things that we did together. Sure, it was for the organization, but it was really, "Are we giving her what she needs?"

During her pre-school, and early grade school years, there was a lot of telling her again that "things are okay," checking up on her because her daycare was close to campus. I would stop in every once in a while and see how she was doing. She was always glad to see me. She wouldn't tell me a lot of what was going on, I usually had to ask what she had done for the day. But she was willing to tell me, willing to answer questions, "This is what we did," and "This is where we went," and "These are the names of the people around me." One of the things she still says is, "No, I don't know who his parents are," or "No, I don't know where her parents work." It seem to be one of the things that we would ask about! "Oh, you know John what's-his-name, what do his parents do?" She picked that up early on so she would answer that question before we had a chance to ask it! (laugh)

Through grade school I included her in a lot of activities. I would take her out of school for a day and we would travel to seminars; I would be out and back in a matter of a couple of hours, maybe as far as Fort Dodge or Des Moines. When I went to conferences in places like Washington D.C. or New Orleans, these were professional conferences that we were attending where either my wife or I were delegates, we took her with us and made it a family vacation. So there were these kinds of interactions where both when my wife and I were with her, or my daughter and I were together in this business sort of setting.

In 4th grade when she was eligible for softball, I thought "Volunteerism is one of those things that I'm suppose to do. I'm an adult now, I have this daughter and she is going to have a softball coach, I guess it might as well be me." And so for about 5 years I was a softball coach on her team. We would talk about the game. We would talk about how people had practiced that day, or how they had played in the last game. She would help me with the lineup for the next game and things like that. Our relationship was often one of just including her in whatever I was doing.

The late teen years were as difficult for us as I think they were for other people. She really made a stab at independence. She didn't want to be told what to do. She didn't want to study at her desk. She wanted to study on her bed instead and often times the harder you pushed her one direction the more she wouldn't do it. A lot of our relationship boiled down to "I'll tell you what I want you to do, and you tell me what you are willing to do, and then we'll sort of glare at each other and go on with it." So there, I think that was typical in that age. A real independence streak in terms of "I can do this, I can take care of it myself. Just because you and everybody else think that I should do something this way, doesn't mean that I'm going to do it that way, I'll have to learn it for myself."

One of the remarkable things is how often she has later, in sort of a sly way, said "You were right." She never came back and said "Okay you were right, I should have done it this way from the very beginning." But, I always seem to interpret it in what she was doing and saying, "I figured it out for myself and you were right, and but it is okay." It wasn't a thing of regret, it was more along the lines of this, "I learned it this way and now it is okay, I'm willing to do it."

**Researcher:** What interests does your daughter share with you now?

**Father:** Well, we have different jobs but we are certainly very interested in our jobs and so if you think about work as an interest, that is something we share a lot. She is still interested in my line of work. There are things that she notices that have happened out in the real world that she observed and she'll ask me about or just report in about. I think there are lots of things that we just talk about in very brief snippets. The restaurant burned down two blocks from where from her apartment and so she walked down and watched the fireman put it out. She told me what kind of fire truck they had and how many hoses they had across the street. These little things in life, these little events that we are both still interested in and share with each other.

This father-daughter pair have remained close across her lifetime. This shy girl hovered in books, her Dad became coach so she would play ball. Although he pushed her to spread her wings and live in a dorm at college, unknown to him she was struggling with depression and sought an environment that she thought would be more manageable, an apartment with her boyfriend. When she needed help she called her Dad. He helped her retreat when she needed it and helped her physically when it came time to move on.

**Daughter:** [*Italics mine for emphasis*] My earliest remembrance, that's hard. I always just remember being outside playing and he'd be mowing the lawn. *He was always around. And when he wasn't I always waited for him because we had such a fun time when he got home.* We had tickle fights when I was real little.

I don't know how old I was but he built a swing set, what do you call it? "An eagles nest." He built bonfires in the garden in the fall.

Summer vacations, we were always getting away, we went camping and canoeing. We've been everywhere in the United States. When I was 8 or 10 years old we went to Vancouver Island and found an abandoned beach. We hiked miles away. I liked it out there, we were looking for sand dollars. I would be walking out beside Dad and looking in the sand for stars, I'd find them and we'd dig them. We found more than 50 of them. We'd see little trails in the sand, like one drawn with a pencil and at the end of every trail was a snail burrowed in the sand. It was just the wonder of the life and everything that was there. We found starfish and sea creatures at low tide.

When I was older he was always there. He was my baseball coach, he coached teams and if he wasn't coaching he'd make as many practices as he could. I danced for many years. He would always tape recitals, all four presentations. One day he pulled the curtains for the recital. I stood by him and if I was good we could stand in back and watch all the dances.



In school, my life got busier. My main interactions with him were to help him. Since we moved to the new house it is Dad's and my job to put bark mulch around. We do this together. At Thanksgiving it is our time to put lights up on the front porch and the back yard. I'm still able to do it with him, we cut the Christmas tree.

*Because he made a point of being around he was there when I needed him, I could talk to him when I needed to. Sometimes I had a better connection with him than with Mom.*

Even now that I'm in college I call him and say, "Dad, the car is in the shop, I couldn't jump it and Dad, it's not working. Please make it better." Then he gives me ideas about who to call. Even though he is not here he helps talk me through it. He encourages me, he says things like, "you'll get through this, it's going to be okay."

*He was always there when I needed him.*

He went to church every Sunday. He always taught the 4 year old Sunday School. He started that when I was four and continued it until I was in high school. When I finished my Sunday School I'd go find Dad in his Sunday School. He helped in the Christmas pageant. He was always there to make sure everything went OK.

Most of the time I go to Dad before Mom. *My dad was always there. If I ever needed help with homework he'd try to help me. I'd go to him before Mom. Finally as a senior when I was taking calculus he'd say, well, you've gone ahead of me there!*

Now I call and I say things like, "Dad, I'm fed up with school, what should I do?" or "Come see me and celebrate my birthday at Easter!" *Dad let me know that if I ever want to come home and I couldn't come home he would come get me. Several times during my freshman year he made the trip up here so I could be home for four days at a time. New years the weather was yucky, he took off work and drove me back to school. I made him stay overnight with one of the guys I know that had an extra bed and he stayed there.*

When I go home on vacation now I always try to find time to stay home two or three days so I can visit with my folks or at least until they go to bed, then I may go out later.

Not all girls have difficulty moving from grade school to middle school. This father-daughter scenario speaks for five of the father's in this study about their daughter's interests and ways they were able to support their daughters during that sometimes difficult transition. Piper (1994) addressed the differences in the way teachers and schools have historically treated girls in relationship to boys, she spoke of the deleterious effects that disenfranchising messages have on girls when they do not do well in school. She wrote that girls need encouragement to persevere in the face of difficulties, to believe in themselves; they need permission to take their time and to make many mistakes before they succeed at scholarly tasks.

**Father:** *[Italics indicating father support in middle school]* I think she enjoyed the transition from grade school to middle school. I think she liked the teachers in both middle school and high school very much, so, the transition was pretty smooth. Then the transition to high school, I think she was ready to get out of middle school, and be a big high schooler.

I think by middle school she still liked to be around her friends in particular, but I think that was not becoming the only thing. She got interested in the Science Olympiad and

that became a passion in middle school. Fortunately, she had a science teacher who started that. It was a competition where they had to compete between schools within the state. They actually did different types of scientific events that were based upon a national agenda. The one that she liked and continued to do throughout the rest of the time she was in both middle school and high school, was this "Mission Possible". It was a project where you put all these different energy transfers they call them, so if you have motors lifting weights, or if you have electric switches making balls, then each energy transfer gets you so many points. So, it ends up with something where balls go around, and lights flash, and things. She really liked doing that. She never managed to get close to winning anything on a national level unfortunately.

*I think I helped out quite a bit the first year she was doing that. I sort of left her alone for the rest of the time. She would ask about how to do some things and we would look in scientific catalogs to try to find things like solar cells and that sort of stuff, so I would help out in that respect, but as far as actually putting stuff together I didn't help. But, I'd always poke at her to say, "You have to try this thing out early, and run it a hundred times." And they would always change things up until the very end. When they were in high school they could never get down to leaving the thing alone, get it to work the way it was, because you only have one chance and you're not allowed to touch it once it starts, if you touched it you could get points taken off.*

The next group of daughters remembered being close with their fathers early in life. While the relationship remained supportive they believed that their interactions with their fathers were becoming more distant during their middle school years and even more distant in adolescence. Each girl was only aware of her own parent-child relationship so none of them were aware that this was a pattern repeated in a variety of ways in other families. Some daughters reported that becoming aware of some of some of their fathers' shortcomings had a negative affect on their relationship and they felt they continue to be distant because they didn't communicate about the intimate issues that they did with her mother. Later on five of the girls said they wished they had a closer emotional bond with their fathers and wondered if that happens naturally in the process of life?

Daughter: One of the earliest memories I have of my dad is of him wrapping me up in an afghan and taking me outside to look at the moon and this would be called "going to see the 'Moo moo'" because I had this fascination with the moon. I don't actually know if I had it before that or if that was what got me interested in the moon. But I remember him bundling me up on those cold fall nights and taking me outside to the driveway. He'd carry me and we'd walk around a little and look at the "Moo moo." *I don't remember anything about the conversation but those were just really special moments [Italics for emphasis].* I was probably about two when he started doing that.

Then he read to me a lot. We would read together when he'd come home from work, sometime in the evening I'd say, "Daddy, let's sit down and read a book," or he'd say, "Would you like to read this?" and I think I always had a bedtime story before bed.

He would always take me on walks to the university. We would go to a little lake in the center of the campus and we'd go fishing or I'd ride my tricycle down there and he'd walk behind me. We would just sit by the lake and talk and feed the swans and the ducks. I have one memory of him sticking his foot into the water and it getting bitten by the swan! I think he just did that to make me laugh but he would always do funny little antics like run around and pretend as if he'd been hurt by it! Then afterwards we would go and get candy or a pop or something and then walk back home.

Let's see (pause) what else? More than my mom he was always the one who would do fun things with my brother and me. He would take us to movies. He would take us swimming. We'd go to parks. He would help me up onto the playground equipment and do lots of "underdogs" That was one of my favorite, going to the playground just around the block and having him do big 'underdogs' and then I would swing as high as I could and I could see him get excited that I was swinging so high.

I remember him always being very excited and happy for me when I would have done something well at school. Another thing, he was always very encouraging of my musical abilities. When I was in the fourth or fifth grade I would play the piano sometimes he would just come and sit in the living room and listen and smile and watch me play and tell me how pretty it was; or he'd make tapes of me playing the piano and listen to those in the car, and I liked that a lot at the time. *I guess that was before I'd gotten to the age of feeling like, oh you know, "I shouldn't be happy that I did so well in such and such," so, yes...I liked that a lot that he liked to listen to my music, I liked to think that hmmm, "My dad's got a tape of me playing in the car."*

I was 11 or 12 and I was a lot more self-conscious than I had been before. I've always been very aware of myself and my relation to other people and what's going on around me. But I became more self-conscious at that age I think and anything that drew attention to me in either a positive or a negative way was somewhat uncomfortable. I would enjoy having the praise but at the same time feel like I didn't know how to react to it as well. When I was younger I could smile and I could be really open and I could admit that, "Yes, I was proud of that." But that isn't as easy for me to do as it used to be even yet.

He helped me with my homework. He was always very good at helping with math because math was his major. When I got into middle school and took algebra for the first time, that was the first time we got into some rather large fights over the homework because either he wouldn't be able to explain it so that I could understand it or he would get too far ahead of me or else I would just get angry because I couldn't figure it out. That was just not probably the greatest experience.

**Researcher:** In retrospect, why do you think you were upset with your father about that?

**Daughter:** [Italics, note change in relationship] Well, I definitely felt comfortable enough around my dad to fuss with him. I think even at the time I was aware that a lot of the frustration came from me and wasn't something he was necessarily doing and that I knew I was kind of using him as just someplace I could vent out my anger and my frustration on. I think he maybe encouraged the frustration just a little bit, too, because he would often make comments like, "Well, I never was any good at teaching any way" or "I'm not going to be able to explain this to you so you can understand it." This kind of set the stage for me to see that he didn't think he could do it for me and then I would then affirm his lack of confidence.

*I guess as I got older my relationship with my dad probably was a little bit more distant than it had been earlier. I think as I grew up he found it harder to relate to me and I sensed that he wasn't as comfortable interacting with me as he had been before and it just*

*made things a little bit more difficult.*

I wouldn't say that our relationship has ever been bad since I've gotten older but I definitely am not anywhere near as close to him as I am to my mom for instance. I think I became more aware of him as someone other than just funny daddy who would take me to see the "Moo Moo" and who would do fun stuff with me and I saw other sides of him. I saw some of his insecurities and his lack of confidence, and I would hear my mom talk about it and that would reinforce some of my opinions.

*I guess just in general as I grew older, about middle-school age, I didn't feel like I had the really close relationship I saw that some of my female friends had with their fathers. Although, all of my female friends have been closer to their mothers than their fathers so I didn't feel that was unusual, but I never felt that I could talk as openly with him as I saw some of my friends doing with their fathers.*

I didn't feel that so much before then. But probably ever since then I just haven't felt completely open with my dad. I don't feel that I could tell him a lot of the things that are on my mind.

I can still relate to him really well on an intellectual level. We'll have discussions about, you know, current events, what's going on in Kosovo, that sort of thing. We'll talk about things I've been reading in class, and we'll have arguments about what that all means and that's kind of my dad at his best because he's up on current events and he loves to do intellectual discussions and that sort of thing. But he's not as open when he gets down to the emotions, the feelings level, and things tend to get a little awkward and so I just don't venture there for the most part.

*Now that I'm in college I guess I don't feel that our relationship has changed a whole lot since I was in high school. He picks me up from college about half the time. He's always excited to see me but once we get over that initial excitement of me coming home and being with them again it's kind of the way it was before, there is still some of the distance. There are certain moments and certain topics when we can connect a little bit more but a lot of times I feel like there's still a space between us.*

The next voice is one of the girls who had taken all the calculus she could take in college by the time she had completed her senior year in high school. She reported remembering a close relationship with her father when she was young and felt that by middle-school she began to distance herself from her father; after that when she spoke about their relationship she talked of her concerns that of losing his approval. She knew those things that bothered him: lack of punctuality; procrastinating, denying getting grades that are less than what he expected, but she made choices to manage her life autonomously. She valued her family and was glad that they missed her. She enjoyed her phone calls home and knew her parents depended on her for problem solving between her siblings and that they looked to her as a problem solver and for help with homework. Even though she was away at college they still maintained a dependence on each other in their home and family setting.

Although she was aware that since middle school some distance had grown between herself and her father, she said she appreciated him more since she went to college because she had an opportunity to compare her family with other families by listening to the girls talking in the dorm.

Daughter: Overall our relationship was good. I remember the whole teaching how-to-ride-a-bike-thing. *Oh, my gosh, it's hard to remember stuff like this*—but when I was young I'd see him only at night, after work. He'd tell me bedtime stories. I think most bedtime stories were about someone who wanted to be someone else, for example a train wanted to be a plane, a mouse wanted to be a cat. I think! Wait a minute, there's a trend here!

In grade school Dad went to PTA meetings. It didn't bother me. When I was a 6<sup>th</sup> grader our class went on an overnight camp-out and he came along. It was fun because the kids liked him. I was apprehensive about it but it was good.

In middle school and high school there were still parent-teacher conferences. I expected they would go but I told them, "Oh, it is no big deal, you don't have to go." They went anyway. I didn't feel any pressure to achieve academically when I was in middle school. But something happened, it wasn't horrible but I did really badly on an exam. I got a D on an exam in science. There weren't any throwaway points in the class. I hid the exam in my room. Both my parents were upset about it; they were upset about my dishonesty. They said I shouldn't have hid it.

In high school: I wouldn't want to tell them if I did badly in class. I thought it was my own problem so I would say, "I'm doing OK". Dad would find out it wasn't true and that bothered him a lot.

I was thinking of him as overprotective in high school, he let up by the end of high school and I had a 1 A.M. curfew. Once I learned how to drive, access to a vehicle helped a lot.

He didn't make me drop out of any activities in high school, like the school play. I wasn't a big actor and I would only be watching TV if I were home, but going to play practice meant I wouldn't be home with the family. Or he would just get home from a meeting then I would leave for play practice and come back at night. He didn't crab at me but I think there might have been a little disapproval.

I'm a big procrastinator. That bothers him a lot. If I do poorly because I've put off studying, that bothers him. He says "Yes, but you could have done better." If something starts at 9 A.M., I leave at 8:55 A.M. Punctuality is important to him. *I don't know how I could be such a procrastinator since it is so important to him, but I am. It bothers him when I call and say I've stayed up all night to study.* I could probably find a way to manage without pulling an all-nighter but that's the way it is.

Now that I'm in college I think my family misses me a lot. My last semester in high school in English class, I didn't turn in two papers and ended up getting a B-. I probably shouldn't have gotten a B-. That really upset him. It really bothered him. I would say my grades were okay but really they weren't. At quarter my grades weren't too bad but I put off bringing them up. Then I would get flack later for hiding them and have to deal with disapproval.

Right before I left for college there was a sense of, "Oh, now you are leaving." And I got a freebie! (laugh) When I go home they are really nice. They haven't seen me in 2-3 months. They like to see me.

In college, I guess at the beginning I'd call home a lot. Either they would call or I would so I wouldn't feel abandoned. It helped to hear their voices. I call and talk with

different members of the family different nights over a week so I could talk to all of them. My brother and sister ask for help on homework so it wasn't a drastic change from being home together. I'm bad about calling now. I miss them. *I don't see my father and my family very often but I'm pleased with the relationship I have with my father now. Especially since I've talked with people here at college who hate their parents. I think mine are really nice, and since we see and talk infrequently we are ONLY NICE to each other, there isn't too much time to be angry* [Italics for emphasis—hers!].

Another daughter remembered her father over her lifetime.

**Daughter:** I think the first memory I have of my Dad was just being up one morning when I was a kid and he had to dress me because I think my mom was gone. He was taking my clothes out of the dresser and putting the clothes on me. That is the first time I can actually remember my Dad other than maybe him holding me when I did something bad.

I remember a lot from trips because that was our main family time. I remember we went on several vacations together, to San Diego, California. I remember walking around the zoo, that kind of thing. My dad was at a meeting then he met up with us and we walked around. I remember the camels, they spit at me. Dad laughed at me, and that kind of thing. That's probably about when I was eight or nine. I thought it was funny too. Big camels spitting at me. It stunk and I didn't want to be spit at.

My dad liked to explain things. We went to the Smithsonian in Washington D. C., the space shuttle was there. Dad went nuts, he talked to us all about all the stuff and answered every question we had. That was always fun.

I think my teenage years were like the common experience of most people, you didn't want to be around your parents, your parents wanted to try to discipline you. So, I was like a wild child. I wanted to do all this stuff with my friends and go out and do things and I remember Dad saying "No." I remember I wanted to go to a birthday party, it was at a hotel with the girls mom in one room and the party across the hallway in a different room. I was crying because I wanted to go and my Dad was just washing the dishes and talking and discussing why I should not go. He finally decided to let me go, but it wasn't as much fun as I expected.

Our relationship is a pretty strong relationship. There were times as a girl I had to go to dad about some stuff. When I came of age I went to Mom, but about other things I would go to him and he would listen and he would make suggestions. I can talk to him about almost everything. I go to Mom for things like struggles with boyfriends, but usually we'll seek out Dad in the end. He has always just been there when I wanted him and even when I didn't want him! He is patient but persistent. When I didn't get along with a friend he was there to talk me through it. He would listen patiently but then try to help me figure out answers. When I call home so frustrated with college he always puts things in perspective. He said he had an honor code. He didn't help anyone cheat, he didn't use unauthorized study aides, he just put two heads together. He didn't copy, he said, "Put your heads together and brainstorm. Go to your professors when they have free time to talk about your problems."

My roommate and I and her boyfriend are in electrical engineering. At one point when we were fed up with college I called my dad and said, "I'm fed up with it and I can't do it." After talking to Dad we went to the professor and took 20 minutes out of his day to walk through the problem step by step so we *understood* what we were doing [emphasis hers]. Then we were able to help our classmates.

Both my parents helped me know how to call for help. I don't hold things in. There is always someone to call when I need help. It helps with self-esteem. I have a sense that "I'm able to do this." Sometimes having someone who will listen to your problems is as important

as having someone helping with answers to problems.

The voice of another daughter. It was a surprising statement when the daughter said that she felt she has covered “everything...there’s only 19 years!” Note the timing of her awareness of her father as a person and her statement of appreciation of him.

Daughter: The earliest memories I have of Dad, the things that we would do together were for the most part pretty mundane. Going out and picking tomatoes in the garden. Saying little expressions that both of us knew-that if he started them I would finish them, like “What are the two things that money can’t buy?” “True love and home grown tomatoes!” That was a big summer thing with us! We played “UNO” and other games. He built me a tree house, a tree platform. I watched him build it. He built me a sandbox too. We played ball together in the back yard, I had one of those big rubber red balls. We watched birds in the backyard, “Come watch this Nuthatch climb down the tree!” and things like that.

He always seemed interested in talking to me. He was always very excited about what I was doing, he took pictures of me in my marching band uniform before our first game and we would march around the track and yell “Way to go Sam!” He would wave at me and catch my attention. He was definitely a major participant in the things that were going on. We both took tap dance one year. Actually a couple years. And there are pictures of us in the yard getting our costumes ready for the recital. We would stand in line at Taco Time and we would both be doing draw backs. (Laugh) We would compare moves on that.

We played softball together. He coached or assistant coached on whatever team I played on from 3rd through 8th grade. We would play catch out in the yard and he would try to teach me to pitch, which never worked out. (Laugh)

Researcher: Did you enjoy having your dad there?

Daughter: Yeah. He was somewhat poky sometimes, but he was a good dad to have around, I liked having him there. You know he would always make sure that you had a big water cooler and a can of pop for each of us after the game. He took us out for pizza at the end of the season and stuff like that.

The teen years actually (pause) feels like I’ve covered everything, I mean there’s only 19 years! I don’t know, when I would struggle with writing, like we talked about before, he would try to help me as best he could. He would always try to help me with homework and things, keep me motivated.

Researcher: How did he do that?

Daughter: He would help me with Algebra, try to reinforce what good study skills I had and bring in some others. You know, like “Why don’t you sit at the table instead of on the floor in your room?” On the other hand, you know, coming into the computer room and saying, “What are you hung up on? You know, this is not the biggest assignment in the world, this is not going to come back to you. This does not have to be 100 percent, just put something down and you will be fine.” And stuff like that. He would recruit me to help him out, “Come on, let’s go to church, I’ve got some stuff to get done. You can sweep and help me out with stuff.”

*Now that I am in college, I don’t know how much our relationship has changed from*

*his end. I think I appreciate him more. I think most people would say that about parents. I look forward to talking to him. It is interesting to compare notes with him, telling him about what is going on and discussions about stuff I'm learning about and you know, I'll hear something related to what he knows and I'll ask him about it. I think I have a stronger sense that I know him better, a stronger sense of pride in him. It was his 50th birthday this weekend and it was fun to see how many people know and like my dad. It was something I hadn't picked up on quite as much when I was younger [Italics for emphasis].*

**Researcher:** Do you think that is a typical experience between children and parents?

**Daughter:** Yep, until we move out (laugh)! A big part of it is moving out erases a lot of the tension of living together and having diversion, different ideas about what should be going on.

**Researcher:** Easier to run your own life, to manage it the way you want.

**Daughter:** And when you are trying to do that at home, and they have a different idea, it gets in the way!

**Researcher:** How do you feel about your relationship with your father and now?

**Daughter:** Good. I think for the most part it is pretty realistic and it has always been like that. I think at least as much now as ever.

Mothers expressed their views of the father-daughter relationship in a variety of ways.

**Mother's perception of the father-daughter relationship:** They have always had a very nice relationship. They are interested in the same things, they have the same sense of humor, when they get together and talk, they just get into a zone that I am not a part of. I do not think there has ever been a time where she has been uncomfortable with him. He is just fun. He is just a fun guy so and they have always had fun together ever since she was little.

Noting mother-daughter relationships over a lifetime are important in grounded theory as a method of triangulation for establishing validity. Six of the eight girls in this study said they had a more intimate relationship with their mothers than they did with their fathers and six of the eight mothers said they were closer to their daughters than their husbands were.

**Researcher:** Talk about the relationship you have had with your daughter over her lifetime.

**Mother:** I was very thrilled when I was pregnant with my first child. I was almost 30 when she was born. We had finished our Ph.D.'s and had taken us awhile to conceive so I was very, very excited. She was the first grandchild on both sides of the family and this was a really big deal. I think that at the time I was very happy to have a girl. I'm not sure I cared and I didn't know whether I was having a boy or a girl, but I think I was very thrilled to have a girl because I grew up with sisters and we were very, very close.

When she was little I still remember she was always writing me little notes, "I love you mommy," and we did a lot of things together. Then her brother was born when she was



about 2½. I think that was somewhat hard for her but she didn't appear to be jealous.

**Mother:** Things got a little harder for her elementary school. I still remember her being kind of unhappy in middle to late elementary school. What I remember is that socially things got hard for her. I remember her crying. All my kids have done this, crying at night, you know, "I don't have any friends" and that kind of thing.

Cliques were hard for her. She always had one or two consistently good friends all through elementary school, luckily. She actually had two little girls who were pretty good friends all through high school but still, she was a little different. I think she was intellectually way ahead but not socially. So it was hard and I remember lots of talking at night and you feel terrible for them.

But I still remember the beginning of middle school where I could tell she was trying out new social relationships, trying to find her niche, and I still remember driving her and some other really flaky girls to a movie or something and she decided that those girls were not for her. I mean she tried but that was it. (Laughs) She never saw those girls again! They were bizarre and she kind of found her niche when she got involved with things like Odyssey of the Mind and mock trial. So there were more intellectual outlets and we were very supportive of that. I remember going through state finals for Mock Trial and she was sort of blossoming at that point. I think getting out of elementary school was good for both of my older kids. They had more diversity of friends in high school.

#### *Father-Daughter Similarities*

**Father:** This may be changing, but we are most alike in a natural curiosity. "How do things work?" "How do other people do their jobs?" "How do they get a television show on air for us?" "How do they make movies?" I think we are alike in that sort of inquisitiveness. It is not that I want to be a movie maker but I watch movies and say, "How do they do that? How did they make the camera go from ground level to five stories tall seamlessly" and things like that. For awhile we shared crossword puzzles, which was a similarity that we had. Sort of the mental exercise of thinking through how words fit together.

I think we are both calm people, I don't get too excited about many things. I'm not terribly demonstrative. I don't do a lot of yelling and screaming in my life, but when good things happen, I'm very happy, and I smile and grin and I think she is that same way. Good things are good but we would never make it on "The Price is Right" because we don't jump up and down when we get the answer right!

Also, we are similar in that, except for depression, except for the periods when she was struggling with depression, we don't let things bother us so much. Bad things happen and you work around it and you go on and life is a challenge and there are all these little puzzles to be solved and I think that is one of the things that we also share that we, in general we don't get too high and we don't get too low. I have often thought I live my life pretty much in the middle. That I don't have high extremes, and I don't have lows and frequently am very in the middle as far as moods go. I'm never very sad, I'm never very happy, not overly happy. I think I'm a contented person. I think that is one of the characteristics that I grew up with is that "What you have is enough, and you'll get by, you'll do all right, but you really don't need a lot." That is why I think contentment is one of my characteristics. And I think my daughter is turning more into that. I think she always was fairly satisfied with where she was, who she was, what she was doing, what she had. She had the typical teenage moments of greed but she was never a clothes horse, she never collected a lot of extravagant kinds of things. She wasn't demanding in terms of what she wanted to buy. She wasn't one of

those who always wanted something every time we went out. And I think there is a certain contentment that we share. So, those are the things that come to mind any way.

**Father:** I wouldn't be a bit surprised if her affinity for history was based on my affinity for it, and she naturally gravitated that way. There is a lot of reading to it, she liked reading. It is possible that if I had a real strong math interest? But, by the same token, our son knows that I like history a great deal and he could care less. So it hasn't rubbed off on him!

**Father:** There were some drawing things we did together actually. It is interesting because I see my kids picking up interests that I have had throughout my life which I never really pursued in a big way. I've always been interested in languages and I liked Spanish when I was in high school and I had a bunch of friends also taking Spanish. We'd call each other up and just talk Spanish to each other and so on. But I never thought of that as something to pursue as a career but now she's obviously taking that another step. I was always interested in drawing and art and took art classes as a kid. It was clear that she was very interested in art. When she was still in high school we decided "Let's sign up together and we'll go to the Octagon and we'll take a drawing class together." This was an opportunity for me to rekindle some of my interest in art because I just do not have time to do it. I've always liked it. That was a lot of fun. We were doing watercolors. It was in the summer, actually we did a lot of different things the teacher would take us to gardens, we'd sit around and draw flowers and stuff and it was really fun being with her and doing something that we both liked doing and so that was fun!

She was a very independent kid so we had to be included in the circle of things that she was doing which, sometimes worked, sometimes didn't. After high school, she went to a university three hours away which is nice. We like having her nearby. She really blossomed there. I think she really came into her own.

She got into cooking in a big way, so it is always fun to have her come home. She is not very good about cleaning up behind herself but she always cooks these great meals. I do some cooking too, so we cook together sometimes. I like to bake bread so I find out what she wants to cook and I make some kind of bread together with it. I enjoy working in the kitchen with her.

**Mother:** She has a neat relationship with her dad that I am not a part of oftentimes. They are more on the same intellectual level. They're both history buffs. They just get into that zone—they can talk about dynasties, kings, queens, and the sequence of historical events and joke back and forth about all of that. I'm just not there and that's okay. I am fine with that.

She is now thinking of a second major in art history and I'm wondering, "Where the heck did that come from?" It came from him, we lived in Chicago during the time she was in kindergarten through her second grade and we went to lots of museums. He got her interested art from books and from going all those places.

**Daughter:** Sometimes I think I am taking history for my Father. I think it was a dream of his and he didn't get to accomplish that dream. I think I am doing it for him.

**Daughter:** My dad has always encouraged my artwork. We took a class together once and he's always been interested in art because he likes to draw. He doesn't draw a lot but it's always been something that he's enjoyed too.

**Daughter:** My dad is naturally very inquisitive and so am I, so I'd assume that it's something I learned from my dad. My dad's always valued learning and that's also something that I

value, so I think my attitude towards learning is something that I must have learned from watching my dad. It was not necessarily from anything he told me specifically, but if neither of my parents had really liked learning then I probably wouldn't have picked up any of that enthusiasm.

**Daughter:** I guess that maybe we judge people in the same ways. Maybe not by the same standards, but we like the same kind of people. I have the same opinions on political and ethnic issues. We support the same issues.

**Daughter:** I guess in some ways I'm like him, sometimes I like to make little pun jokes. I'm not very good at it but I still like to make them like he does. When I speak I think I speak somewhat like he does; I try to speak intelligently and not say silly stuff like a lot of people do. Otherwise, I think my dad is very persistent and I think I'm persistent. I have that trait, actually my mom has the same trait, so I could have developed that trait from either of them.

I had my dad's shyness when I was a kid. I'd hide behind my mom's leg a lot, especially when other children were around, I don't remember being that shy with adults. I usually talked to adults, they ask you what you're doing, and I'd think, "Well, someone is asking me what I'm doing, so I have to answer them." My Dad is like that too in some situations; he's very forward when he's talking about his work or something but he is not very open when he's talking about his feelings.

**Daughter:** I think I am like my father in being very organized. I think that is important to both of us. We both get very upset if we are late for things. Punctuality is important to us; in addition, we always keep track of what we have to do. (Pause). I think I am like him that in we both think in quietly resentful ways, like if something is bothering us we would rather sit there and sulk. I think I am like him in that I don't initiate anything socially, we are always waiting for someone else to mention something and then we're more than happy to go along with it. But we never try to start things.

**A daughter's journal:** My dad and I are each other's comic relief. One of our major bonding points is our shared sense of humor, which exists in a world that is extremely difficult for anyone else to enter, and I think that for years my mother felt like an outsider in this respect. My dad and I say the same things, can turn almost any situation into an amusing experience by telling jokes that only we can understand, and easily feed off each other in our humor. Our humor is a major way we feel close to each other and is a concrete phenomenon that demonstrates how we are like each other. It brings out our similarities, providing a feeling of unity in both of us.

### *Father-Daughter Differences*

**Father:** I think she is more insightful than I am. I think she relates to people intuitively on a deeper level than I do. I know to aid and comfort people in distress but I probably don't see their stress as early as she would. She would much sooner say something to somebody or approach them to try to help them than I would. She is certainly much better read than I am. She understands a lot of world history that just passed me by. One of my regrets in my own childhood was that I ignored things I didn't like, and history was one of them, dancing was one of them, and things that now, as an adult, I look back and say, "I had an opportunity to understand the Russian Revolution, someone would have patiently explained it to me as much as I needed, and I didn't want to know it," I never even pursued it. And now there are

all these things about European history and Chinese history that I don't know anything about, but she does. *She is much better read, she is much more worldly, she is probably a little more independent than I am.* She has been through American and English Literature classes and been assigned all the classics and read those.

My approach to English literature in high school was to skim the chapters that were required the night before they were due and never really just sat down and read the books like I was expected to. I still don't read novels. I don't do a lot of leisure reading. The leisure reading I do is usually the newspaper and a couple of magazines. The rest of my time I spend reading technical material related to my job. So I think what she has learned from, reading and studying, and she has taken a lot of classes. The Advanced Placement world studies, European studies, history of civilization, these are classes that I never took. I think both from her exposure in class work and her reading, she has just picked up a whole lot more of the world around her than I have. I don't know where her independence comes from. I think she knew from the beginning that she had some authority and she was willing to exercise it and we let her on occasion. Probably more often than we should have.

She is not counter-culture by any means. As far as I know she has not pierced anything. As far as I know, she has not tattooed anything. Her clothing was casual-to-sloppy but never in-your-face protest kind of clothing. Yet there is just certain "I'll do what I want to do" about her, where as my life is a little more, "I'll do this because it comes with my station." "I'll do this because this is what's expected," and I never regret any of those things. After all, I'm a contented person, and if I'm supposed to wear a shirt with a collar to work, that's no problem. If that is the expectation there is no problem to meet them. I certainly do a lot of what I want to do, and as a faculty member I have a great deal of independence in my life. So, that probably sounds pretty hollow compared to someone who works in a factory and has a very regimented kind of life because I have so much independence and freedom in what I do. But, I never feel like I want to abuse that in any way. I don't think she abuses her freedom, but she certainly takes more advantage of it than I do.

Daughter: I think the biggest difference between my dad and me is that now I open up to people a lot, I mean a lot. If someone is doing something I don't like, I will tell them and my dad won't tell them. You can see that he doesn't like it, but, he won't say anything. I have to say that I like to talk to people a lot. I like finding out things, to see things. Now that I'm in college I don't think I'm as shy as I used to be. I was a very shy person even when I was in high school, I didn't talk to a lot of people, but now, I just see so many people that interest me.

Daughter: He is more punctual and organized. I'm less punctual and more disorganized.

Daughter: He is a business professor and he does not really do anything with the arts so in that way I branched off on my own from him.

### *The Context within which Support is Perceived*

#### *Daughter's self perception of giftedness*

Daughter: I'm not aware that Dad's parenting changed when they knew I was in the gifted program at school. They knew I got very high grades on all standardized tests, and science and math were pretty high on my list of interests.

**Daughter:** I don't know if there was a definite time when I learned that I was gifted, but I could see that I was doing well on my test scores. I was studying but not as much as some people and I thought maybe I have something natural. In first grade it was actually very good at math. They gave us timed tests in addition and subtraction and I was pretty far ahead, I just took off. I could see the patterns too. Math is patterns and it's easy if you can see them, and if you can't then you have a hard time.

I remember a specific instance in 5th where we'd take these pre-tests and if you got 100 on the pretest you didn't have to take the test after it. My teacher, said that one person in the class got 100 on a pretest, and he was handing out everybody's test and I hadn't gotten my test back so I asked him where my test was. He said, "Don't you know, you got the 100 on the test?" He gave free candy bars so I got a free Snickers bar for that.

**Researcher:** How'd you feel about that?

**Daughter:** Oh, I liked it. I liked knowing that I could get 100 on a pretest. So, I always tried for it.

**Researcher:** Did you study?

**Daughter:** I didn't study, I just thought about all those questions and wanted to do more and more math. I noticed the patterns in Calculus as well. I saw things and I thought "Wow, I understand this, I understand how to do this whole entire integral or this whole entire derivative." People would be like, "How do you do that?" I said 'It's like this, use the steps and this is how you do it.' They got lost somewhere and I tried to explain it to them again.

**Researcher:** How old were you when you were first aware that you were gifted?

**Daughter:** Maybe second grade.

**Researcher:** What did you first notice about your ability?

**Daughter:** I did really well on my Iowa Test of Basic Skills (ITBS). I was called to the principal's office so the principal could say, "I'm proud". I was really mortified. I was very introverted so it was a good experience to receive praise but it was frightening. I would have wanted to be left alone. But I was taken to his office and I was standing there with him, I didn't know what to say. When I got back to my classroom the teacher asked if I had said this or that, I hadn't and I felt bad.

**Researcher:** How did you come to terms with your own giftedness?

**Daughter:** I don't really know. I guess I never really understood about it. I knew I was gifted but it was never a big deal. School just came easier, but my friends did well in school too so it didn't seem like anything to me. When I was a sixth grader the math teacher came to Home Room and had us take pre-tests. If you got 95% or above you went into a pre-algebra book while others did math. That was the first time we got set aside to do math. It was really fun; it seemed like a challenge. There were 6 or 8 of us in that pre-algebra class.

I went to high school. The norm there was brighter and there were students there who really got good grades. My SAT was 710 in Math; I had a 4.0 GPA in high school.

I guess it was never a problem for me. I don't think I ever thought "I don't want to be gifted."

I'd see kids who couldn't come to terms with a concept and I'd think I don't understand how they couldn't see it. I'd rather be more than less. I didn't dwell on it too much.

Two of the girls voiced the sentiment that they did not feel particularly gifted. They said that within the network of their peers there were "always" students who excelled in areas that they did not. The girls did not take into account what particular measures allowed them to participate in the coursework with those other students, they did not differentiate levels of giftedness, they simply made these statements based on their perception of fit within their peer group.

Daughter: I don't know that I ever felt particularly gifted, I was never without a peer group. I think to this day (pause) I don't see myself as being extraordinary in any way. I don't think I ever really did.

Researcher: Do you think it was because you were with a group of students at school that were also bright?

Daughter: Possibly. I was never way ahead of everybody.

Researcher: Were you always in an accelerated group or in honors classes with other honors students?

Daughter: From kindergarten on there were always two or three other people that were in the same math setting and in high school there was a definite group of people who were honors students. Who was in which honors class would vary but, largely, there was a group that we all felt comfortable in. We were comfortable around each other

Researcher: Do you think your father parented you differently because you were gifted?

Daughter: He probably just changed his parenting as I grew older and I was starting to know more and become more independent. I think his parenting changed when I became a teenager. I mean, I've talked to a lot of people, even to my boyfriend about it and he said the same thing. When we were little kids, we were afraid of our dad's, it's just the way they represented themselves. I was never afraid of my mom, I could stand up to her and if she said, "Go get the apples." I could say "No," but if Dad said, "Go get the apples." I went and got the apples, because he said so and then you ran and got the apples. He said go and his voice is just a little lower and I was kind of afraid. Not that he ever had a temper, it was just his way when he said things!

I don't think Dad parented me differently because I was gifted, I think he had the idea that his child was going to be bright and he was going to be the kind of a parent who would help her grow and learn. From as far back as I can remember he was always reading to me and working with me to develop my intellect, maybe even more so than my Mom, I'm not sure.

Daughter's Journal: I do not think of myself as gifted. I am intelligent, but no longer gifted. In elementary school I was gifted. Middle school and high school were great levelers where I

found myself above average academically, but not in the select group of remarkably bright students. This classification holds up for college as well.

*Daughter Adjusting to Change*

A daughter spoke of the differences between father and mother support as she adjusted to school, from the first day of elementary school through entry into college. "They both helped me but each of them helped me in a different way." And the difference in the parents' dealings with the very separate tasks of emotional issues vs. tasks on hand are obvious.

Father: Unfortunately, the instances of friendships I recall during middle school are mostly negative and I don't suppose it made a whole lot of difference, but through grade school she was sensitive to some of the teasing the kids do to each other. I don't suppose inordinately so, and I don't think kids were mean to her for any reason. At the time it never occurred to me it was because she was in more different math classes than the rest of her 5th grade buddies or whatever, I just always thought it was kids picking on each other but it weighed on her to a certain extent.

Five of the girls spoke about the difficulties of asynchronous development in middle school. They spoke of the difficulties of feeling inadequate around their peers who were "peaking" socially while intellectually they were far ahead of them. They felt that the middle school time in life was challenging yet they did not take these fears to their parents for discussion and they said that in retrospect, they didn't think their parents were aware of their problems.

Intergenerational differences were obvious with this issue however because fathers struggled with "what to do", "how to help" when they saw their daughters dealing with difficult issues in middle school. They knew that when students went to middle school they moved from their "neighborhood elementary schools" to larger schools and were additionally removed from the former grade school groups by being separated into various groups within classes. They said they watched silent girls determinedly step out of the car the first day of middle school to face new challenges.

Father: Kindergarten was a wonderful experience, she had a great teacher and met all these high ability kids and she just had a wonderful time so we expected nothing but wonderful things. Grade school was a little rough on her, not academically, I mean she just plowed through everything very easily, but the social kinds of things were a little bit more difficult. I think it was partly because our elementary school is just a very small school even though most of the people going to the school are kids of professionals. She didn't really find any

kids there that matched her in terms of interests and so on. There were some crying sessions where she would complain about school or how teachers were treating her. But she would always find something to do, she could always read or do something, so it didn't bother her that much. But socially she wasn't quite with it. It did concern her, I don't know how she thinks about it, looking back on it, whether she really felt she was an oddball or something, but she would find what she was doing interesting enough that it wasn't the focus of her attention. I mean she would go through a day and oftentimes she would be fairly oblivious to the social context of things, she'd get interested in what she was doing and fall off her chair and kids would laugh at her. I can still remember the teacher talking to us in the sessions about that. 'Sometimes she falls off her chair when she's concentrating on something!' She had a couple of friends that she was kind of close with there at least for a limited period of time.

**Researcher:** Did she come home to you and talk about them?

**Father:** Well, I don't think I was the first person she talked to about these things but *she would probably talk to my wife first about this and then the three of us would get together and talk about how are we were going to deal with this situation. We'd tell her, "This is the way kids are and don't let what these kids think about you influence you all that much, they're just kids."* Teachers too for that matter, [Italics to emphasize father support] she had some teachers that just didn't seem to like her for some reason. We don't know why. She's not an unlikable person.

**Daughter:** Seventh grade was just a hard time in general, I don't know, but I think seventh and eighth grades were just in general difficult times.

**Researcher:** What was difficult about it? What were the difficulties?

**Daughter:** I think the transition to middle school was difficult. I was kind of separating from my friends faster than I was making new friends, and just all the stress of early adolescence.

**Researcher:** When you say stresses of early adolescence, what do you mean?

**Daughter:** It's just, you know, you go from being a kid where everything is mostly just plain okay, and people like each other, and then you reach a certain stage people start wanting to be like in cliques, I think people just get very mean around that time. It's like the social world manages to divide itself up into the popular people and the unpopular people, and then, (pause) so it's very hard to be an unpopular person at that time.

**Researcher:** Were they mean to you?

**Daughter:** Well, I mean they were just generally mean. I don't think they did anything in particular to me, but I was very much aware of the fact that most of the people in my class didn't like me, so it was really difficult. I had a couple of good friends at that point, that helped some, but it didn't entirely offset it because you were at a point where having people like you was very important. I think when you're 13 years old your self esteem isn't all that high to begin with.

**Researcher:** What happens to girl's self esteem at 13?



**Daughter:** I don't know. I don't know if it's because like our bodies are changing, or if it's because of our emotions are changing, or we just think we're supposed to be changing. I don't know. But somehow life is just suddenly a lot more difficult. So like when you're 13 it's hard, you can't really take solace in the fact that you're a smart girl and everything will turn out okay. It's not that encouraging.

**Daughter:** From my experiences and from talking with friends I think that the time period from sixth through eighth grade can be extra hard for smart girls. I don't know what kind of support is needed at that point in time but I think something is needed.

**Researcher:** Do you think it would help to talk to parents about it so that parents are aware of the challenges of middle school?

**Daughter:** I don't know. I think it may be hard for the parents even if they know that their kid is unhappy; there's not a whole lot they can really do about it. I don't know what the problem really is and I don't know what needs fixing, but if part of the problem is that there are people peaking intellectually and socially at that point in time, and if the smart people are going to peak later in college, then obviously at that point we are way behind the average student. It's a hard time when you're so far behind everybody else socially. And even though it's not a bad thing at all, what do you do about it, it is going to be hard on you emotionally?

Not all girls had trouble in those middle school years, four of the fathers made statements similar to this one:

**Father:** When she made that transition from the lower grades to middle school she didn't seem to have any problem at all. She has always had a very quiet self-confidence about herself. I don't think that has changed much, if it has changed at all I'd have to say that she's gotten more confident as time has gone along. She has become more willing to speak out and stand up for her rights. I think it's just a constant with her, she's always been willing to try things, and I think as you have successes, and continue along that route and continue to have more successes I think the confidence just builds. She has always done well in school and I think that just fed on itself.

As the girls grew and moved into college some of them were surprised at what seemed like a change in their father's expectations of working hard and focusing on their education.

**Daughter:** For the first time in my life, during my freshman year at college, Dad told me that I shouldn't study so much. That just blew me away! I was studying like crazy and didn't have a lot of time for other things in my life that year. I couldn't figure out how he managed to see that I was working as hard as I was, because I was only home for breaks yet he said, "You shouldn't study so hard." I was telling them that if they came and visited they wouldn't stay long, they'd just stop by and then they would leave. I'd say well, "I've got to go and do some reading" or something like that. My Dad said, "Well why don't you go and hang out with some friends and then go to bed. Why don't you do that, you can study later." It was really an odd feeling and was very contradictory to what I was used hearing from him while I was growing up where most of his messages had been, and still are, that academics are a number one priority!

*Daughter's unique qualities of internal drive and intensity*

**Father:** She has been strong-willed from the beginning. Definitely by middle school you could easily tell she was pretty intense in terms of when she went after something she went after it with full guns.

I think when she was ten that she probably did not think much of either her Mother or me. I think that right now we have a good relationship, she is maturing now and it is nice to see a young lady coming out of all that. She is smart as a whip, and she is pretty directed towards what she wants to do and that's great, we'll help her.

**Father:** There was a lot of hands on involvement in school projects through sixth grade. I can think of posters we made in particular for the Science Olympiad project. She did a mummy kind of a display and she said, 'How am I going to get these pictures onto this poster? and so I showed her a trick I had learned. So we went through those kinds of 'This is how you do this kind of stuff through grade school.

By the time she got into *middle school*, there was very little I could do with her homework. She was not one that we were able to teach much by that age in her life. She really didn't accept what we tried to teach her. "Here, let me show you how to do this." Her response was "No, I'll figure this out myself," or "No, I don't want your help with this!"

So, in a sense, up until middle school, it was pretty hands on and after that it was more along the lines, "Do you have it done?" "What more do you need to finish this project."

By the time she got into Odyssey of the Mind, a program that emphasizes no parental involvement, that really fit how she was developing. "We're working on this, and no we don't need your help," but then she would come and say, "Where do I get black paint?" And so it was, "Do you know how to clean out the paint brush afterward?" "No, but we'll figure it out." (Laugh!) *So she still needed help in some of the providing things but after middle school, it was never us teaching her as such. It was letting her learn on her own, or letting her get it from other [Italics for emphasis].*

Part of my problem was she was in subject matter that I really couldn't help her with, once she got past Trigonometry in math, I could understand what the book was saying but I couldn't reinforce or help in those regards at all. *So her skills quickly got ahead of mine and it was just as well that she wanted to do things on her own.[Italics for emphasis]*

**Mother:** She has an internal drive that I still am in awe of. She has an internal drive to do well. It's not in everything because if you ever saw her room you would know it's not a drive for cleanliness, to have a clean room is just an unimportant thing for her. However, to do well in school and to do well in whatever career path she is going to pick is very important. We can tell her to lighten up and it does not matter. It's there.

**Mother:** We've gotten past the honor's thing she was nearly obsessed with during high school, yet she's still driven by grades in college. She got all A's again spring semester and I think that's pretty incredible for a freshman year in college. That's not something that we have asked her for, we never really wanted her to hit the books so heavily but once again she's found a group of people at college who are of like "driven ness" and so, she's right back into that mode. I know that she will always do well in school. I know that she will go to graduate school. If she doesn't get a Ph.D. I'm going to be really surprised. But it isn't anything we ask. But like she said, 'I really like school. I like the atmosphere.'

**Daughter:** I was always proud of the work I did growing up in school and felt that I have accomplished a lot and managed to learn a lot. I have always had this drive to be the best at whatever I do.

**Daughter:** Actually when I was tiny I would memorize the books when he would read them to me and then I would “read” it to him, this was before I knew how to read. I would memorize the words and I would hold the book and it would look as if I was reading because I would know the pictures and I would know which words went with which picture. I would read those to him and he was always very warm and full of lots of praise. (laugh)

**Daughter:** Did I need urging to practice? Oh no, not at all. I was devoted to my instrument and no one ever had to say practice, sometimes they had to say “Stop!”

**Researcher:** How many hours a day did you practice?

**Daughter:** I think in the beginning we were supposed to practice 30 minutes, 3-4 times a week. When I was older I tried to practice every day. I remember I practiced a lot my sophomore year of high school. At least an hour every day and then on the weekends a lot more. I remember I would practice on Saturdays and the whole afternoon would go by. I could practice 3-4 hours and the time just disappeared. My Junior year time for practice dropped off because of personal problems, it went way down, by the end of the year it was way back up. And now, I try to practice 2 hours a day, it should be 4 hours at a minimum. Hopefully next semester in San Francisco I will be able to practice 5 or 6 hours a day.

### *Action/Interaction Strategies*

#### *Fathering Practices*

Within the various supportive influences in the lives of these gifted girls, the following action/interaction strategies of father support of giftedness: (a) Expectations (b) Encouraging, (c) Advocating, and (d) Guiding, were found to be the core of father support of giftedness. An integral part of being a core variable was that these action/interaction strategies changed over time.

***Expectations.*** The father’s expressions of expectation and encouragement were sometimes difficult to separate. Fathers gave messages of expectation to their daughters through the kinds of playthings they provided and through the type of play they facilitated. They demonstrated their expectations of unflagging honesty in their lives, and in advice they gave while they helped with homework, with math and science fairs. These were some of the ways fathers expressed their expectations to their daughters. Fathers voiced their high expectations when they talked about the importance of hard work and emphasized the need for hard work and determined effort even in the

areas of their ability. Sadker and Sadker (1994) indicated that expectations are the heart of academic achievement, they quoted a woman who recalled her father's unwavering belief in her ability to be successful as an engineer, "I did it because my father believed I could." These families spoke of father expectations:

**Father:** I don't think I influenced her learning because looking back I would say she was already on the right track. We just provided energy for her. When I say energy I mean internal energy perhaps we provided the fuel. I watched to see if there was something she would need, some material thing, anything, we never made any objection to those. I remember we went out and bought a set of Encyclopedia Britannica even when we were students and that was very expensive. The sole preference was that was for our daughter. So that is the way we motivated or encouraged her, we could do nothing because I think it was internal from her point or at least that's what I think.

**Father:** We have told them grade wise that we would not reward them for good grades. We wanted them to do what they did in school for themselves rather than for us. We didn't give them presents or anything because they always got good grades. I think the message was that they're supposed to use it for themselves, not for us. We told them that explicitly, it was not just understood. That's the way we want to operate.

**Father:** I told her that when you go to college you're much more on your own. You have to do it all yourself, you don't have teachers, principals or people like me telling you what it's all about, they expect you to go and figure it out. I think she had a pretty good idea of what it was all about. My kids would see me grade student papers when I got home from work and they would yell, "Hey you only gave this guy a C." They never got any C's. They would holler worse if I gave him an F.

She decided she wanted to stay at this university and live in the dorm. It is a good school of engineering. We don't know where she's planning to go to medical school, probably wherever we can afford. We'll see how that works when the time comes.

**Father:** She is in an honors program at college, and she struggled a little bit, but you just say, "You've had successes in the past, you've taken on difficult things in the past, you've overcome those things and you've been successful because of your abilities and because you put effort into it. All we expect of you is that you keep putting that effort into it and keep doing your best, and feel good about that and accept the outcome. But, don't ever look back and feel like you weren't successful at something because you didn't try." That's all we've ever asked of either of our kids, is put your best effort into it and then be happy with the result.

**Mother:** I thought she was too intense with her studying. There was more to high school and more to living than just that narrow tunnel of focus on grades. I hated to see her go through high school just doing that, although she had nice friends and they did things together, so I would say we supported her in what she liked to do but we asked more. Her dad's law was she had to take four years of math and mine was you have to do something fun! She did them both somewhat grudgingly. We support our children differently. Our son's activities are definitely sports and that sort of thing so we go to a lot of games now.

**Mother:** I guess I'd say first of all I probably communicate our expectations more by example than by saying things. Certainly I and my husband have always tried to be very honest in our dealings with anybody. I think the kids know, they see that hard work is an important value, a good education, obviously those things are important. They know these things because they have said that while we haven't been overt, yet they feel a lot of pressure that they should do well in school. It's just expected by us. I know it was expected by my parents, and I think it sometimes bothers them that this is an expectation. You know we just assume that they're going to do well.

Several of the parents had a strong feelings about the importance of their daughters pushing themselves in math because they knew it was an important subject and they knew their daughters had a proclivity to the subject. This mother says well what other parents also verbalized to their daughters.

**Mother:** When she was in the third grade she came and said "I don't think I like math" or she said, "Oh, math is not my favorite," or something like that. I told her, "No, probably math is the most important subject and no matter what you would do and no matter what major you are going to have you're going to be good if you are good in math." I told her, "Never say, I'm bad in that class. If you try you can do it." And that was it. Just one day I told her, "You know don't say that word because I know you can do it and don't say I don't like it because I know you like it. This is a problem some other kids told you. Now they don't like math. You're repeating their words.' So that was it and later on math was her strong subject. I'm glad she came and told me, otherwise, I could not figure it out.

She was tutoring some students in math. She said, "Yeah, Mom you told me that," and I remembered saying 'Don't say I don't like it. If you try you will like it,' and then later that was it. She did like it.

**Daughter:** I don't think Dad parented me differently because I was gifted, I think he had the idea that his child was going to be bright and he was going to be the kind of a parent who would help her grow and learn. From as far back as I can remember he was always reading to me and working with me to develop my intellect, maybe even more so than my Mom, I'm not sure.

**Daughter:** How I did in school was important to my parents and because it was important to them it was important to me. I wanted to fulfill their expectations. They didn't even say anything like "You have to get an A." I just remember *knowing* they expected it.

**Daughter:** My father had expectations that influenced my choice of a career goal. I guess it started when I was little, he wanted me to have a job where I would be respected. When I was little I wanted to be an architect. He said that would be fine, he wanted me to have a job that made money, that was respected and one that I would need a significant education for. Sometimes when people would ask what I was going to do after high school I would sing the advertisement for La James: School of beauty, "Style is your fame, Nails are your game" (laugh)! I had no idea where I was going to school, I just didn't have an answer, so that would be my response! But all along I knew what he expected.

Two girls spoke specifically of their fathers' expectations for them to work as hard as they

could in their schoolwork. These examples address their advancement in the accelerated programs at school.

**Daughter:** Dad has always pushed me to push myself. He pushed me to take the Advanced Placement classes, keep going forward with math and taking classes at the university when I was a high school senior, "Keep going," always going forward, never settling for where things are.

I never thought of his counsel as overbearing. *I realized eventually that it was his way of showing his confidence in me; of him saying that I am capable of these things. So that made me feel like "I can do this, I am going to keep going. [Italics for emphasis] I can take advanced classes in high school, take the honor's classes, and I can really succeed in things."*

I don't think he's been a factor in my extra-curricular goals. He has been more involved in the way I think about my academic goals because academics has always been the focal point of our relationship and what he sees as important, especially at this time period in my life. He says that this is the time for me to study hard and learn all that I can and then later on have something else too. He didn't always talk to me about issues of life, but with coursework he had expectations for me and he always stated his opinion, "You need to take *these* classes!" "You should take the honors classes," "You should work hard and get A's in them," and that kind of thing.

**Daughter:** Dad supported the Extended Learning Program (E. L. P.) when I was little, and the summer math courses. Then in high school I signed up for honors courses, that was my own decision, and he didn't say "No." He set up expectations for me, I thought it was expected of me to be in honors courses. I remember looking at the cost of books and was amazed that they cost so much. Dad said, "Oh well, don't worry, they are important." Whenever I asked to take extra courses, he encouraged me to take them.

When the girls left home for college, their father's words detailing parental expectations were seen as supportive.

**Daughter:** Just before I left for college Dad sat me down and talked to me about how grades are important but they are not the only thing that is important in life. He told me that A's are not all there is to college, he said it is important to go out and have fun, make friends. He said that if I was always doing schoolwork and didn't take breaks I'd burn out. He said a 4.0 GPA is not a necessary thing. He said he didn't want me to kill myself for grades. He didn't want me to feel pressure especially in college where an A- goes against your GPA. In high school an A- still equaled 4.00, but in college an A- equals 3.7.

**Researcher:** How did you feel after he said these things?

**Daughter:** I was a little shocked but I had mostly pushed myself to get 4.0 in high school so I knew it would still be something I would push myself for. But I knew if I didn't succeed at the highest standard, he would still love me.

**Daughter:** I think my dad has always wanted to raise a very intelligent, very successful child. I think that's probably his number one interest. I think he wouldn't consciously say it but he also wants a child who is kind and compassionate and thoughtful. Probably if you asked him

he would say 'I want my child to be successful' but that would include all of those things for him. I don't think he consciously voices his belief in the importance of kindness, or those sorts of qualities but I think those are assumed for him. Occasionally he'll get into a conversation and he'll say something like, 'Well, of course, you know you'd never do that sort of thing to another person.' His values will just come out that way but he doesn't openly talk about them as much as my mom would for instance.

*Encouraging.* Fathers encouraged their daughters in many ways and at times the encouragement seemed like the dual actions of encouraging and motivating. While one father said that "being present at extra-curricular activities" was a way he could encourage his daughter to be well-rounded; another father said that when he saw his daughter becoming a bit of an "egg-head" he wanted to motivate her to be well-rounded, so he talked to her about extra-curricular activities and attended as many of her activities as he could. Encouraging took on various forms: to inspire with hope, courage, and confidence; and to support. Encouraging looked like motivating when the father acted as an adviser, inspirer, and/or counselor.

The fathers stated that encouragement "takes many forms"; they found that activities such as building playground equipment, going to parent-teacher conferences, being present at extra-curricular activities, were all activities that were viewed as encouraging. Fathers reported that encouraging their children seemed to be something that came naturally as though it was an integral part of parenting; and the encouragement continued as their daughters grew and their interests broadened. These fathers believed that it was their responsibility to provide their daughters with safe environments in which to explore and this was seen by the fathers as providing encouragement to excel and to take advantage of course offerings in the gifted community.

Supporting the concept that encouragement enhances high academic achievement were findings in a 10-year longitudinal study conducted by Benbow and Arjmand (1990). An analysis of the educational patterns of a cohort of 1,247 youths in the SMPY project, from 7<sup>th</sup>/8<sup>th</sup> grade, after high school graduation and after college graduation, identified factors correlated with both high and low academic achievement. Participating in special mathematics or science programs specifically

designed for gifted students were the best discriminators between high and low achievers in this study. They found that high ability and educational experiences interact to produce subsequent high academic achievement in the sciences. Non-specific family characteristics also had predictive value for high academic achievement .

**Father:** I think communicating encouragement to your daughter is extremely important. You need to let her know that you're pleased with the decisions she has made. That you agree with her decisions, whatever they may be, whether it's friends they hang out with, or decisions about, "Should I stay home and study for this test tonight or go out with the guys to a movie?" Anything like that, any choice they make. That kind of encouragement helps them be confident in themselves, they see that their parents trust them and that is a powerful guide.

**Father:** I coached softball because I thought as a grade school kid she was looking like an egghead to me and that maybe if she got into sports she would see this whole other world. I'm not an athlete, I never was, but she might see it and want something to do with sports. She tolerated softball until the seventh grade and then left that behind as fast as she could.

**Father:** A lot of the encouragement was acknowledgment, "I saw you do this, and it looked good," or "The play was spectacular and even though you had a small part, it was really good." A lot of it was "I was there, I saw it and it was good, and you need to know it was good." Other encouragements were more along the lines of "It is okay."

A lot of what I thought I was doing was pretty much along the lines of cheerleader, "This will be all right." "Yes, this didn't work out exactly right this time, but it is okay, it will work out."

Some of this encouragement was directly related to disagreements with her mother over clothing, or where she was going. I would step in and try to be a calming influence. "Okay, you are agitated, you've fought with her, but it will be okay. You'll go on, you'll have a good time." "It is all right." "Put it behind you." "You can do it." Keep going' kinds of words usually in small doses.

**Father:** We certainly encouraged her to take advantage of opportunities that were given to her and encouragement takes several forms. One is the verbal, "Gee we heard about this program, what have you heard?" And she would respond, "There is something in my back pack that I was suppose to fill out and send in." "Well get it filled out and sent in." So there is that kind of encouragement, but there is also the physically making time and the logistics of allowing these things to happen. One of them is the extracurricular classes like dance, would be something that you say, "Okay, we'll support you in this because we are going to haul you there and back, and we'll make this time in our schedules to do that." The talented and gifted program had a poster display at the end of the year, and "Yes, here is a project that you have to finish and you need a poster to display." So, "Yes here are the supplies to help you get this done" and "Yes we are going to drive you there," these are all minimal things that happen in everyday life. These are not special things that we did because of her ability. Science Olympiad, and Odyssey of the Mind were projects that she was in and this required saying, "Yes we can make this happen because we will take you to school for these after-school activities," and so forth. *So, a lot of these things she wanted to do, these weren't things that we pushed her into, but we did support her in making them happen after she had committed*



*to them. And sometimes making them happen after she committed was to remind her of her commitment [Italics for emphasis]. “You said that you would do this. Have you gotten it done?” “Where are you in this project?” those following up kinds of things.*

**Father:** Helping her with academics has always been the easiest to mentor because that’s my background, education is my business. I think dance classes and tumbling classes were seen as enrichment activities to say to her, “Look, there is a physical side to your life.” That wasn’t something I deliberated, it was just something that I did. In retrospect, of course we were looking after her social well-being and so we balanced these things in our family. It wasn’t that hard to think about, we just did these things.

**Father** I think we have always shied away from the usual, “Oh, we’re so proud of you” kind of statement. We tend to be more towards the, “That should really make you feel good about yourself” kind of statement. I think when you say you’re so proud of them it is like they’re only acceptable to you if they do something well. Where I think if you tend to lean more towards the, ‘that should make you feel good about yourself, you put a lot of effort into that’ kinds of words tend to be more encouraging and not so conditional.

**Father:** I think she’s smart so she recognized that her achievement always made me happy and proud. “Oh,” for example I would say, “Let’s go out and have ice cream, let’s go to restaurant...”

**Father:** *I have always wanted to be an encouragement to her and I knew that role would change as she grew up.* One of the things I vowed to myself when she went off to college the first time was that there wouldn’t be a week go by that I wouldn’t talk to her. We are not very good about writing letters, but we sure love to dial the phone. And then when she got to college we had e-mail, that was a goal that I set for myself, “I would be in touch with her once every week no matter where we were,” and we have been able to do that. So, it’s important for us *to share our lives as much as we can by keeping in touch*, and if she doesn’t call us, I’ll call her. Already, I have moved her furniture twice since she started college and we’re getting ready to do that again. *I always want to be involved in her life* and right now sharing in her life by doing things like picking up her physical belongings and moving them from one place to another seems to be a fairly good involvement and something that I can do for her.[Italics for emphasis]

#### **A father’s journal:**

I believe my role as a father has been supportive in nature. This is what I have done in her life:

- Cheerleader
- Go-between
- Good-cop/Bad-cop
- Teacher

Explain, demonstrate

“Hey, look at this”

“Hey, listen to this”

I was conscious of the need to praise her. I never felt it was a power trip. Through all the changes in her life I have always tried to remain steady.

Only one mother said her husband was more nurturing than she was and that he attended to

their daughters' emotional needs better than she did. Mothers had a broad range of behaviors they considered to be encouraging. Encouragement from the mothers' point of view was to meet their daughters' needs and to facilitate her development by showing her she was loved. Mothers encouraged their daughters by letting them know they were willing to help; they did not indicate to their daughters that life would be easy, but they provided thoughts and encouragements that sent messages to their daughters that they believed they would be successful.

Mother: It sounds hokey but I think we just loved her. I think we just, (pause) we were so entranced by her as a small child that how can you not just engulf her with your whole being when you have a kid who was as bright as she was? I think if we encouraged her it was just by loving her.

Mother: When I think about how we nurtured her development and encouraged her, I think that we have not thought in terms of an area of ability or intellect, *I think we probably always just followed her interests.* When she was real little she thought she was going to be veterinarian and somewhere she was going to be a doctor. She had so many interests that we would just think about what she would enjoy doing, about what would be good for her. We never did anything that I would call really high level; we weren't thinking of looking for classes to put her in and we didn't take part in many of the summer offerings although she did Super Summer every summer because she liked the courses they offered. When I think about how parents nurture their children's development and encourage them along, *I think, it happens all the time because you're always doing something.* [Italics for emphasis] For example there's so much stuff to talk about in a grocery store, anywhere you are and I think just talking, explaining what you're doing teaches your children and shows them you are interested in them and that in itself is encouraging.

Mother: I don't know. I mean it came natural, it's just probably the way my mother raised me. I tried to be close to them, to listen to them, take time with them, and they became the first thing in my life. Nothing else mattered for me except my children. They are the most important things so if they wanted something I escape anything else and then do whatever they wanted me to do or they needed to have done. As a mother it just comes, it's natural. to help her to strengthen the part that she is strong in. I sent her to the gifted program. Then as soon as I found out about CY-TAG I talked to her and told her that it is a good idea to go there and we did not mind about the money, time, or anything. We tried our best to use every facility available in this town and at the university to help her to improve.

Mother: We went to all of her activities. In fact, while her Dad was working on his Ph.D. and living in Iowa City for a little over three years I single parented them with him coming home on the weekends. Whenever she was in any activity even if it was in the middle of the week he drove back to attend. He would drive from Iowa City and go to whatever it was and sometimes drive back that night. Dance recitals are held Thursday night, Friday night, Saturday night, and Sunday and we went to all four of them every single year! Wherever she performed or whatever she did we needed to be there, that was really important to us.

**Mother:** There have been times when she needed encouragement. She seemed to need encouragement, for us to say "You can do it!," but then the time came when she received a B and she thought, "That's it!" She was a wreck. So encouragement can swing both ways. I am in awe of someone who is as focused as she is, I also am afraid that she is so driven. It is a two-edged sword for me. I think her drive is great except I worry whether she is emotionally strong enough to survive if something goes wrong with that focus. She is young for her placement in school, she has already left home, and she has not had to deal with any real setbacks yet.

**Mother:** I've thought that kids need to be treated like they were thinking individuals all the time and that it is very important to talk to kids, I mean talk about their feelings. I also thought that there should not be a power relationship between parent and child. Ultimately I knew I would have to make decisions. But I would always want to have it so that given what my child knew, I could present options and we could talk about the situation and the child would have to come to a decision. I wanted my children to be able to make decisions, make choices, at least with a little help and not feel they had been pinned to one. What I wanted for my children was that they would be able to make understanding choices or educated choices in different situations. I wanted them to know the consequences, I don't mean consequences that I would do but what the effect of their choice would be, what the outcome would be.

I talked to her a lot and talked about my feelings and her feelings. I would say talking and giving her a lot of control, but not letting her do anything she wanted to do. If I did have concern for her, I talked to her about it.

Another thing I do, and I think it has been very important in rearing my kids, is to tell them about their characteristics. I like to tell her, "You really bounce back, when you have adversity you really bounce back," I want her to know that it is a strength because otherwise you cannot go on if you don't bounce back.

**Mother:** I also think it is real important to acknowledge the work they have done. I like to tell them at a real serious time when we are alone, "You know, you're such a good writer. I look at your writing and I think this is so good!" I won't tell her what other people have said about it, everybody says after they read something they say, "It's nice! I really liked it! It's very good! Good job!" We say that, but if you're going to portray it as really special then that's more of a private thing. I think it's like telling somebody your feelings for them, it's not always that meaningful when somebody just yells it out or if you say at the end of a conversation, it just isn't as meaningful as if you say those things in a real special way. I have some relatives who say at the end of the conversation, "Love you!" They don't even say I! They say "Love you!" And we say, "Oh, love you!" I just think intimacy is really important.

I think kids are more likely to believe what you say about them if they hear you tell it to somebody else. In addition to telling my kids what I think about them I would make a point of waiting until they're within earshot and then I would tell my husband or my sister, but usually my husband, something like, "She is such a good dancer!" Or, "Oh, she writes so well!" I think that is really effective, then it's like they think, "Ooh, I heard a secret" and they believe it more.

I think talking about the effort is real important too. Even when kids don't achieve, if they get an A-, I'd say, "You put everything into that you could. You did a great job! And that first test you didn't get this and then this happened, but you know, you did a really good job and you have something to be proud of there," and I review. I think reviewing is important. "What all did you do here? Look what you did? Look how much you did?" It's so important.

**Parent concern: mother:** *So if there is a negative thing, I would say that sometimes it is hard not to push them too hard in areas where you think that they have ability. (pause) Sometimes there is such a fine line between motivation and too strong of a push. And sometimes, it is difficult as a parent to learn not to cross that line[Italics for emphasis].*

The daughter's perception of their fathers' encouragement given to these girls by their fathers over time appeared to foster qualities that are critical to learning—persistence, diligence, and the ability to delay gratification.

**Daughter:** Dad encouraged me in terms of just providing the help for math and physics, not saying "Oh you can't do this?" but, sitting down and working through problems with me. He wasn't good at helping me with math at first, because he'd just sort of go through the material and say, "Here's the answer." Then I'd say, "Dad I don't want the answer, I want to know how to do the problem." Right away I had to have more information, I had to know how to do the problems. So, I did make him slow down a lot. He knew he was teaching me; his college students would go through it so fast but I'd be like "Dad slow down I don't understand this." Then I'd start asking questions and then he'd start explaining a lot of stuff.

**Daughter:** I think my father encouraged me think of learning as something enjoyable because he made it an important part of our lives and he made sure that I saw people learn. He still reads a lot and he is interested in learning more, he teaches at the university so he is involved in learning himself. Learning is very interesting to him and it was always important in our house. I think in the most fundamental way he made sure that my attitude toward learning was that I would know learning is important, that it can be fun, and that it should be on-going. He didn't want me to think of learning as a chore you have to complete.

He has motivated me to have well-rounded interests and to my attitude toward learning in the areas of language, history and literature, but he also made sure that I took science and math although he himself isn't the most interested in those areas.

**Daughter:** *I think the main encouragement to be well-rounded came from my parents' providing opportunities to try things.* With my parents support and my sister there to help me realize I could do anything I worked at, everything went okay for me. Then once I tried something and it worked out for me, I adopted my own style and did my own thing! I think that is what they wanted anyway.

**Daughter:** *My Dad encouraged me by just being there if I needed to talk.* He encouraged me to try hardest in whatever I wanted to go into even when it was math and science. I think he would have encouraged me just the same if my interests had been in history or in music. He encouraged me to play sports and more "boy" toys, but I think I would have done that anyway because I wasn't one to play with Barbie dolls. When I was little I had a play-mobile and a lot of Lego's!

**Daughter:** I think a lot of support has to do with encouragement. I think it's important for gifted girls to realize that people will look up to you if you're intelligent, I think that's something that the girls and women of this generation have really experienced. There does not seem to be so much discounting of women who are intelligent now as you read about in the past. I think a lot of people have looked up to me and what I've accomplished and that's a

great feeling, a feeling gifted girls really need to have. *I work a lot by positive reinforcement, that just keeps me going* [Emphasis hers]. I don't know if that's typical of gifted people or not.

Daughter's Journal: It's hard for me to put a lot of thoughts down on paper about my Dad because our relationship is not one that I think about very often. My Dad is simply a constant in my life, that is how he is a motivator. I trust him to be constant, and he is strong and solid. He is willing to do whatever he can to help me or to make me happy. I guess at heart I am just an old-fashioned "Daddy's Girl." We have a comfortable relationship and now that I am older and have become interested in the same things as he is academically, we have been able to have a much more equal relationship.

Daughter: My parents were encouraging when it was time for me to go away to college. *To prepare me for college, my Mom helped me with the more emotional things. My Dad helped me get things done. They both helped me but each of them helped me in a different way* [Italics for emphasis].

College, my Dad played a big role in deciding where I went to school. *He was very good at organizational things and making sure things were done. He helped make sure all my applications for college were complete and mailed by the certain date and that sort of thing. He asked what school I wanted to go to and I really had no idea if I wanted to go a big school or a little school. He thought I should go to a small school. My Dad was very good at the technical aspects of the transition from high school to college. He helped me with the orientation at school, making sure I talked to all the people I needed to, making sure I registered for my classes,* that sort of thing. Both of them supported me in that transition.

Daughters had different ways of interpreting their fathers' counsel about getting "good grades", most of them seemed to appreciate their father's interest in their grades and spoke of it as being encouraging.

Daughter: I know my Dad definitely influenced my attitudes about learning, he did it by encouraging me to try my hardest. He stressed working hard in all areas of education but math and science were the easiest for me, both my parents encouraged me to challenge myself in math and science. Even now in college, they continue to encourage me to work hard.

Daughter: Dad always encouraged me to try my hardest but he didn't push me to always get A's. He didn't tell me I had to get the best grades, he just encouraged me to work to my potential. He said not everyone can get A's, just work your hardest. I think it was important advice.

Encouragement was perceived as supportive when her father piqued her curiosity for new interests:

Daughter: My father never really said "no" to anything, he always encouraged me to do everything: take dance lessons, gymnastics, soccer, music lessons and photography classes. If my parents hadn't been open to so many different opportunities and put that kind of financial support, their time and effort into letting me do those things, I think I would be a very different person. My sister is the kind of person who loves to do anything and

everything and will try it all. But I'm very different, I'm very shy and I won't try anything unless I know that I'm good at it. My parents gave me the encouragement to try things.

Encouragement was seen as support when fathers participated in common activities with their daughters:

**Daughter:** My dad has always encouraged my artwork. We took a class together one summer when I was young. He has always been interested in art because he likes to draw. Now I'm an art major in college.

**Daughter:** I think the parents of a gifted girl need to recognize that she is smart, and they need to be supportive of that. I think you have to be supportive of what your children want to do as long as it is reasonable. I think you need that kind of support at home, and you need your parents to tell you that you're smart, because even when you're gifted, even if you probably know you are smart, *I think it helps to have someone tell you that being smart is a good thing. When you're younger, if you're at the stage where it's not cool to be smart, you need someone to tell you that it is a good thing, and that it's okay to be smart.*

Although encouragement was sometimes appreciated, this statement indicates that it sometimes caused friction. There were instances when the daughter did not feel her father recognized that she was "growing up" and had her own goals, that she did not need "pushing":

**Daughter:** I think the way he nurtured me was to push me. It would have felt more like nurturing if there had been more interactive communication instead of our communication being so one sided with him telling me, "I know this, this will help you in the future", that kind of thing. I wish his pushing would have been more of a real two-way communication. *I would have liked for him to know that his pushing wasn't necessary, I wish he understood that I had the drive inside myself and I didn't need it coming from someone else.* Maybe he wasn't always fully aware of that and maybe more through communication would have helped. I would have been more excited about what I was doing instead of feeling like the hard work was an obligation.

Even when daughters' opinions differ from their parents' opinions, they still seek approval. Lack of parental/father approval did not deter the daughter's decision for participating in her chosen activity, the daughters develop a determination to "show" they can *do well* at everything they choose.

**Daughter:** I don't know that my parents like my extracurricular activities. I get really good grades but my mom especially wants me to focus completely on schoolwork. I think my dad wants the same thing mainly because he knows how important good grades are. But I want to have some fun time, sort of relax so I'm not so stressed out. They support the volunteer work I do, they say that is good for me, but they don't really support the other stuff like mountain biking and mountain climbing.

*I wish they'd be a little bit more supportive [Italics for emphasis].* I know they weren't supportive of the relationship between me and my boyfriend. He's quite a ways away, my

mom told me to just drop him and find somebody else. But, I told her “I’m not going to, building a relationship is hard, but we can make it work.” I wish they’d be supportive of my racing and say “Well you can go racing,” *I know they’re proud of me* that I can juggle both school and racing at the same time. *But, I wish they’d be more openly supportive to me. I’ll bring a medal home and show them.* They will be happy to see it but my mom will always add a little thing like “You should be studying and not racing.” It doesn’t really hinder me, it just makes me want to go and do more.

One girl who had demonstrated high ability in math and science throughout her lifetime, changed her major from medicine to music. While she said she felt free to make that choice, she felt she did not have her father’s respect for that decision. When asked how it felt not to have his respect she said, “*It felt terrible not to have his respect*”[emphasis hers]. She felt as though she “had to fight to get his respect for playing her instrument.”

Daughter: When I was in high school my Dad was supportive, but he would always comment, “Well, you do enough of this stuff with music, why don’t you do something else? Why don’t you go to a Civics camp or something?” This was his attitude that was in my face all through high school. Those comments made me feel horrible. I thought, “How am I supposed to get better if I’m not allowed to work at music?” I thought, “Music is what I want to do, I love music, I know better than you what I enjoy doing, how can you tell me what I should do?” Obviously, he thought it was in my own best interest to keep me well-rounded, he appreciated my music he just wanted it to be something I did on the side.

He was concerned that I was changing from my science and math interests to a strong interest in music. He was concerned that I was going to major in music at a college with a really strong science department. I think he told me it was a waste of my intellect. *I felt like I had to fight to get his respect for playing my instrument. I did not necessarily feel like I had to fight for the freedom to do it, but the respect for doing it*

*It felt terrible*[emphasis hers] *not to have his respect.* I think it’s really hard because he doesn’t know anything about music. *I felt like he was denying me my hard work. Instead of saying, ‘Yes, you worked hard, you did really well,’ his general attitude was one of ‘Well if she won another competition, then it’s not that hard to play the her instrument.’ He did not say that but that was his general tone.*[Italics for emphasis—hers]

Although encouragement for staying the course, for achieving goals were par for the course for parents and were accepted as supportive by the daughters, following is an example of one daughter’s response to the “lack of encouragement for the *effort* that goes into her work”:

Daughter: I remember being really proud of myself my sophomore year of high school because in the fall semester I got a 4.0 G. P. A. while taking three honors classes, being two or three years ahead in advanced math classes; and for making All-State in orchestra, which was excellent, I practiced 20 hours a week to do that. *For my Dad to ignore the effort and the time I put into it and say “it simply comes naturally” to me, is discouraging. I think in a way it does come naturally for me, but that doesn’t mean I don’t have to work hard to accomplish*

*what I do. And for him to think that it simple and say things like, "Well sure you should be in All-State, you were last year," is really disheartening to me because it does not work that way [Italics for emphasis]. When you are auditioning, your ten minutes to audition comes after hours of preparation, actually years of playing the flute, and things can just go wrong. And for him to simply say 'Well that's expected isn't it?' "What's the big deal about that?" "What's the big deal about making orchestra?" "Of course you would, I knew you would make it." He saw his comments as being really supportive, and as believing in me. "Of course you can do it." Well, that is nice to hear, but acknowledge the hard work that went into it, acknowledge the effort and the talent that went into that. [Italics for emphasis] So, he is supportive of me, but with a big struggle.*

Encouragement was also perceived as supportive when EFFORT as well as accomplishments were applauded.

**Daughter:** I did do things well naturally and easily, but I've always been a perfectionist and I've always worked really hard at things. I always felt that my parents praised me for both the ability and the effort.

**Daughter:** My senior year of high school I took a full load of courses and band. We did tours, we played at Northwestern University, and a few other universities in Illinois and it was a really big deal for me. He just does not get that, he says things like "What's the big deal?" to me. My parents came to see our band's last performance, the last concert at our high school. They made my parents stand up in the middle of the concert before I played a special selection and the director talked about my parents and everything. That made him feel good. I think the fact that I got more recognition from everyone else made him recognize my accomplishments on the flute and that it was a good thing. He saw that my three different band directors at the high school just loved me and were really proud of me. The fact that afterwards all the parents wanted to come up and talk to me, I think that made my Dad feel that. "This is my kid, she is doing well and you know it is nice." *It seems to take that for him, everyone else has to point something out and take notice, and then he will come around and say something [Italics for emphasis].*

**Advocating.** Advocacy as a property of support was noted when fathers addressed issues of inequity. Mothers and daughters described their husbands/fathers as advocates when they provided active support for interests expressed by the daughter or for interests not necessarily voiced by the daughter but which were observed by the parent as an interest of the daughter. And daughters perceived father interactions as advocating when they took the form of sharing philosophical beliefs about life-long-learning; and about reasons to select a career.

**Father:** I think the scientific field is a pretty good field for her but there's still a lot of male domination in that field. If she goes into medicine there's probably a lot more openings there for women. But, certainly the engineering field she is in right now is male dominated. I think she will handle it okay. It is just not something I would wish for anyone to have to deal with.



Basically women are excluded by virtue of trying to ignore them. I think in the student realm that's very much what happens. She was entering a robotic competition at the university; the project was following up on an interest the Science Olympiad had created. She I think was pretty disappointed when she started working on it because the boys in her class wanted to reserve all the good things for themselves. I kept after her and after her to talk to her professor, she did complain to the professor, and I talked to him as well. I told him he should simply tell those guys, "Hey wake up, this is the 1990's, you guys can't do this." I talked to her later to find out what had happened, and the professor's solution was to just give her some things to do on her own. Which I don't think is the right solution at all. He gave her something more meaningful to do, so that was okay. But still it doesn't resolve any of the issue.

**Researcher:** Did she ask you to talk to this professor or did you do it on your own initiative?

**Father:** She told me what was going on and I just did it myself.

**Mother:** I used to worry about a lot more things, I mean about her being successful but now I think its more a change in me. I realize that she is going to be successful in whatever she chooses to do and that what would make me happy is not necessarily what is going to make her happy. So that is more my realization. I was her advocate, I guess I still am. But it is more personal, I am her sounding board and it is my job to watch her grow, to help her whenever I can as she comes up against issues in the adult world that she is not used to and to be here to talk when she needs me.

**Daughter:** I think he has always taught me is that learning isn't something that ends once you get out of school, but it is something that you do throughout your life. He really advocates reading, that is one of his hobbies. He reads a lot of biographies and non-fiction books. He is also really big on current events and reading newspaper. He is always wanting me learn about what is going on in the world around me and not just what is happening in my home town. I think he has instilled in me the idea it is really disappointing and discouraging to be uneducated. I do at times think I can be quite the snob toward other students if I don't feel that they are matching up to my level or to my expectations. I have always had a strong desire to be well educated and knowledgeable. I think that the sense I have that it is important for me to face up to society and meet the needs of society probably comes from my dad.

He always talks about how there are so many people in this world and that it is a competitive world. He says that if you want to succeed you have to work very hard to be one of the best, especially for the kind of the career that I want. I don't want to have any old job that doesn't take any training or education whatsoever. He is that way too; he wants to be at the top.

Advocacy was also noted when the father acted as a cheer-leader to encourage his daughter to persist...

**Daughter:** Dad would send me off to school feeling positive like, you know, "Wear your new outfit and have a good day." He encouraged me to enjoy what was going on. In high school I had some adjusting to do. Both my parents encouraged me to stay active. Dad would say "Stay in band, it is a good thing." "Keep doing theater," "Yes, we'll drive you," "Yes, we'll haul your friends around." "We like it that you're taking part in all this stuff."

Advocating by showing interest at parent-teacher conferences and communicating his interest in his daughter's efforts to both the teachers and to his daughter.

**Daughter:** My parents always went to any open-house the school had and to all the parent-teacher conferences. Afterwards we would go over what the teacher said and they would tell me about the areas I did well or what areas I needed to work harder in. If Mom couldn't go, then Dad would go, he would find out what the teachers were thinking and he would come home and talk to me.

Parents can be taught to advocate for their gifted children appropriately. Parents have the moral obligation and the responsibility to engage as a participant in their children's education (Rash, 1998). Advocacy takes on different forms, it is seen when parents are proactive for their children and carve out a relationship with the school anticipating needs in order to prevent problems. Volunteerism, parent groups, fund raising and lobbying for school interests are all ways parents can help schools make positive changes.

Davalos and Griffin (1999) wrote about the positive socialization girls receive from teachers by meeting the expectations of being quiet, cooperative, and neat in the schoolroom. By conforming to these expectations, by learning to wait and watch for a teacher's attention, girls have not learned to interact with teachers and peers on difficult issues, thus missing the opportunity to get feedback necessary in order to improve their efforts on really difficult material. At every level, parents and teachers must do what has not been done earlier in the home or in the school, they must become the student's advocate and create an environment where open discussion of difficult issues is the norm so that bright students feel an excitement about discussing concepts and expand their ability to deal effectively with difficult issues.

**Guiding.** Steinberg, Elmen, and Mounts (1989) conducted a longitudinal study of first-borns in 120 families. In yearly intervals they gave questionnaires to adolescents during school and home visits eliciting information about both parents. Adolescents' reported on ways that three aspects of authoritative parenting practices, parental acceptance, psychological autonomy and democratic and behavioral control make positive and independent impacts on school performance. "Adolescents who

describe their parents as treating them warmly, democratically, and firmly are more likely than their peers to develop positive attitudes toward, and beliefs about their achievement, and as a consequence, are more likely to do better in school than adolescents whose parents treat them either too severely or in too passive a manner (p. 1143).

Shulman and Seiffge-Krenke (1997) had interesting findings about father relationships and the impact on autonomy. They wrote:

In general, the results of our study are similar to results of other studies pointing to the lower involvement of fathers with their children. Our suggestion is that fathers' being less engaged with their adolescents may serve a developmental function. It is well established that fathers spend less time than mothers with their children and adolescents. However, a distinction should be made between "distance" and "detachment." Although fathers spend less time with their offspring and are less familiar with their children's daily activities this does not mean they are uninterested in their children. When it comes to issues such as studies, fathers are as much involved as mothers. *Being distant allows a "bigger space" between father and adolescent; it also enables the adolescent to exert individuality and leads to less friction ... nevertheless, findings show when it comes to crucial issues such as scholastic studies or discipline, fathers are involved on a level similar to mothers. This suggests that although fathers' immediate presence is low, what counts, especially during adolescence, is the strength of inner confidence in availability of the parent* (p. 25, 27) [Italics mine, for emphasis].

It seems that the father's encouraging presence promotes an atmosphere of expectation and provides a secure space for the development of talent and facilitates the development of autonomy.

The idea of guiding emerged from a discussion of discipline. While intergenerational differences were noted immediately in response to the term discipline, the concept of guiding came through in every setting. The term discipline was not often used by these parents, but the principles of

discipline, as in guiding, staying the course through practice, were repeated across the lifespan of the daughter. While daughters immediately responded to the idea of discipline as something akin to training that was expected to produce a specific characteristic or pattern of behavior, the parents responded to that thought more subtly. Parents talked about the need to guide their children into thinking about choices they would make during their lives. Both fathers and mothers said that discussions arose easily during the family time when issues surrounding daily life arose about school activities, friends, choices, and that news became the catalyst for discussions. Fathers were guiding their daughters when they discussed the work ethic that goes into becoming a great musician—practice, as well as when they discussed the amount of effort that goes into studying which results in good grades! And fathers were guiding their daughters when they told them repeatedly that people have to work for what they get in life.

**Father:** One of the values that I think that we demonstrated, and again we never stopped and said, we're teaching a value, but one of the values that I think we demonstrated and that our daughter has learned is that *you have to work for what you get*, no one is going to give you anything, and we go to work to get the money to buy the things that we want. If we want the garden to look a certain way, we spend the time out there working at it. If you want to play the piano, you're going to have to practice. These are things that we reinforced sometimes with greater success than others, that practice is part of the routine to achieve a goal of where you want to go. *Certain frustrations of hers were that everything should come easily on the first try. One of the things we worked on with our daughter is that practice and repetition is part of life, and you are going to have to start doing it sooner or later so you might as well do it now.*[Emphasis his]

**Father:** She wanted to borrow our car for the trip to Colorado instead of impinging on the boyfriend's family car. We did not particularly want to have to rescue them out of the middle of nowhere. So I have to ask her if she has figured out what the heck she would do if they break down when they're in the middle of Colorado. And I have to ask her what they will do when they're in the park, how they will figure out whether it's safe to climb mountains and things like that. Those are the sorts of questions that I raise, and she came back with answers to all of them in terms of how she would handle each situation. Finally I said, "Okay fine". Her responses are thought out but they are also very much pointed towards her goal. But she is still young. So I am not sure she really has all that handled. *She is a responsible girl, however, we make her go through some hoops sometimes, we make sure that the hoops are there.*[Emphasis his]

**Father:** She has always been very level headed and emotionally not high strung so reasoning with her was very successful. It hasn't been quite as successful with one of our children (laughs) who also has a high level of ability but is highly emotional. But basically you could

talk to her about things and reason things out. She understood logical arguments and so she was very easy to parent actually.

**Mother:** It was hard sometimes to find a guide her to do what seemed right that worked for her because she would just get stubborn about it. It was always easier to reason with her than it would have been to get into arguments with her.

**Daughter:** He was very rarely the bad guy. Especially in my teenage years. A little younger that was reserved for Mom for the most part. Dad has a very characteristic style when I would do something, and I would have to do something pretty offensive to him to get him riled up. He was quiet, he's not someone who would yell at you, you could tell. He would be stern. Usually he's the one who will talk it out. (Pause)

**Daughter:** He never spanked us. I remember being grounded once, because I went to a friends' house without telling. He told us what he expected of us, and if we did this then, well! For example, if he noticed a room wasn't cleaned he would say it must be done by a certain day. And then you knew it was cleaning day.

I remember one time I got home really late, after a dance. My Mom was really angry. She thought I'd be home at one time, I didn't know, it was a miscommunication. We always tried to communicate. 12 o'clock midnight was the unspoken curfew, but if something was going on I'd let them know and it was okay.

I hate to say we were given free reign, but as long as we did what was expected, our chores and cleaning, then we let them know where we were going and what we were doing and we came home at suppertime unless prior arrangements were made and we stayed out of trouble we pretty much did as we chose.

**Daughter:** Well, my parents were always pretty lenient in general; they were never big on exact bedtimes or strict rules about one hour of TV, etc. But when my brother came along, things changed at our house and the rules came out.

**Daughter:** My dad was in charge of discipline but I don't remember much about it. I don't think my childhood was very structured. I think when I was really little I was spanked. That stopped before kindergarten. It was not devastating or traumatic.

*The times I got into trouble were rare enough that when it happened I remembered. Doing the right thing was important to my Dad. When I did wrong he would tell me it was wrong. When the issue came up he told me his version. I don't remember a big spiel. He would say, this is right, this is wrong, this is the standard [Italics for emphasis].*

**Daughter:** Authority has never really been a big issue with my parents and me because, in all honesty, they never had to discipline me that much. So now, it is easy for me to fall into a mutual and equal relationship with my father, rather than be afraid of his power and authority. Guiding, as a property of support occurred between fathers and daughters when fathers

supported their daughter's determination to stay on task.

**Daughter:** He encouraged me to stay in the honors classes, to stick with the things. Who knows but that a big part of his support was that kind of encouragement?

**Daughter:** One of the most important lessons Dad taught me was to value my time. I had

planned to spend summer mornings on a project of my own but it seemed like that was also the perfect time to catch up on sleep and reading and in the late mornings on calling friends and e-mail. One day Dad asked me to meet him in the back yard garden in about a half an hour. When we talked he told me that he had been watching and he thought I could easily finish my project in two weeks if I saved my morning time for myself. He said I could do that if I wouldn't let anyone interrupt me and if I wouldn't interrupt myself. He said to tell people not to call until afternoon because I would be busy. That was the first time in my life that I realized I should value my own time, that I could be busy, that the plans I had were important and valuable enough to clear a space of time for myself.

Daughters noted father's guiding them when their fathers provided themselves as role models in demonstrating tenacity.

Daughter: He taught me lessons early on how to apply myself. Later on I took the responsibility myself. My parents didn't always ask, "have you done your homework?"

Steinberg, et al. (1989) found support for this kind of parental encouragement to tenacity in students of average ability, they found that "motivating adolescents to work hard and strive for success held the most promise for psychological interventions designed to enhance school performance" (p. 1435).

Daughter: They didn't want us involved in drugs or anything. I didn't hear that from my parents. I knew that I shouldn't because I saw drunk people when I was an exchange student in Germany and I didn't think it was funny. It scared me; I just thought, "Why would you want to do that, that's insane." My parents do not drink a lot of alcohol, maybe a beer with pizza, but we have pizza like once a year, and wine with fancy dinners like Thanksgiving and Christmas dinner, maybe birthdays, but that is not a lot. It is just a pattern of behavior, we saw that you did not need alcohol to be happy.

I like to be respectful to other people, even to step in when other people are beating people up emotionally. We have morals right? I think a very important moral is to say, "I want to uphold my morals." Like choosing not to drink alcohol, choosing whether you're going to get up every morning at 6:30 or you're going to sleep in and forget your alarm. I think unless you are consistent in everything you're cheating yourself. You're only hurting you, not anyone else.

After school we went to Dad's office, we would hear him interacting with his co-workers. He's very fair with them, he gives them a chance and maybe gives them a challenge or a hard problem to work out but still... (pause) that's what they're there for. I talked to my mom briefly about morals and values once and she said, "We hope we're good models for you kids." Sometimes behavior is more important than words. They wanted us to take something from what we saw in our family.

As far as guiding their daughters toward compliance or to enforce order, parents said in nearly one voice that these daughters seemed to have a sense of right and wrong and they chose to do

right. As teenagers the girls had not stayed out late, they and their friends chose to enjoy themselves without using drugs or alcohol so the parents didn't have the worry or discipline problems with their daughters that some people do. Three of the families have sons who challenge the rules and rebel at the guidance offered. Those parents strongly emphasized that individual differences in children creates the need for individualized parenting.

### *Consequences of Support*

#### *Perserverence*

Words from a sign on the wall in an athletic complex: "Perseverence: the difference between a successful person and others is not a lack of strength, not a lack of knowledge but rather a lack of heart" (author unkown). The solid support these fathers provided for their daughters built their "hearts", and these girls had the stamina to persevere toward their academic goals.

Miller (1993) discussed women's relationships and stated that:

in relationships where there appear to be positive psychological growth, there are "observable phenomena, some or all of which may be present: each person feels a greater sense of "zest" (vitality, energy); they feel more able to act; they do act; they have a more accurate picture of themselves and others; they feel a greater sense of worth; and they feel more connected to other people and experience a greater motivation for connections with other people beyond those in the specific relationship (p. 15).

Patterns of women's relationships begins with the very early supportive relationship between girls and their fathers. The majority of the father-daughter relationships in this study seem to be a description of the relationships in Miller's study as these eight girls who had positive, supportive relationships with their fathers grew up with the vitality and energy that Miller wrote about. Miller wrote that "...it is this sense of being cared for that builds on the vitality that sustains psychological development, ..." (p. 22).

Daughter: I think I saw in my older sister a tremendous dedication to learning; that isn't something that I developed until my junior year in high school. Until my junior year schoolwork was really easy for me, I never really had to work hard. She saw that and she talked to me about the same things Dad had said, that learning and grades are important but

that thinking and understanding are more important and sometimes that takes real hard work. I think she made me realize that Dad was right, that achievement is not necessarily going to come without hard work, I decided to start working hard to understand what I was learning. Now I am proud of what I learn, but I am more proud of what I understand.

### *Purposiveness*

Without being told, and from within their own value systems these girls were on course with their lives. As they grew, they responded positively to their father's affirmation and encouragement and their independence and drive took on a life of its own. It is possible that their fathers' affirmation and encouragement provided the structure of support that allowed the girls to focus on their goals with such a sense of purpose.

Father: She's always been a very independent person and never, I don't think she ever came up to me or my wife and said, "I'm bored." This was never her pattern anytime when she was growing up. She always found something to do either reading or she was interested in drawing and art and those kinds of things. You could always give her another sketchbook and she would be off doing something. She was always very independent and I guess we are realizing now just how independent. Here she is going off to Europe for a whole year by herself. I guess what that means is she did her own thing. She wasn't looking to us so much for getting her interested in something and so we just let her do her own thing.

Daughter: I knew what I had to do and I did it. They never told me to do my homework, it was my responsibility, I had to do it for myself. I don't think I would have liked it if they forced me to.

Daughter: I really jumped into RAGBRAI and I didn't go with anyone else. I was 17 when I first went and I didn't go with my parents. I dove into it and I was the shy one in the club! (laugh) It seemed like there were 100 people surrounding me, I just sat there and people came up and started talking to me and I would start talking back to them! I heard several life stories, it was really interesting, and I sort of opened up and started talking to people. That was really a turning point in my life, I've never felt so shy again.

### *Equanimity*

These young women all seemed to have a characteristic composure, a calmness about themselves as they talked about their lives, about their accomplishments, and about their plans for the future. They were busy, energetic young women with drive to accomplish their goals but with a confidence that indicated self-control. They had developed a characteristic trait of equanimity because of the security they gained from the structure of support their fathers had provided for their lives.



**Researcher:** What do you think it does for your development to have a father whom you admire and who is supportive of you?

**Daughter:** He's also a model for you, you can model yourself after him. I think it's harder for girls to make connections with their dads than their mom's because of the gender gap. Dad wants to do male things like society has taught him; he likes to do hard work with his hands. But, *I think girls learn that kind of thing from their father, if they stick around and listen to their father.*

And, he liked to poke at me sometimes and he'd ask me what I was doing. He'd kind of poke at me and tease me that "No that doesn't look right," and "Make it this way!" or when I brought home a finished product he'd say, "Well that looks like such and such," Like a little clay figure I'd made in art, he would say, 'It looks like one of the cats,' that would be funny. *It's always good to say, "Oh you did a great job" and pat you on the back kind of thing, but Dad would do more, he would joke around and he would take your work and sort of expand it. He made you feel good about what you just did [Italics for emphasis].*

My dad gave me a pretty good direction in terms of helping me with math and keeping me interested in science and engineering especially. He had a lot of stuff around the house and I'd ask him about it. He had a lot of aerospace magazines and mechanical engineering magazines, and many different science journals. I asked him, "Why do you get all these magazines that are from all different fields, they're not aerospace, they're mechanical engineering or something else." And he told me, "Well, because information crosses over in a lot of those areas." So I look through them to see what is going on, that helps with direction; *he helps me understand how things work in the bigger world.*

Her Dad helped her to learn how to look at her work from a different perspective and take pride in it, he gave her confidence to face a bigger world.

**Daughter:** When I think about the relationship I've had with my Dad through my life I realize that I used to feel resentful because he didn't spend as much time with me as he did with my brother, I thought that was because I was a girl and it upset me. Yet now, I think I'm glad that he didn't relate to me so closely, I might have thought he was over-involved! He has always been there for me as a presence, I don't worry that he is going to criticize me or point me in a direction I don't want to go. He is very present and he is very patient. I am satisfied with the affirmation that I meet with his approval, I am satisfied with the idea that he is pleased with the decisions I have made and what I am going to do with my life.

I am not used to having him directly involved but I don't feel deprived. I would feel it was a problem if he wasn't in my life in the role of support; I think I would feel more confused about whether I was making right decisions, I'm still confused about what I will do with my life but if he was negative I'd have a sense of clouded confidence in my choices. He has enough trust in whatever I do that it will be good, that it will not be wrong. I think about the metaphor of a bridge, whatever I do he is there to support me.

My stress is figuring out what is right for me, if I had to wonder what is right for him that would be an added stress. I hear others talk about their Dads' requirements, one girl has to talk through her plans with her Dad; it all seems constrictive, I can't imagine it. It would be received as support if he said, "OK," but if he didn't she'd have to rebel or give into something she didn't want.

I think feedback is very important at every age and I want feedback, but if I had the same kind of support from both parents it might be overwhelming! I can't imagine more than

one mother. I need other adults but if both of them were as involved in my life as my mother is it might be overwhelming, I don't know!

Mom and Dad are so different. I'm more serious with Mom, we talk about very practical things. Dad comes in and says, "Let's rent a movie." He brightens things up, he makes the atmosphere lighter, you can't do serious, practical things all the time.

When I'm more aware of how I'm doing in my life, when I'm feeling good, I don't sense his support, but I know he is reinforcing me. When I feel down and don't have a good feeling about myself, I don't feel his support is lacking, but I am less able to see his validation of me as accurate. Dad does make blanket statements to me while Mom gives the reasons things will work out. I can recognize the difference between Mom and Dad, she is willing to look at a problem while he smoothes over the problem! Dad sees a work in progress and he marvels at me, but he doesn't know how to get close and involve himself. He is just always there approving, proud from a distance. He gives this sense that this is his girl growing up and that he can't go back to the closeness we had when I was little until after I've *become* [emphasis hers] on my own right.

I think what he has done for me is to try to see the world through my eyes, to understand me and where I am in my life, then he tries to help me develop confidence in myself. Having ability is one thing, knowing you have capacity is important, but I needed a sense of affirmation. He gives that to me. He is like a foundation for me, he reaffirms what I am doing so I don't have to worry and I can use that as a jumping-off point. Having his support to count on allows me to move forward, it takes a burden of self-doubt away. It helps me be open-minded, I haven't had to feel constraints on my life. Because he doesn't judge me, I have learned to look at things through other people's lives without being judgmental.

All of this comes from the perspective of having parental figures who say they would never stand in my way, they would never try to dictate the path I want to take. If they didn't support me that would be a deviation from what they said originally.

I don't know how I would react if he was ever disappointed in me, I've never had to deal with that.

## CHAPTER 5

### Looking Back, Looking Forward

Gifted children need others in their lives to recognize and value their giftedness, to provide them with appropriate resources, and to encourage them to learn. This is a healthy interdependence which promotes growth. ...At a deeper level, the self of the gifted child depends on the reactions of essential others. Recognizing, valuing, and cherishing the personal qualities of the gifted child leads to the recognition, valuing, and cherishing of the self by the child. (Greenspon, 1998, p. 166)

There is much that can be done to nurture gifted girls, but this nurturing must begin long before any formal education; it must begin in the home. Findings from this dissertation research imply that the supportive relationship between a gifted girl and her father is basic to her optimal development. Findings from this research in eight families where fathers held high expectations of their daughters, and where fathers provided encouragement, affirmation, and assistance to explore, suggest that daughters of these fathers developed traits beyond personal drive and intensity; these daughters demonstrated perseverance and persistence with a sense of equanimity. Was the sense of calm and composure seen in these girls the result of father support? Is it possible that the father support found in this study balanced the emotional intensity that Silverman (1995) described? Gifted young women have enormous personal potential that requires nurturing; it may be that optimal father support “builds the vitality that sustains psychological development” (Miller, 1993, p. 22).

The phenomenon of father support was evident as fathers perceived their daughter’s growing independence, intensity, drive, and a do-it-myself attitude when these “babies” were less than two years old. Their “babies” with vocabularies that reached into the hundreds of “words” were already beginning to read and make sense of the world around them. In this context, instead of changing fathering practices they already intended, they recognized the need to keep pace with the developing needs of their daughters and began to provide all those things they intended—but sooner in their daughters’ lives rather than later. Fathers provided support through showing interest, participating, and

observing their daughters' activities. They were interested participants, interested observers, and providers of materials, advice, and encouragement. They took advantage of community opportunities and encouraged their daughters to explore additional interests. Moreover, as the fathers saw their daughters' high ability blossom, fathers advocated for their daughters, maintained high expectations of their daughters, and encouraged them to work hard and stay the course. It seemed as though, at least in part, this structure of support worked to give their daughters confidence in their own ability and to persevere toward their dreams and goals.

Supportive fathers were involved with their daughters' activities; they monitored and encouraged them not only in academics but also in achieving a well-rounded life. Supportive fathers encouraged excellence by acknowledging the part that hard work, persistence, and effort play in achievement and they affirmed their daughters' achievement by acknowledging both the achievement and the hard work that went into it. Daughters of these fathers were growing up, not sheltered from all the problems of life, but with a developing confidence and courage to act on their best impulses and to go forward with equanimity. A daughter's perception that her father believed in her and held high expectations of her promoted high achievement. Fathers who took time for their gifted daughters fostered a personal relationship of trust. Fathers who role modeled integrity and lived an exemplary and consistent life taught values that were observed by and valued by their daughters. This rich relationship between a father and his gifted daughter provided a secure foundation for growth and a platform for launching.

The grounded theory of father support of giftedness developed in this research seems to mirror Bowen's (1978) Intergenerational Model of Family Functioning. Bowen suggested that well-differentiated families have the tendency to have children who function at the high end of the self-differentiated continuum. In well-differentiated families, the respect for uniqueness and approval of each person's right to manage their own identity makes self-differentiation possible and permits each person to function with an intelligent understanding of self. Bowen expanded these thoughts with a description of individuals who operate on the high end of the self-differentiation scale. He suggested

that people with an intelligent understanding of self have the capacity to separate their emotional from their intellectual functioning; fair-mindedness and discernment describe their emotional state. They may make judgments based on a careful consideration of the facts rather than on their current feelings. Persons on the high end of the differentiation scale perceive themselves as self-controlled rather than at the disposition of uncontrolled emotional forces.

Steinberg et al. (1989) identified psychosocial mediators of the relationship between parenting and academic performance. Their findings demonstrated that authoritative parenting practices were a positive motivation to enhance school performance in children. The authoritative parenting practices noted in this research were also found to enhance the academic performance of the eight girls in this study.

There are studies that have delineated characteristics of gifted children and noted the stability of their families, the openness of their homes, and the opportunities they have to explore (Benbow & Connolly, 1999; Silverman & Kearney, 1989). Longitudinal research on fathering has measured father play with 240 men and their children who are in the same generation as the fathers in the present study (Snarey, 1993). Snarey inherited research started in the 1940's by the Gluecks of Harvard Law School whose research was conducted with 1000 boys (500 delinquent and 500 comparison non-delinquent boys). Snarey's research subjects were 240 men who as boys had served as a control group for a group of delinquent boys in the larger study. The subjects were born to families in the lower- and working-class and were interviewed to provide self-reported data regarding parental generativity. Those fathers, who reported providing the highest level of support to their sons during the childhood and adolescent decades of life, reported providing the highest level of support to their daughters during those decades of their lives as well. Fathers reporting the highest levels of paternal generativity played, read, and supported their children, both sons and daughters across their lifetime, similar to the way supportive fathers in the current study did with their gifted daughters.

A theoretical framework was needed to advance our understanding of the complex nature of a supportive relationship between a father and his gifted daughter that is supportive of giftedness. As

extensive as the Snarey (1993) research was, data were gathered from father report only. It was important to develop a theoretical framework of father support of giftedness based on data obtained from both father and daughter. The present study is singular in its systematic examination of the structure of support between a father and his gifted daughter that supports her giftedness from the perspective of eight father-mother-daughter triads in intact families with gifted girls.

Due to the emotional complexity of gifted girls, they may experience problems which impede their optimal development. We as a society need to do everything we can to discover what those problems are, we need to discover solutions and implement whatever assistance is needed to launch them into life, to better serve themselves, their families, and society. The prevailing attitude that bright children will make it on their own prevents many bright children from achieving success. One father in this study, a naturalized citizen from an Asian country, immigrated to America as a young man with an attitude from his homeland that reflected his values of the importance of facilitating the optimal development of his daughter: "The shame comes when you do less than your potential, not when you strive to reach it." There are people in our country who recognize the value of facilitating the optimal development of all our children, even gifted girls, but much work remains to be done to shake off the attitude that if they are gifted they will make their way independently.

Three out of eight (37.5 %) girls in this study had problems with depression that were severe enough to need a physician's care. The stigma must be removed from depression; and gifted girls, their parents, teachers, friends, and the society around them need to learn about it. Information about the signs and symptoms of depression needs to be understandable and accessible. The treatment (both medical and psychological treatment) for depression, including the most helpful diet, the importance of exercise, rest, and medications needs to be clearly understood and readily available. Gifted girls and their families need to learn the danger signs—those signs that indicate when depression is at a critical point and must be reported to medical or civil authorities in order to save lives. The relationship between depression and giftedness must become a high priority in research, in medicine, in education, and in groups working with the gifted. Depression is a disease with a deadly outcome. If depression is

not treated, depressed people die. Depression runs in families. Depression is only one segment of the emotional complexity of giftedness that must be addressed in research.

Because of the academic nature of this research, the participants were not paid for their contributions. However the participants all stated that the investigation helped them in numerous ways. Each of the parents stayed at least one hour after all the interviews were completed to talk about their relationships with their daughters and about their concerns for her well-being in a society that is not always accepting of gifted women.

The fathers stayed to talk about their beliefs about the responsibility communities and schools have to gifted children, and about the needs parents themselves have for support as they are raising gifted children. They talked about the importance of father support in families, and about hard challenges fathers see for their gifted daughters in typically male programs in universities and in the work-world.

Five of the girls spent additional time with the researcher after all their interviews were completed to talk about issues of giftedness; they wanted to normalize their experiences. We talked about books and articles I had read discussing eminent women and about Barbara Kerr's work and books about gifted girls. They wondered too if their relationships with their fathers would grow deeper over time. Two of the girls called and asked for additional time to talk with the researcher about family issues not related to father support and said the opportunity to tell their "story" had been "almost therapeutic." One girl wrote a letter from Europe thanking the researcher for the opportunity to consider in depth the relationship she had with her father over her lifetime. She said that as she put her childhood behind her and pursued her education, it seemed monumental to have a clear picture of just how supportive her father had been and what he meant to her.

#### *Delimitations*

This qualitative research confined itself to a limited number of interviews with eight intact family groups consisting of father, mother, and their gifted daughter age 18-21 during the summer prior to the daughters second or third year of college.

### *Limitations*

The emergent theoretical model for father support of giftedness was, in effect, the researcher's interpretation of the constructions of support given by the participating families. The purposive sampling procedure decreases the generalizability of findings to all areas of father-daughter relationships and to gifted girls in general. The depth of the study is a limitation because of boundaries imposed by time and the number of families interviewed.

Twenty-four invitations were extended to girls in intact families who were listed in the high school graduation bulletin as having graduated with distinction to participate in this research study. Only eight girls responded affirmatively to the invitation, and of their fathers, the majority were predominately Ph.D.'s who have spent their professional lives in a university setting.

Measures of personality and temperament were not considered in this study. The difference in the kind of support fathers gave to siblings in these families was not examined.

Limitations of interviews were noted by Creswell (1994): interviews do not provide first hand information, they provide recalled information as observed and understood by the interviewees; interviews are conducted in an appointed place which may be intimidating to the interviewee instead of the natural setting of the family; the researcher's presence and the researcher's statements may bias responses; not all participants are equally expressive or discerning.

### *Significance of the Study*

A study of the supportive relationship between a father and his gifted daughter is important for several reasons. This research serves as a model of intergenerational research in family studies. This research gave a voice to gifted girls who are in the launching phase of their lives; they had an opportunity to speak about the supportive nature of their relationship with their fathers over their lifetime. Fathers in the generative phase of their lives had an opportunity to discuss the supportive nature of their relationship with their gifted daughters. Scholarly research was important to build on extant literature in an area of family studies that has not been thoroughly investigated.

- An awareness of the perceptions of the father-daughter relationship from the point of view of



both father and daughter could be beneficial for gifted girls of all ages as they compare their life stories with those of other gifted girls.

- Society can no longer ignore gifted children. The importance of father support in the life of his gifted daughter is essential knowledge for fathers of gifted daughters as they struggle to encourage their daughters who are developing ahead of their peers and have needs that do not match the same age child in books on parenting. Morelock, (1996) wrote that "...real children with real developmental differences and differentiated special needs are in danger of being reduced to mere "abstractions" and sacrificed in the interest of contemporary social and political agendas....The research suggests that gifted children are special needs children because they learn differently, function differently neuropsychologically and require a different level and type of cognitive stimulation. They are also potentially socially and emotionally at risk. The developmental differences increase as the level of asynchrony increases" (p. 10). Evidence of this is that in a sample of eight gifted girls, three of them suffer with problems of depression.
- There is an assumption that if you are gifted, educational funding is not necessary for optimal development because gifted children can find themselves; therefore as a society we do not allow the selves of gifted children to grow and reach their potential because we have not nurtured our brightest students, and this is particularly true for gifted girls. A father's statement that "The shame comes when you do less than your potential, not when you strive to reach it" may apply to people involved in research, and in education reforms as well as to growing children.
- This research will promote a general understanding of families with gifted daughters.
- This research has implications for family theorists as they advance research in intergenerational linkages. Because the perception of relationships differ in each generation, it is important to obtain the viewpoint of all family members involved.

- The gifted young women in this study who within the grounded theory framework, had father support for and freedom to develop and explore in their areas of ability had a sense of joy and wholeness that may be a partial answer to Silverman's (1995) call for modification of parenting for gifted girls because of their cognitive complexity and emotional intensity. A challenge for society in the new millennium should be for the optimal development of all of our citizens; this must mean more than recognizing the developmental needs of some of our children, it must mean making a determined effort to meet the individual developmental needs of all of our children so that the greater needs of society can also be met.

### *Implications for Future Research*

As Gruber (1982) recommended "Looking at extraordinary functioning where it does occur is one way to construct that vision . . . of people at their best" (p. 9). It is essential that we listen to the voices of gifted girls and their fathers when determining content in parenting and family life courses.

Additional research is needed in intergenerational linkages to confirm these findings and add to them, to promote healthier families and more supportive relationships between fathers and their gifted daughters. Additional research is needed with these eight girls in five, ten, and fifteen years to see how they use their talents and gifts and to follow the course of the father-daughter relationship into adulthood.

As our society shies away from giftedness, Nelson Mandella spoke as a statesman and a Father to the women in his country and in the world.

Our deepest fear is not that we are inadequate. Our deepest fear is that we are powerful beyond measure. It is our light, not our darkness that most frightens us. We ask ourselves, who am I to be brilliant, gorgeous, talented and fabulous? Actually, who are you not to be? You are a child of God. Your playing small doesn't serve the world, there's nothing enlightened about shrinking so that other people won't feel insecure around you. It's not just in some of us, it's in everyone. And as we let our own light shine, we unconsciously give other people permission to do the same. As we are liberated from our own fear, our presence automatically

**liberates others.**

**More research is needed to determine the effect that valuing gifted girls has on their lives. Research is needed to measure the effect that being valued has on gifted girls in their homes, their workplaces, their countries, and in the world. The research needs to examine ways that young men can be taught fathering skills if they have not learned them from their own fathers in the homes of their youth. Research needs to examine the differences in the ways fathers and mothers support their gifted children and research needs to look at ways that young people can be taught parenting skills as a partnership to provide a structure of support for their gifted children.**

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**Appendix A**

**Original & Amended letter to Human Subjects in Research Committee**

**Information for Review of Research Involving Human Subjects**  
**Iowa State University**

**(Please type and use the attached instructions for completing this form)**

1. Title of Project      The Essential Structure of the Relationship between Fathers and their Gifted Daughters that Supports Giftedness
2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are protected. I will report any adverse reactions to the committee. Additions to or changes in research procedures after the project has been approved will be submitted to the committee for review. I agree to request renewal of approval for any project continuing more than one year.

**Sylvia Louise Kinzer Blanchfield**

**Typed name of principal investigator**

## Human Development and Family Studies

Department

**515-389-3192**

**Phone number to report results**

**5/21/99**

Date \_\_\_\_\_

**101 Child Development, Ames, IA 50010**

**Campus address**

*Sylvia Louise Kenner Blanchfield*  
Signature of principal investigator

Signature of principal investigator

- ### 3. Signatures of other investigators

**Date****Relationship to principal investigator**

**5/21/99**

## Major Professor

- 4. Principal investigator(s) (check all that apply)**

☐ **Faculty**

**Staff**

☒ Graduate student☐ Undergraduate student

- 5. Project (check all that apply)**

**Research**

☒ Thesis or dissertation

## Class project

☐ Independent Study (490, 590, Honors project)

- 6. Number of subjects (complete all that apply)**

**# adults, non-students: 24**

**# minors under 14:**

**# minors 14 - 17:**

**# ISU students:**

**other**

**(explain):**

7. **Brief description of proposed research involving human subjects:** (See instructions, item 7. Use an additional page if needed.)

The purpose of this research is to examine the essential structure of the relationship between fathers and their gifted daughters that supports giftedness from the perspective of both the father and the gifted daughter who is 19-20 years of age. Utilizing a qualitative research design I will conduct a phenomenologic study to examine the meaning of the father-daughter relationship in 8 families with a gifted 19-20 year-old daughter. Eight gifted girls and their parents who live in central Iowa will be asked by letter to participate in this study. These girls will be selected with the assistance of Keith Davis, Director of Office of Precollegiate Programs for Talented and Gifted (OPPTAG) from a cohort of students of the Study of Mathematically Precocious Youth (SMPY) study. Four of the girls will have entered the SMPY study as a result of high verbal <sup>skills</sup> ~~score~~ on the SATV, and four of the girls will have entered the SMPY program as a result of high math <sup>skills</sup> ~~score~~ on the SATM as seventh graders. Criteria for selection will include age, two parents, geographical location. Individual interviews will be conducted with fathers, mothers and their gifted daughters. Three 90-minute interviews will be conducted with each father and daughter separately. The mother will be interviewed separately about the father-daughter relationship in one 90-minute interview. Fathers and daughters will be asked to keep a written journal between interview sessions of their thoughts about the father-daughter relationship that supports giftedness. The journals will be submitted as part of the research data. In

qualitative research the interviews are unstructured and open-ended to allow the subjects to express their experiences. However, I have attached a list of questions that will serve as a guide for the unstructured, informal interviews. Interviews will be conducted in locations convenient to the family members and will be rooms that serve as conference rooms or classrooms that are not currently in use in schools or other public buildings. Throughout the interview process I will give the respondents an opportunity to review, comment on, and correct reconstructions of the data. No incentives or compensations will be offered.

**8. Informed  
Consent:**

- (Please do not send research, thesis, or dissertation proposals.)**
- ☒ Signed informed consent will be obtained. (Attach a copy of your form.)
  - ☐ Modified informed consent will be obtained. (See instructions, item 8.)
  - ☐ Not applicable to this project.

9. **Confidentiality of Data:** Describe below the methods you will use to ensure the confidentiality of data obtained. (See instructions, item 9.)

All information gathered for this study will be coded and pseudonyms will be used to protect the subjects for this dissertation and for any articles published which evolve from this research. Audio tapes will be transcribed and coded then erased at the end of the study; journals will be coded; and all information gathered from the SMPY database will be coded and treated in a confidential manner. The individual identifiers (name and assigned code number) will be stored on a disk; coded transcriptions of tape-recorded interviews, and coded data files will be stored in my office at home in a locked file cabinet. ISU personnel will not have access to the identifier files.

10. What risks or discomfort will be part of the study? Will subjects in the research be placed at risk or incur discomfort? Describe any risks to the subjects and precautions that will be taken to minimize them. (The concept of risk goes beyond physical risk and includes risks to subjects' dignity and self-respect as well as psychological or emotional risk. See instructions, item 10.)
- We foresee no risks or discomforts to participants in this research.

11. **CHECK ALL** of the following that apply to your research:

- ☐ A. Medical clearance necessary before subjects can participate
- ☐ B. Administration of substances (foods, drugs, etc.) to subjects
- ☐ C. Physical exercise or conditioning for subjects
- ☐ D. Samples (blood, tissue, etc.) from subjects
- ☐ E. Administration of infectious agents or recombinant DNA
- ☐ F. Deception of subjects
- ☐ G. Subjects under 14 years of age and/or ☐ Subjects 14 - 17 years of age
- ☐ H. Subjects in institutions (nursing homes, prisons, etc.)
- ☒ I. Research must be approved by another institution or agency (Attach letters of approval)

If you checked any of the items in 11, please complete the following in the space below (include any attachments):

**Items A-E** Describe the procedures and note the proposed safety precautions.

**Items D-E** The principal investigator should send a copy of this form to Environmental Health and Safety, 118 Agronomy Lab for review.

**Item F** Describe how subjects will be deceived; justify the deception; indicate the debriefing procedure, including the timing and information to be presented to subjects.

**Item G** For subjects under the age of 14, indicate how informed consent will be obtained from parents or legally authorized representatives as well as from subjects.

**Items H-I** Specify the agency or institution that must approve the project. If subjects in any outside agency or institution are involved, approval must be obtained prior to beginning the research, and the letter of approval should be filed.

Demographic data such as age, course of study in college, number of siblings, leisure activities and interests, career goals and life goals, as well as data on locus of control, values, and self esteem will be obtained for daughters from formalized data sets initiated in 1991-1992 for this cohort of students in the Iowa Talent Search. Cohort 4 of the Study of Mathematically Precocious Youth (SMPY) is currently located at Vanderbilt University, Nashville, TN.

**Keith Davis and I are in communication with Dr. Benbow concerning the mechanism for obtaining the data from Vanderbilt University. Approval from that institution will be forthcoming following these communications.**

Last name of Principal Investigator Blanchfield**Checklist for Attachments and Time Schedule**

The following are attached (please check):

12. ☒ Letter or written statement to subjects indicating clearly:
- a) the purpose of the research
  - b) the use of any identifier codes (names, #'s), how they will be used, and when they will be removed (see item 17)
  - c) an estimate of time needed for participation in the research
  - d) if applicable, the location of the research activity
  - e) how you will ensure confidentiality
  - f) in a longitudinal study, when and how you will contact subjects later
  - g) that participation is voluntary; nonparticipation will not affect evaluations of the subject
13. ☒ Signed consent form (if applicable) *(Form is attached; completed forms will be sent upon receipt)*
14. ☒ Letter of approval for research from cooperating organizations or institutions (if applicable)  
*(Letter will be sent upon receipt)*
15. ☒ Data-gathering instruments

16. Anticipated dates for contact with subjects:

First contact

Last contact

June 15, 1999May 30, 2000

Month/Day/Year

Month/Day/Year

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:

August 1, 2000

Month/Day/Year

18. Signature of Departmental Executive Officer

Date

Department or Administrative Unit

*Marvita Mae Arnold*5/21/99Human Development and Family Studies

19. Decision of the University Human Subjects Review Committee:

☐ Project approved☐ Project not approved☐ No action required

Name of Human Subjects in Research Committee Chair

Date

Signature of Committee Chair

Patricia M. Keith

**Memorandum**

To: Dr. Pat Keith, Chair  
Human Subjects Review Committee

Date: June 14, 1999

From: ✓ Sylvia Louise Kinzer Blanchfield *Sylvia L. Kinzer Blanchfield  
6/14/99*

Re: A change in methods and procedures

I am writing to amend my letter to Human Subjects Review regarding obtaining subjects for my dissertation research.

Keith Davis, director of the Office of Precollegiate Programs for Talented and Gifted (OPPTAG) here at ISU has been informed by Dr. Camilla Benbow, who is now at Vanderbilt University, that we will not be able to access data on a cohort of students from the Study of Mathematically Precocious Youth (SMPY) data base that is currently housed at Vanderbilt University. Because I will not be accessing data from Vanderbilt University for my research, no letter of permission to access their data will be sent to your committee.

Instead of selecting subjects from the SMPY research, I will select as subjects eight gifted girls who graduated with distinction (with a cumulative GPA of 3.90 or higher) from Ames High School on May 28, 1998 to participate in this study. The names of these girls will be taken from the graduation program. These girls and their parents live in the Ames, Iowa region and their phone numbers and addresses will be located in the local telephone directory. Permission to include these subjects in this research will be given by written consent of the gifted girl and her parents.

I have attached an amended letter to subjects indicating clearly: the purpose of the research; the use of any identifier codes, how they will be used, and when they will be removed; an estimate of time needed for participation in the research; location of the research activity; how I will ensure confidentiality; as well as a statement that participation is voluntary; that non participation will not affect evaluations of the subjects. In addition, I have attached an amended Informed Consent Form.

Finally, since I will not be using the SMPY subjects, whose psychological data is already on file, I will need to administer tests to these young women and their fathers. I am currently accumulating the instrument package. I will send you the packets of instruments that I will give the subjects to complete.

*Approved  
P. Keith  
6-14-99*



**Appendix B**

**Letters of Invitation and Informed Consent**

May 21, 1999

Dear

I am involved in a research study of talent and gifted girls and their fathers at Iowa State University. I learned about you through the Office of Precollegiate Programs for Talented and Gifted (OPPTAG) at Iowa State University. Because you have participated in the Iowa Talent Search and are a part of the Study of Mathematically Precocious Youth (SMPY) project, I am contacting you to see if you would be willing to be a part of my study.

The purpose of my study is to examine the relationship between fathers and their gifted daughters to understand what in the relationship between father and daughter helped the daughter be successful in her personal, academic and extracurricular endeavors. Although mothers and gifted children have been studied, there is very little research on fathers and their gifted daughters. I have chosen to focus on the relationship between fathers and their gifted daughters.

This research will use an interview format to examine the meaning of the father-daughter relationship in 8 families with gifted 19-20 year old daughters from the perspective of both the father and the gifted daughter in order to better understand how giftedness is promoted. Input from the mother is also going to be important to help me better understand the father-daughter relationship.

I would like to interview you and your parents over the next several weeks. Your time commitment in this project would be for a total of 3 audio taped interviews each lasting approximately 90 minutes. I would like to interview you 3 times, your father 3 times, and your mother 1 time. You and your father will also be asked to keep a journal of your thoughts about your relationship with each other for the weeks while the interviews are being conducted. The journal will be included as a document for study in this research.

All information obtained will be confidential. The audio taped interviews will be transcribed and then erased at the end of the study; the journals will be coded and then destroyed. I would also like to review your records and other pertinent information collected through the Iowa Talent Search and as a member of Cohort 4 in the Study of Mathematically Precocious Youth. Information gathered for this study will be coded and pseudonyms will be used to protect your privacy for this dissertation and for any articles published which evolve from this research. In addition, you are free to withdraw from the study at any time.

Interviews will be conducted in a location convenient for you and for your parents. I will locate comfortable rooms in your community that serve as conference rooms or classrooms that are not in current use in schools or other public buildings for us to use for the interviews.

Interviews will be conducted in a location convenient for you and for your parents. I will locate comfortable rooms in your community that serve as conference rooms or classrooms that are not in current use in schools or other public buildings for us to use for the interviews.

If you have any questions or concerns about the study please do not hesitate to contact me at Iowa State University, Department of Human Development and Family Studies, 101 Child Development Building, Ames, IA 50011; phone number: 515 294-9659. Because of your unique perspective on this subject of giftedness, I hope you will be willing to help me with this project.

If you and your family are willing to participate in this study, please sign the enclosed Informed Consent Form and return one copy to me in the self-addressed stamped envelope. Please keep the other copy of the Informed Consent Form for yourself. In addition, please indicate on the enclosed form the address and phone numbers where you and your parents can be reached in order to set up an appointment.

My goal is to begin the research within the next 2 to 3 weeks and to complete it by mid-August, 1999. However, my schedule is flexible. I know summer is a busy time and I will be very happy to work around your work and vacation schedules. I look forward to hearing from you as soon as possible.

Sincerely,

Lou Blanchfield, M.S.  
Doctoral Candidate

Sedahlia J. Crase, Ph.D.  
Major Professor

### Informed Consent Form

I have read the attached letter and understand I will be involved in a research project to examine the relationship between fathers and their gifted daughters in order to understand what in the relationship between father and daughter helped the daughter be successful in her personal, academic and extracurricular endeavors.

I understand I will be asked to participate in audio-taped interviews. Those interviews will be organized in the following format: three 90-minute interviews with you, the daughter; three 90-minute interviews with you, the father; and one 90-minute interview with you, the mother.

I understand that I will be asked to keep a journal of my thoughts about my relationship with my father/daughter for the weeks while the interviews are being conducted. I understand that the journal will be included as a document for study in this research.

I understand that my records maintained by the Study of Mathematically Precocious Youth (SMPY) project will be reviewed and pertinent information may be used in this research.

I understand that all information obtained will be confidential. I understand that all information gathered for this study will be coded and pseudonyms will be used to protect my privacy for this dissertation and for any articles published which evolve from this research. I understand that audio tapes will be transcribed and then destroyed, I understand that the journals will be coded and then destroyed.

I understand that I am free to withdraw from this project at any time.

I understand that if I have any questions or concerns about the study I may contact the researcher, Lou Blanchfield at Iowa State University, Department of Human Development and Family Studies, 101 Child Development Building, Ames, IA 50011; phone 515-294-9659.

I agree to participate in the study described above. Date: \_\_\_\_\_

Daughter's name (please print) \_\_\_\_\_ (signature) \_\_\_\_\_

Daughter's phone number: \_\_\_\_\_ address: \_\_\_\_\_

Father's name (please print) \_\_\_\_\_ (signature) \_\_\_\_\_

Father's phone number: \_\_\_\_\_ address: \_\_\_\_\_

Mother's name (please print) \_\_\_\_\_ (signature) \_\_\_\_\_

Mother's phone number: \_\_\_\_\_ address: \_\_\_\_\_

**Appendix C**

**Academic Data for Daughters**

## Daughters' Academics

	1-Holly	2-Alissa	3-Meg	4-Juliana	5-Suzanne	6-Jessica	7-Noelle	8-Joanie
H. S. GPA on 4.0 Scale	3.904	3.974	3.534	4.000	3.896	4.000	3.976	3.979
H. S. Rank	26/360	20/337	103/337	1/337	41/337	1/337	9/360	8/360
9th grade ITBS Nat'l/IA %ile	99/98	99/99	97.62/95	99/99	99/99	99/98	99/-99	88/75
11th grade PSAT								
Verbal	98	89	95	95	97	91	99	67
Math	81	99	99	93	98	97	99	99
Selection Index	96	95	98	96	98	95	99	88
A.C.T.								
English	31	30		33		31	35	24
Math	28	36		31		32	33	32
Reading	36	32		35		32	36	28
Comprehensive	33	31		30		32	35	28
Graduated with Distinction	x	x	x	x	x	x	x	x
National Merit Scholar					x		x	
National Merit Commended Scholar	x		x	x				
State of Iowa Scholar	x	x		x	x	x		x
DSM Register All Academ. Team		x						
Commission on Presidential Scholars							x	
ELP Elementary School	x	x	x	x	x	x	x	x

**Appendix D**

**Family Demographics**

## Family Demographics

	<u>Family 1</u>		<u>Family 2</u>		<u>Family 3</u>	
	<u>Mother</u>	<u>Father</u>	<u>Mother</u>	<u>Father</u>	<u>Mother</u>	<u>Father</u>
<u>Immediate Family Factors</u>						
<b>Education</b>	BA+	ABD	Ph.D.	Ph.D.	MA+	Ph.D.
<b>Current job</b>	University	University	College	University	University	University
<b>Age at birth of daughter</b>	29	29	29	30	29	30
<b>Time home with newborn</b>	Full time	Part time	Full time	Evening	Full time	Part time; evening
<b>Time home with preschooler</b>	Part time	Part time	Part time; flexible hrs.	Evening	Full time 1st 18 mo.	Part time; evening
<b>Time home during elementary school</b>	Morning; evening	Weekend	Morning; afternoon; flexible hrs.	Morning; evening	Flexible hrs., evening	Evening by 4:30 p.m.
<b>Time home during middle school</b>	Morning; evening	Morning; evening	Afternoon; evening; flexible hrs.	Evening	Flexible hrs.; evening	Evening by 4:30 p.m.
<b>Time home during high school</b>	Morning; evening	Morning; evening	Afternoon; evening	Morning; afternoon; evening	Flexible hrs.; evening	Evening by 4:30 p.m.
<b>Early indicators of giftedness (father report)</b>		Spoke clearly early; tested age 3 for Pegasus preschool		Large vocabulary early; tested age 3 for Pegasus preschool		Large vocabulary very early; 18 months day-care
<b>Siblings</b>	One younger brother		One older sister		Only child	
<b>Sibling identified as gifted</b>	No		Yes, early; Pegasus		NA	

## Family History Factors

<b>Parent's IQ indicators</b>	Not tested;	Not tested;	Not tested;	Not tested	Tested grade 7; accelerated
-------------------------------	-------------	-------------	-------------	------------	-----------------------------





	valued education	loved reading; valued education	excelled at country school, high GPA	accelerated classes, special teachers
<b>Grandparents IQ indicators</b>	Not tested; university professors	Not tested; blue-collar laborer, not value education	Not tested; little formal education; valued learning	Gifted; both with post graduate degrees  G-mother a tutor; very bright; G-father constant reader.
<b>Great grandparents</b>	Well educated	Blue collar; encouraged reading; took grandson to library		
<b><u>Stability Factors</u></b>				
<b>Distance from maternal and paternal relatives</b>	1 hour	1 hour	2 hours	6-7 hours
<b>Time spent with extended family</b>		Holidays + one weekend/mo.	Holidays + 6-8 wks.	Twice a year for 5 or 6 days; Christmas & summer
<b>Time in years lived in same community</b>	18 years		19 years	20 years
<b>Read to child</b>	From birth, read all the time; she memorized books by 18 mo.		From birth, bedtime stories; she memorized books by age 2	From birth, bedtime stories; she memorized books while still in her crib.
<b>Examples of books</b>	Dr. Seuss; Barenstein Bears; Little House on the Prairie;		Went to the library a lot, even when she was very young. Games	The World According to Garp; nursery, singing, and counting rhymes; games
<b>Movies/plays</b>				Ballet; Concerts; Opera; Season tickets to concert series
<b>Acceleration</b>	Pegasus preschool ELP		Pegasus preschool; ELP; Math grad 1-6 at her level above level	Pegasus preschool; ELP; Math gr. 1-6 at her level
<b>Gifted programs attended</b>	TAG, Super Summers		TAG, Super Summers	TAG, Super Summers
<b>Advanced Placement and accelerated courses</b>	English, Math History		Calc. I & II English, History	Calc. I & II
<b>Areas of high ability</b>	Verbal reasoning		Math; music	Math; verbal
<b>Major/s in college</b>	History		Music	Religion



## Family Demographics

<u>Family 4</u>	
Mother	Father

<u>Family 5</u>	
Mother	Father

<u>Family 6</u>	
Mother	Father

### Immediate Family Factors

<b>Education</b>	Ph. D.	MS+	Ph.D.	Ph.D.	Associate Degree	Ph.D.
<b>Current job</b>	University	Industry	University	University	Health Science	Industry
<b>Age at birth of daughter</b>	34	36	29	30	25	26
<b>Time home with newborn</b>	Full time	Evening	Flexible hrs.; evening	Flexible hrs.; evening	Full-time	Flexible hrs.; evening
<b>Time home with preschooler</b>	Part time; flexible hrs.	Evening	Flexible hrs.; evening	Flexible hrs.; evening	Part-time; evening	Flexible hrs.; evening
<b>Time home during elementary school</b>	Part time; flexible hrs.	Evening	Flexible hrs.; evening	Flexible hrs.; evening	Part-time; evening	Flexible hrs.; evening
<b>Time home during middle school</b>	Part time; flexible hrs.	Evening	Flexible hrs.; evening	Flexible hrs.; evening	Part-time; evening	Flexible hrs.; evening
<b>Time home during high school</b>	Part time; flexible hrs.	Evening	Flexible hrs.; evening	Flexible hrs.; evening	Part-time; evening	Flexible hrs.; evening
<b>Early indicators of giftedness (father report)</b>		Spoke early and clearly; creative reasoning; independent		Spoke, read, reasoned early; tested age 3 for Pegasus preschool		Inquisitive, serious, intense early
<b>Siblings</b>	One brother		Two younger brothers		One younger brother	
<b>Sibling identified as gifted</b>	Yes, early; Pegasus		Yes, early; Pegasus		No	

### Family History Factors

<b>Parent's IQ indicators</b>	Not tested; finished Ph.D. before age 30	Tested grade 7; accelerated classes	Tested grade 7; accelerated classes	Tested grade 7; accelerated classes	Not tested	Tested grade 7; accelerated classes
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<b>Grandparents IQ indicators</b>	Little to no formal education; valued learning	Well educated; encouraged learning	Professors; valued, encouraged excellence	G-father in academics; G-mother reared 7 children; did well in school; valued learning
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## Great grandparents

### Stability Factors

<b>Distance from maternal and paternal relatives</b>	12 hours	12 hours	24 hours	5+ hours	5-6 hours
<b>Time spent with extended family</b>	Holidays, summer vacations (4x/yr +)		Every opportunity available		As often as possible; holidays, summer
<b>Time in years lived in same community</b>	30 years		20 years		20 years
<b>Read to child</b>	From birth, read to her daily; books were commonplace, she memorized books early		From birth, both parents read bedtime stories; she read to self while in crib		Early in life, infancy
<b>Examples of books read</b>	Visited library often; read many ty types of books books		Charlotte's Web, Midnight Moon; singing, playing music together		Puzzles, games
<b>Movies/plays</b>	Concert season tickets		Concert season tickets		
<b>Acceleration</b>	ELP		Pegasus preschool, ELP, Math gr. 1-6		Math gr. 1-6
<b>Gifted programs attended</b>	TAG Super Summers		TAG Super Summers		
<b>Advanced Placement and accelerated courses</b>	English, Math European History American History		Calc. I & II Languages English, History		Calc. I & II
<b>Areas of high ability</b>	Verbal Language		Math, Art Language		Math Science
<b>Major/s in College</b>	World History		Art Languages		Engineering



## Family Demographics

	<u>Family 7</u>		<u>Family 8</u>	
	<u>Mother</u>	<u>Father</u>	<u>Mother</u>	<u>Father</u>

### Immediate Family Factors

<b>Education</b>	Ph. D+	Ph.D.+	Ph. D.	Ph.D.
<b>Current job</b>	Government	University	Industry	University
<b>Age at birth of daughter</b>	26	27	33	35
<b>Time home with newborn</b>	Afternoon; evening	Evening	Commute time; evening	Commute time; evening
<b>Time home with preschooler</b>	Afternoon; evening	Evening	Commute time; evening	Commute time; evening
<b>Time home during elementary school</b>	Afternoon; evening	Evening	Commute time; evening	Commute time; evening
<b>Time home during middle school</b>	Afternoon; evening	Evening	Commute time; evening	Commute time; evening
<b>Time home during high school</b>	Afternoon; evening	Evening	Commute time; evening	Commute time; evening
<b>Early indicators of giftedness (father report)</b>		Reading signs, words at 18 months		Discussed gigabytes at age 5
<b>Siblings</b>	One sister, one brother, each 2 yrs. apart		Two brothers, one year between each	
<b>Sibling identified as gifted</b>	Yes, both early		Yes, both	

### Family History Factors

<b>Parent's IQ indicators</b>	Tested top of class in math & science	Tested top of class	Not tested; Ph.D. before age 30	Tested; Ph.D. before age 30
<b>Grandparents IQ indicators</b>	Both professionals; valued, encouraged excellence	G-mother accelerated 3 yrs.; teacher. G- father high math/ literature knowledge	G-mother abusive; dysfunctional family life	Well educated; encouraged education, self- development





encouraged  
excellence

father high math/  
literature  
knowledge

family life

development

**Great grandparents**

Great G-father  
started univ. in  
Asia; expected  
dtrs. to be  
professionals.

Great G-mother  
encouraged risk-  
taking

### Stability Factors

**Distance from maternal and  
paternal relatives**

8-30 hrs. or Asia

Deceased

10 hours

**Time spent with extended  
family**

Relatives come  
once a year for  
several months

Once a year

**Time in years lived in same  
community**

25 years

**Read to Child**

From birth, both parents read bedtime stories, she  
read to herself in crib

From birth, then had much reading material  
available for them to read.

**Examples of books**

Disney series; all kinds of books

National Geog.; Scientific American; Science;  
American Scientist; Aviation Week & Space  
Technology; Aerospace America; Natural History;  
American History of Invention & Technology;  
Smithsonian Society Magazine; Mac World; PC  
Week; Time; US News & World Report; Ms.;  
Psychology Today; Compton's yearbook updates;  
How things work updates

**Movies/plays**

**Acceleration**

Pegasus preschool  
ELP, math gr. 1-6

Math gr. 1-6

**Gifted programs attended**

TAG, Super Summers

Science fairs middle & high school

**Advanced Placement and  
accelerated courses**

Math  
Honors English

Math, Calc. I & II

**Areas of high ability**

Math, Verbal  
Science

Math, Science

**Major/a in college**

Pre-med

Pre-med/engineering



**Appendix E**  
**Questionnaires**

## INTERVIEW QUESTIONS WITH FATHER

**A NOTE ABOUT QUESTION DEVELOPMENT:** Based on input from the pilot fathers, the original “grand tour” question was expanded to help fathers “get at” the essential meaning of father support of giftedness. I also had an opportunity to have a telephone conversation with Dr. Celeste Rhoades (1996) about this dissertation research. Dr. Rhoades requested that questions from her dissertation research (a case study) where they matched the needs of this study. Purposes for including her questions were to provide her questions exposure in research; and to begin developing a base of questions for use in quantitative research in families with gifted girls. Many of the concepts around which Rhoades formulated her questions matched important variables I had found in my review of the literature as concepts that were important in the life of gifted children. Many questions borrowed from Rhodes’ research were questions that helped fathers relax and describe the support they provided their daughters over her lifetime. Rhodes’ questions have been noted with an apteryx\*.

Typical of grounded theory, new concepts emerged during interviews. While the questions presented in these documents were useful initially, as the researcher developed theoretical sensitivity, the questions that seemed more relevant to the developing theory became the focus while other questions were left behind.

### Day 1

#### Get acquainted

- ☐ Introduce self.
- ☐ Thank him for being willing to participate in study.
- ☐ Remind of confidentiality, response of all families grouped, free to withdraw at any time without consequence.
- ☐ I have a list of questions & am tape recording as mentioned in the letter, I may take occasional notes but I don’t want this to feel too structured, so if you have any questions you want clarified or have additional comments, please feel free to interrupt. It is your interview and I want your ideas to take precedence.
- ☐ There are some short-answer/demographic type questions and some questions that will take more thought and time for recall. Please feel comfortable to take as much time as you want. There are no right or wrong responses, there are just your responses.

#### Talk about you and your family

1. What kind of work do you do?
2. Where do you work
3. What hours?
4. What is your formal education?
5. How much did you work away from home when your daughter was growing up?
6. How much did your wife work away from home while your daughter was growing up?
7. What time of day did the two of you spend with your children when they were young?
8. How long have you lived in Ames?
9. Do you have close relatives who live nearby?
10. How far away do your daughter’s grandparents live?
11. How much time do you and your family spend with relatives?
12. What is the importance of relatives in your family’s life?
13. Does your daughter have a group of close friends?\*
14. Why do you think they are friends?\*
15. What do you think of her friends?\*
16. How many children do you have?

17. Is \_\_\_\_\_ your oldest, youngest, or middle child?
18. How old were you and your wife when she was born?
19. How old was she when you first noticed she was gifted?
20. What was it about her that made you think she was gifted?
21. Have your other children been identified as gifted also?
  
22. Did you think differently about \_\_\_\_ when you realized she was gifted?
23. How did you feel when you realized she was gifted?
24. Do you think your parenting changed when you realized she was gifted?
25. Do you think you supported or pushed her in different ways than you did your children with other abilities?
  
26. I'd like for you to talk about the relationship you have had with your daughter over her lifetime. This question covers a long span of time; it might help to think about how you felt when you discovered you had a baby girl, and then about the things you did for her and with her as she grew:  
  
Describe your relationship with \_\_\_\_\_
  - a. during her infancy
  - b. during her childhood
  - c. during her grade school years
  - d. during middle school
  - e. in high school
  - f. now that she is in college.
  
27. What did you do to help your daughter to adjust to school?\*
28. Is there anything else you would like to talk about?

## **INTERVIEW QUESTIONS WITH FATHER**

### **Day 2**

**Are there any questions you have from our last meeting? Any thoughts you wanted to add to?**

29. What makes your daughter unique?\*
30. How is she like you?
31. How is she different from you?
32. What values have you tried to communicate to her?\*
33. What values do you see her reflecting and communicating in her life?\*
34. Did you read aloud to your daughter?
35. At what age did you begin reading?
36. What kinds of books did you read together?
37. Have you always taken an active part in parenting your daughter?
38. Do you think the women's movement affected the way you parent?
39. How have you nurtured your daughter's giftedness ability over time?
40. Childhood
41. Middle school
42. Teenage years
43. College?
44. What kinds of things do you talk about with your daughter?\*
45. What do you not talk about with her?\*
46. What kinds of things does she talk about with you?\*
47. What kinds of things do you think she doesn't talk about with you? And why?\*
48. How have you mentored your daughter for a balanced development?\*
49. What kind of activities was your daughter involved in as a child? Middle school? Teen years? College?
50. How much effort do you make to share in your daughter's life?
51. What interests do you share with your daughter?
52. What interests does she share with you?
53. Is there anything else you would like to add?

**INTERVIEW QUESTIONS WITH FATHER****Day 3**

- 54. Do you think you influenced your daughter's attitudes towards learning?
- 55. How?
- 56. In what areas?
- 57. What kinds of disagreements or conflicts have you had with your daughter?\*
- 58. How are they resolved?\*
- 59. How does your daughter approach problems in her everyday life?
- 60. What kinds of things do you worry about for your daughter's future?\*
- 61. Did you participate in IQ testing as a child?
- 62. Were you identified as gifted when you were young?
- 63. What responsibility do you believe the community has to nurture the development of children who will be leaders of tomorrow?
- 64. Do you think a gifted girl requires a certain kind of support for optimal development?
- 65. What would that support look like?
- 66. What would lack of support look like?
- 67. Is there anything else you would like to tell me?



## INTERVIEW QUESTIONS WITH DAUGHTER

### Day 1

#### Get acquainted

- ☐ Introduce self.
- ☐ Thank her for being willing to participate in study.
- ☐ Remind of confidentiality, responses of all families grouped, free to withdraw at any time without consequence.
- ☐ I have a list of questions & am tape recording as mentioned in the letter, I may take occasional notes but I don't want this to feel too structured, so if you have any questions you want clarified or have additional comments, please feel free to interrupt. It is your interview and I want your ideas to take precedence.
- ☐ There are some short-answer/demographic type questions and some questions that will take more thought and time for recall. Please feel comfortable to take as much time as you want. There are no right or wrong responses, there are just your responses.

#### Talk about you and your family

1. Where have you attended college?
2. Have you been a full-time student?
3. How old are you now?
4. How old were your parents when you were born?
5. What time of day did your father spend with you when you were young?
8. How long have you lived in Ames?
9. Do you have close relatives who live nearby?
10. How far away do your grandparents live?
11. How much time do you and your family spend with relatives?
12. What is the importance of relatives in your life?
13. Do you have a group of close friends?
14. Why do you think you are friends?
15. What do your parents think of your friends?
17. Have your siblings been identified as gifted also?
23. How did you feel when you realized you were gifted?
24. Do you think your father supported or pushed you in different ways than he did your siblings with other abilities?
25. I'd like for you to talk about the relationship you have had with your father over your lifetime.  
This question covers a long span of time:
 

Describe your relationship with your father \_\_\_\_\_

  - a. during your childhood
  - b. during your grade school years
  - c. during middle school
  - d. in high school
  - e. now that you are in college.
26. How do you feel about your relationship with your father now?\*
27. What did your father do to help you to adjust to school?\*
28. Is there anything else you would like to talk about?

## **INTERVIEW QUESTIONS WITH DAUGHTER**

### **Day 2**

Questions that develop in a grounded theory can change from the original format and some of these questions were focused on more than others because thoughts/concepts did not seem important to some family members and they were passed by, while thoughts which emerged seemed more important and were followed up on more closely.

Are there any questions you have from our last meeting? Any thoughts you wanted to add to?

29. In what ways are you like your father?\*
30. How are you different from your father?\*
31. In what ways are you unique?\*
  
32. What values has your father tried to communicate to you?
33. What values are important to you?
34. What values do you see yourself reflecting that your father communicated?
  
35. Did your father read aloud to you when you were a child?
36. At what age did you begin reading?
37. What kinds of books did you read together?
  
38. Has your father always taken an active part in parenting you?
39. Do you think the women's movement affected the way your parents parented you?
40. In the role your father took in your development?
41. In the role your mother took?
  
42. How has your father nurtured you and your giftedness over time?
  - a. Childhood
  - b. Middle school
  - c. Teenage years
  - d. College?
  - e.
43. What kinds of things do you talk about with your father?
44. What do you not talk about with him?
45. What kinds of things does he talk about with you?
46. What kinds of things do you think he doesn't talk about with you? And why?
  
47. How did your father mentored you for a balanced development?
  
48. What kind of activities was you involved in as a child? Middle school? Teen years? College?
  
49. How much effort does your father make to share in your life?
50. What interests do you share with your father?
51. What interests does he share with you?
  
52. Is there anything else you would like to add?

## **INTERVIEW QUESTIONS WITH DAUGHTER**

### **Day 3**

53. Do you think your father influenced your attitude towards learning?
54. How?
55. In what areas?
56. How much effort do your parents make to share in your life?
57. What interests do you share with your father?
58. What interests do you share with your mother?
59. Describe the leisure time activities you shared with your parents when you were a child.
60. What kinds of disagreements or conflicts have you had with your father?
61. How are they resolved?
62. How do you approach problems in your everyday life?
63. What kinds of things do you worry about for your future?
64. Did your parents participate in IQ testing as a child?
65. Were they identified as gifted when they were young?
66. What about your siblings? Were they tested? Have they been identified as gifted also?
67. What responsibility do you believe the community has to nurture the development of children who will be leaders of tomorrow?
68. Do you think a gifted girl requires a certain kind of support for optimal development?
69. What would that support look like?
70. What would lack of support look like?
71. Is there anything else you would like to tell me?

**INTERVIEW QUESTIONS WITH MOTHER (One 90-minute interview)****Get acquainted**

- ☐ Introduce self.
- ☐ Thank her for being willing to participate in study.
- ☐ Remind of confidentiality, response of all families grouped, free to withdraw at any time without consequence.
- ☐ I have a list of questions & am tape recording as mentioned in the letter, I may take occasional notes but I don't want this to feel too structured, so if you have any questions you want clarified or have additional comments, please feel free to interrupt. It is your interview and I want your ideas to take precedence.
- ☐ There are some short-answer/demographic type questions and some questions that will take more thought and time for recall. Please feel comfortable to take as much time as you want. There are no right or wrong responses, there are just your responses.

**Talk about you and your family:**

1. What kind of work do you do?
2. Where do you work?
3. What hours?
4. What is your formal education?
5. How much did you work away from home when your daughter was growing up?
6. How much did your husband work away from home while your daughter was growing up?
7. What time of day did the two of you spend with your children when they were young?
  
8. How long have you lived in Ames?
9. Do you have close relatives who live nearby?
10. How far away do your daughter's grandparents live?
11. How much time do you and your family spend with relatives?
12. What is the importance of relatives in your family's life?
  
13. How many children do you have?
14. Is \_\_\_\_\_ your oldest, youngest, or middle child?
15. How old were you and your husband when she was born?
  
16. How old was your daughter when you first noticed she was gifted?
17. What was it about her that made you think she was gifted?
18. Have your other children been identified as gifted also?
  
23. How did you feel when you realized she was gifted?
24. Do you think your parenting changed when you realized she was gifted?
25. Do you think you supported or pushed her in different ways than you did your children with other abilities?
  
20. Does your daughter have a group of close friends?
21. Why do you think they are friends?
22. What do you think of her friends?
  
23. I'd like for you to talk about the relationship you and your husband have had with your daughter over her lifetime. This question covers a long span of time; it might help to think about how you felt when you discovered you had a baby girl, and then about the things you did for her and with her as she grew:

Describe your relationship and your husband's relationship with \_\_\_\_\_  
 a. during her infancy

- b. during her childhood
- c. during her grade school years
- d. during middle school
- e. in high school
- f. now that she is in college.

**NOW, IF TIME REMAINS ASK ANY OF THE FOLLOWING QUESTIONS:**

- 24. What makes your daughter unique?\*
- 25. How is she like you?
- 26. How is she different from you?
- 27. What values has your husband tried to communicate to your daughter?
- 28. What values do you see her reflecting and communicating in her life?
- 29. Did you read aloud to your daughter?
- 30. At what age did you begin reading?
- 31. What kinds of books did you read together?
- 32. Has your husband always taken an active part in parenting your daughter?
- 33. Do you think the women's movement affected the way you parent?
- 34. How have you and your husband nurtured your daughter's giftedness ability over time?
  - a. Childhood
  - b. Middle school
  - c. Teenage years
  - d. College?
- 35. What kinds of things does your husband talk about with your daughter?
- 36. What kinds of things do you think she talks about with him?
- 37. What kinds of things do you talk about with your daughter?\*
- 38. What do you not talk about with her?\*
- 39. What kinds of things does she talk about with you?\*
- 40. What kinds of things do you think she doesn't talk about with you? And why?\*
- 41. How has your husband mentored your daughter for a balanced development?\*
- 42. How much effort do you make to share in your daughter's life?
- 43. What interests do you share with your daughter?
- 44. What interests does she share with you?
- 45. Do you think you influenced your daughter's attitudes towards learning?
- 45. How?
- 46. In what areas?
- 47. What kinds of disagreements or conflicts have you had with your daughter?\*
- 48. How are they resolved?\*
- 49. How does your daughter approach problems in her everyday life?
- 50. What kinds of things do you worry about for your daughter's future?\*
- 51. Did you participate in IQ testing as a child?
- 52. Were you identified as gifted when you were young?
- 53. What responsibility do you believe the community has to nurture the development of children who will be leaders of tomorrow?

- 54. Do you think a gifted girl requires a certain kind of support for optimal development?
- 55. What would that support look like?
- 56. What would lack of support look like?
  
- 57. Is there anything else you would like to tell me?

**Appendix F**

**Directions for Journal Writing**

**The Journal**

Thank you very much for taking time to participate in this research project. Much research has been conducted investigating the relationship between mothers and their gifted daughters and between fathers and gifted sons. Though some research was conducted in the mid 1970's looking at the effects of fathering on gifted children, no current research has been found that investigates the relationship between fathers and their gifted daughters that supports giftedness. Your thoughts on this subject are very important.

Interview sessions may spark additional thoughts that you would like to include in the discussion of the relationship with your daughter. So that you don't lose those thoughts, I am providing you with a notebook to record your thoughts about your relationship with your daughter over her lifetime. You will want to think especially about the supportive nature of your relationship. How did you support her giftedness?

It is possible that you will feel you have been able to discuss the nature of the supportive relationship you have had with your daughter during our interviews. If not & you think of things you would like to add, then please feel free to write in this journal and return it at the last interview. The only "right" way to keep a journal is YOUR way! Maybe you want to jot down notes? Or write a story? Maybe you want to begin when she was a child and tell about your developing relationship as she grew up?

Whatever you write, it is right!

I appreciate your help very much.



**Appendix G**

**Example of Field Note Memos**

**EXPLANATION OF FIELD NOTES: (April, 2002)**

The following notes are field notes I wrote in my laptop computer between interview sessions that helped me monitor where I was in the research process: I wrote my thoughts, questions that came up, questions I needed to ask, and thoughts about the direction I needed to take in my questioning, etc. The following notes are notes I wrote early on, but they are interesting because they show the metacognitive processes I went through struggling with the decision to change from a phenomenologic research methodology to a grounded theory methodology.

When I wrote these notes I had just completed my third pilot interview with a father of a musically gifted daughter; he was the chair of a math department in a liberal arts college and his daughter was away at college. After we completed the interview, I realized several problems, the biggest problem was that in order to get at the responses I needed from these fathers I needed to ask more questions, and it seemed that the responses that would follow would be larger in scope than merely a description of a phenomenon.

Dissertation memos:

**QUESTIONNAIRE DEVELOPMENT (June, 2000)**

**Phenomenon under investigation:** The central idea (SUPPORT OF GIFTEDNESS) about which a set of actions or interactions are directed at managing.

I just completed the third pilot interview with fathers of gifted girls and their wives, (I interviewed the third pilot couple via telephone). All three families, fathers are two Ph.D.'s & an MD, are friends of mine & are fairly gregarious people. I read them the questions I had formulated to extrapolate the phenomenon of support. The first question worded, "What has been the relationship you have had with your daughter over her lifetime that has been supportive of her giftedness?" and worded it another way "What has your relationship with your gifted daughter been like over her lifetime?"

Personally, as a researcher I am having a difficult time figuring out how to separate the daughter from her giftedness? It all made so much sense when I started this, but now that I'm asking the questions it is really difficult. How is support divided between supporting a daughter and supporting her giftedness? Or is it? I'm having a hard time deciding what those questions I formulated mean or how to answer them. AND I WATCHED my friend at our greeting—"Hi good to see you!" arms extended, open attitude, "Glad to be able to help you with your research—tell me how I can help"—change. When he heard the questions he pulled in his arms, sat quiet and stone faced, thinking. After a time I asked what had happened. Two of the fathers said, "I don't know if I had a relationship with her over her lifetime?" The third father said "How do you expect men to respond to a question like that? Do you think men will tell you about their feelings? You are going to need to lead the fathers into that question pretty gently!!"

While fathers reacted in that manner, all three mothers, without further prompting, began talking about their daughters and their relationships with them beginning at their pregnancy and proceeding to their relationship now that they are in college without any cues from me!!!

SO what have I encountered? Gender differences in communication patterns? Or is the issue bigger? Is there something else I need to look at in the father-daughter relationship that I cannot approach with only two questions? I'm not looking at personality and I haven't addressed gender differences but I have encountered a difference that needs addressing!!

**KEEP FOCUSED: REMEMBER,** my focus is how fathers view their relationship with their daughters as supportive and how daughters view their relationship with their fathers as supportive. In order to do this I must understand their perspective of their relationship and the meaning they give to giftedness and to support.

The next step I took was to ask the fathers how I, as a researcher, could help them recall the information they were willing to give if only they could get at it! They said almost in one

voice that they needed to be led into this question that spanned their daughter's lifetime. They needed to be led to consider issues of support, what did support mean to them? What was their relationship like in their families? With their daughters as preschooler, as elementary schooler, as a middle schooler and as an high schooler. What was their relationship like now that she is gone away to college? What are her friends like? What was our home like what activities do we do together during play, work, study, family time? So, after this initial "block" each father responded to the questions they had helped formulate and in one 60 minute interview provided an interesting overview of the supportive nature of their relationships with their daughters.

These conversations led me to examine qualitative research methodologies farther and I found Creswell (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Newbury Park: SAGE. It appeared to me that I had exceeded the bounds of phenomenology and was approaching a grounded theory research project. Reading Strauss & Corbin (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park: SAGE confirmed my suspicions and provided the framework for my questions that seemed to make sense.

I need to follow up on questions initiated by my pilot fathers, I needed to ask,  
Who provided support to gifted girls?

Was it internal?

Was it external?

Was it from parents, one? Both? Siblings? Friends? Teachers?

What gives support?

Home environment?

School environment?

How do parents encourage their daughters?

What do families do with each other when they are together?

Does parenting make a difference? Do they parent all their children alike?

AND I FOUND in axial coding a method to specify support in terms of the conditions that give rise to support:

What are the properties of support?

What are the conditions of support?

What is the context within which support is given/noted?

What are the causal conditions of support

(events, incidents, actions that lead to the occurrence or development of

support)

What are the intervening conditions of support?

Structural conditions bearing on support?

Interactions that pertain to support?

What are the consequences of support?

What are the consequences of non-support?

**Appendix H**

**Moos' Family Environment Scale (Form R)**

# FAMILY ENVIRONMENT SCALE

## FORM R

Rudolf H. Moos

### Instructions

There are 90 statements in this booklet. They are statements about families. You are to decide which of these statements are true of your family and which are false. Make all your marks on the separate answer sheet. If you think the statement is *True* or mostly *True* of your family, make an X in the box labeled T (true). If you think the statement is *False* or mostly *False* of your family, make an X in the box labeled F (false).

You may feel that some of the statements are true for some family members and false for others. Mark T if the statement is *true* for most members. Mark F if the statement is *false* for most members. If the members are evenly divided, decide what is the stronger overall impression and answer accordingly.

Remember, we would like to know what your family seems like to *you*. So *do not* try to figure out how other members see your family, but *do* give us your general impression of your family for each statement.

68. In our family each person has different ideas about what is right and wrong.
69. Each person's duties are clearly defined in our family.
70. We can do whatever we want to in our family.
71. We really get along well with each other.
72. We are usually careful about what we say to each other.
73. Family members often try to one-up or out-do each other.
74. It's hard to be by yourself without hurting someone's feelings in our household.
75. "Work before play" is the rule in our family.
76. Watching T.V. is more important than reading in our family.
77. Family members go out a lot.
78. The Bible is a very important book in our home.
79. Money is not handled very carefully in our family.
80. Rules are pretty inflexible in our household.
81. There is plenty of time and attention for everyone in our family.
82. There are a lot of spontaneous discussions in our family.
83. In our family, we believe you don't ever get anywhere by raising your voice.
84. We are not really encouraged to speak up for ourselves in our family.
85. Family members are often compared with others as to how well they are doing at work or school.
86. Family members really like music, art and literature.
87. Our main form of entertainment is watching T.V. or listening to the radio.
88. Family members believe that if you sin you will be punished.
89. Dishes are usually done immediately after eating.
90. You can't get away with much in our family.

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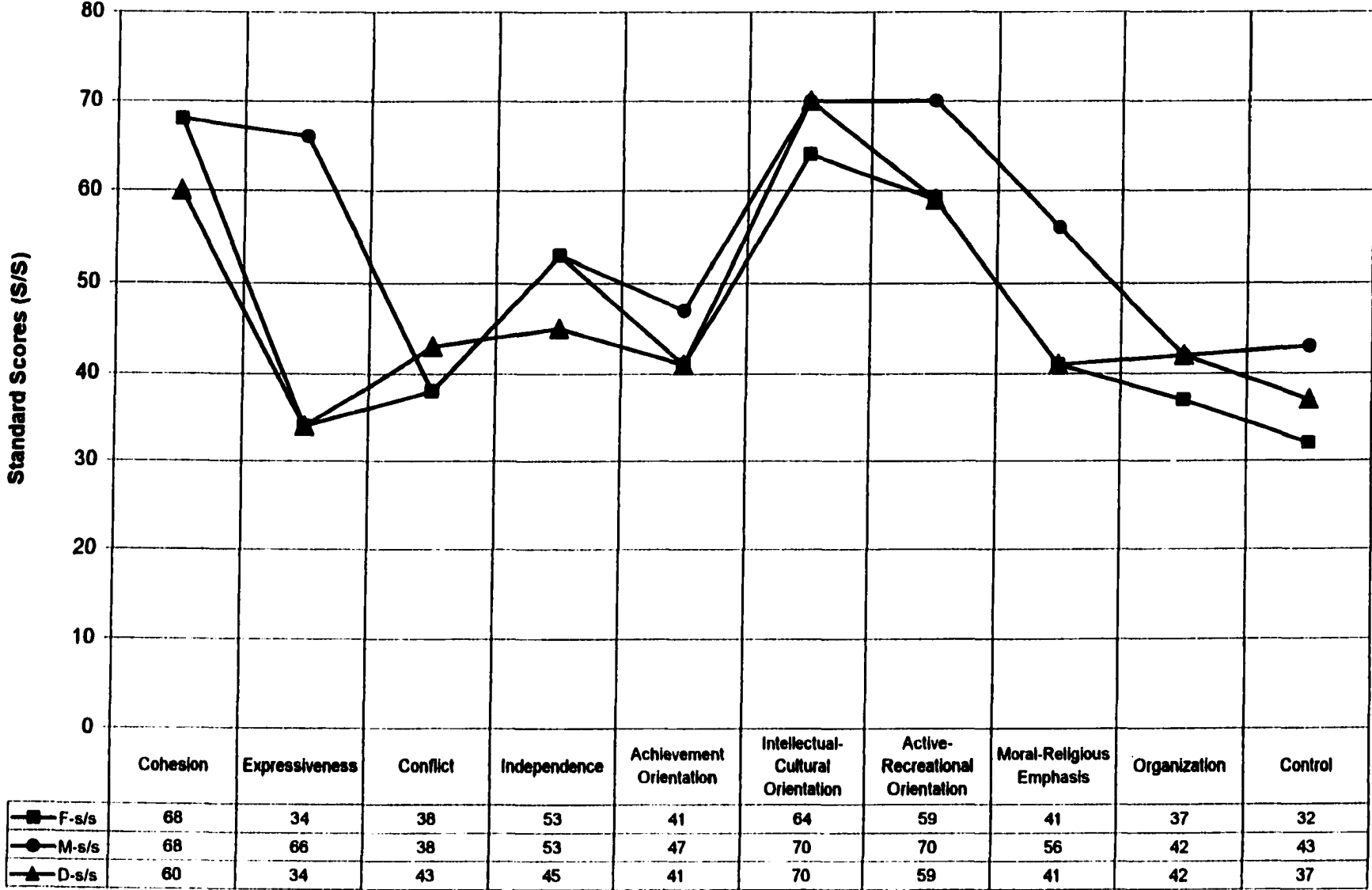
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1. Family members really help and support one another.
2. Family members often keep their feelings to themselves.
3. We fight a lot in our family.
4. We don't do things on our own very often in our family.
5. We feel it is important to be the best at whatever you do.
6. We often talk about political and social problems.
7. We spend most weekends and evenings at home.
8. Family members attend church, synagogue, or Sunday School fairly often.
9. Activities in our family are pretty carefully planned.
10. Family members are rarely ordered around.
11. We often seem to be killing time at home.
12. We say anything we want to around home.
13. Family members rarely become openly angry.
14. In our family, we are strongly encouraged to be independent.
15. Getting ahead in life is very important in our family.
16. We rarely go to lectures, plays or concerts.
17. Friends often come over for dinner or to visit.
18. We don't say prayers in our family.
19. We are generally very neat and orderly.
20. There are very few rules to follow in our family.
21. We put a lot of energy into what we do at home.
22. It's hard to "blow off steam" at home without upsetting somebody.
23. Family members sometimes get so angry they throw things.
24. We think things out for ourselves in our family.
25. How much money a person makes is not very important to us.
26. Learning about new and different things is very important in our family.
27. Nobody in our family is active in sports, Little League, bowling, etc.
28. We often talk about the religious meaning of Christmas, Passover, or other holidays.
29. It's often hard to find things when you need them in our household.
30. There is one family member who makes most of the decisions.
31. There is a feeling of togetherness in our family.
32. We tell each other about our personal problems.
33. Family members hardly ever lose their tempers.
34. We come and go as we want to in our family.
35. We believe in competition and "may the best man win."
36. We are not that interested in cultural activities.
37. We often go to movies, sports events, camping, etc.
38. We don't believe in heaven or hell.
39. Being on time is very important in our family.
40. There are set ways of doing things at home.
41. We rarely volunteer when something has to be done at home.
42. If we feel like doing something on the spur of the moment we often just pick up and go.
43. Family members often criticize each other.
44. There is very little privacy in our family.
45. We always strive to do things just a little better the next time.
46. We rarely have intellectual discussions.
47. Everyone in our family has a hobby or two.
48. Family members have strict ideas about what is right and wrong.
49. People change their minds often in our family.
50. There is a strong emphasis on following rules in our family.
51. Family members really back each other up.
52. Someone usually gets upset if you complain in our family.
53. Family members sometimes hit each other.
54. Family members almost always rely on themselves when a problem comes up.
55. Family members rarely worry about job promotions, school grades, etc.
56. Someone in our family plays a musical instrument.
57. Family members are not very involved in recreational activities outside work or school.
58. We believe there are some things you just have to take on faith.
59. Family members make sure their rooms are neat.
60. Everyone has an equal say in family decisions.
61. There is very little group spirit in our family.
62. Money and paying bills is openly talked about in our family.
63. If there's a disagreement in our family, we try hard to smooth things over and keep the peace.
64. Family members strongly encourage each other to stand up for their rights.
65. In our family, we don't try that hard to succeed.
66. Family members often go to the library.
67. Family members sometimes attend courses or take lessons for some hobby or interest (outside of school).

**Appendix I**

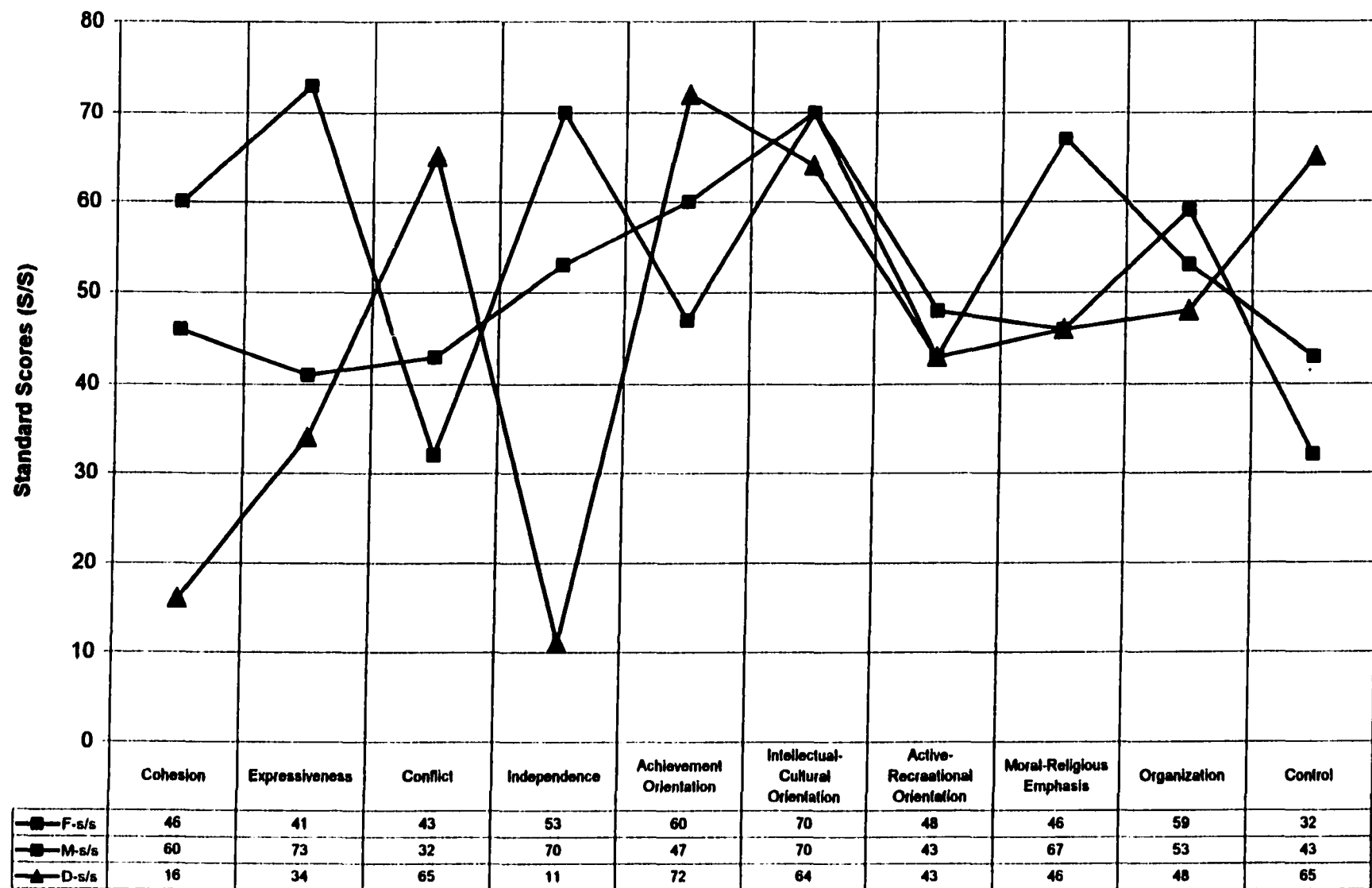
**Relationships Measured by the Moos' FES within Families**

Moos' Family Environment Scale--Family 1

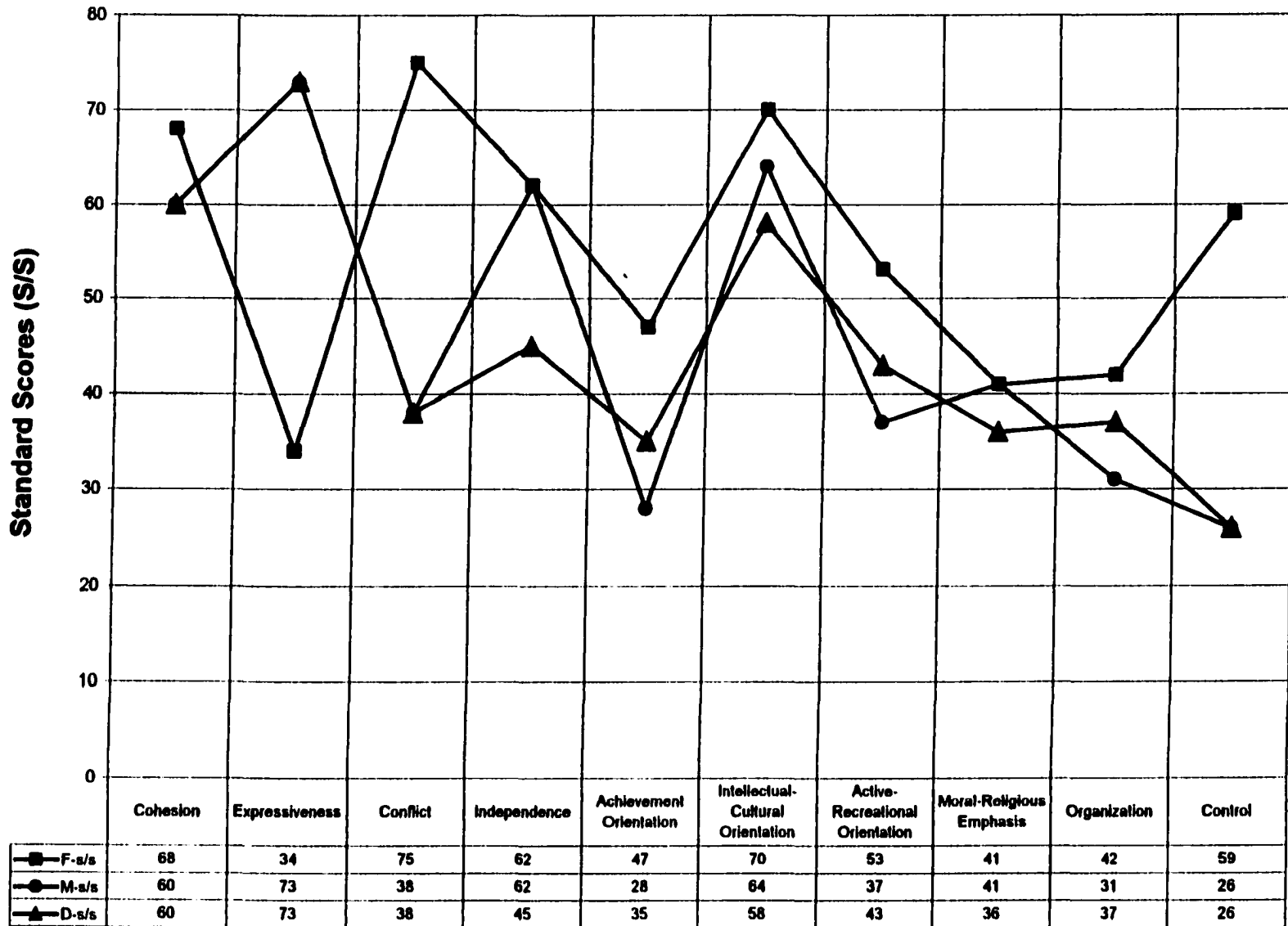




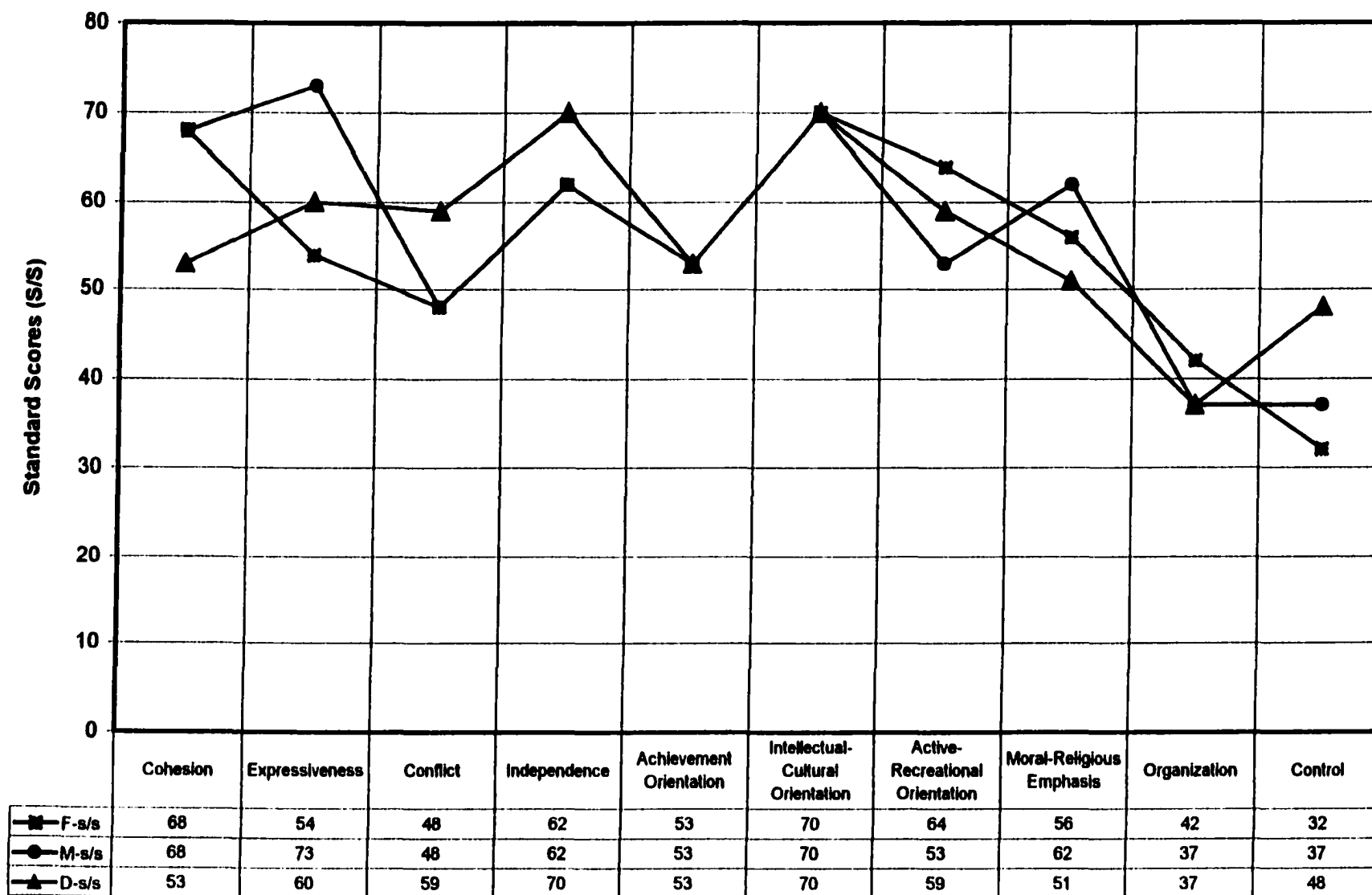
# Moos' Family Environment Scale--Family 2



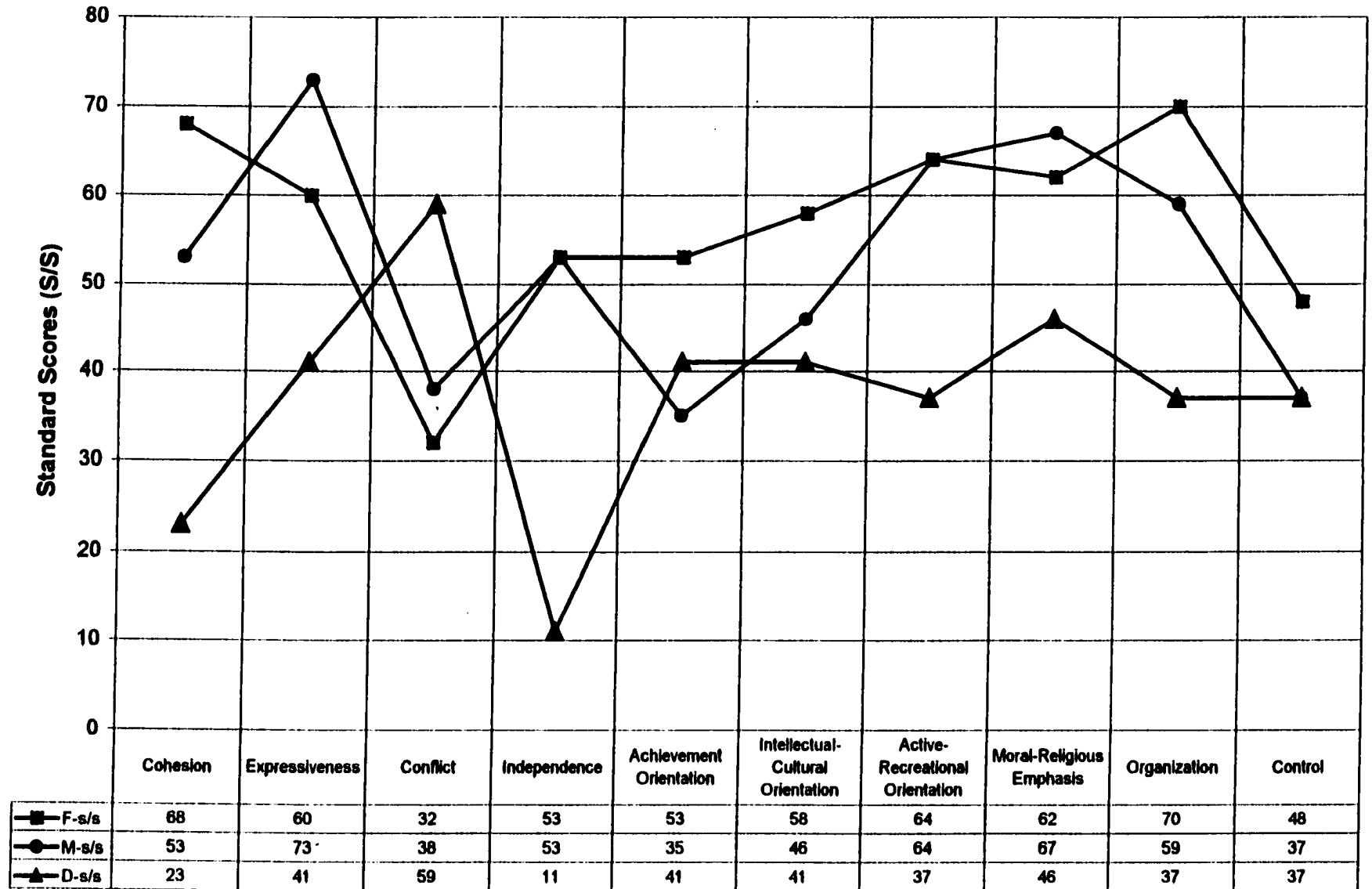
### Moos' Family Environment Scale--Family 3



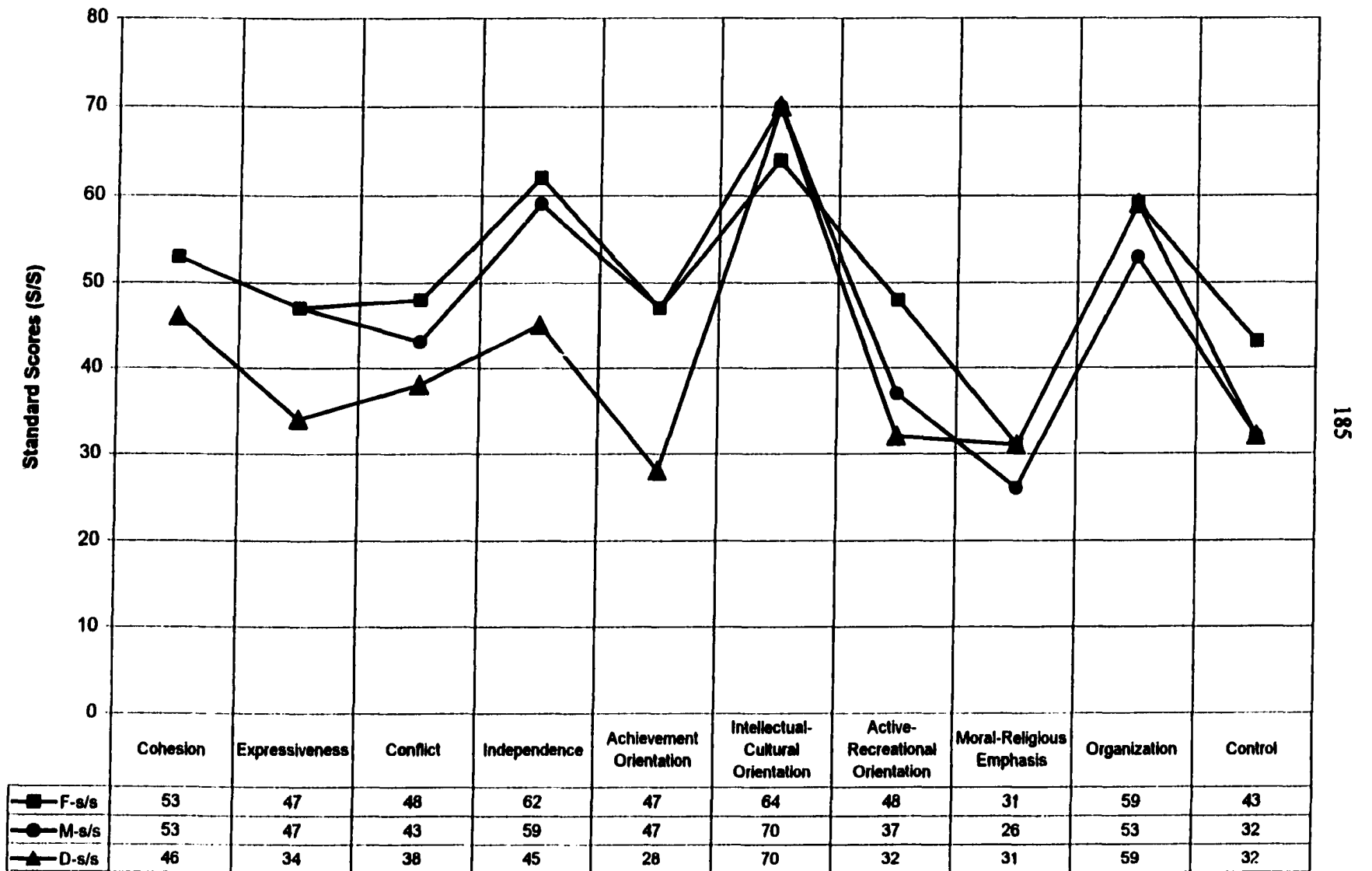
**Moos' Family Environment Scale--Family 4**



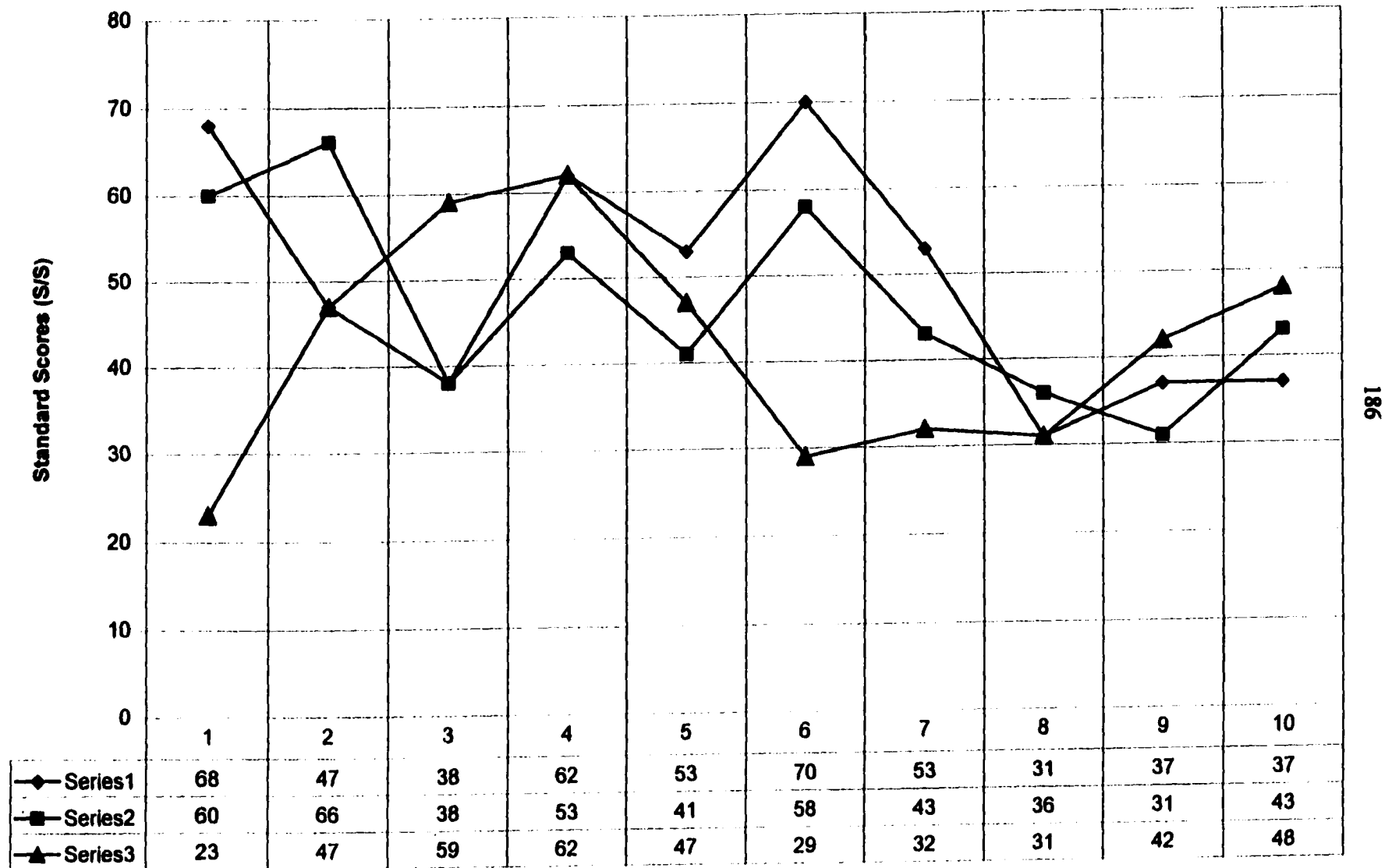
Moos' Family Environment Scale--Family 6



# Moos' Family Environment Scale--Family 7



**Moos' Family Environment Scale--Family 8**



**Appendix J**

**Paired t-test for Differences**

Paired t--Test for MOOS Father-Daughter Pairs  
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**Paired Samples Statistics**

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 FA	51.8714	7	3.7165	1.4047
DAUG	45.0714	7	5.8923	2.2271

**Paired Samples Correlations**

	N	Correlation	Sig.
Pair 1 FA & DAUG	7	-.045	.924

**Paired Samples Test**

		Paired Differences					t
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		
					Lower	Upper	
Pair 1	FA - DAUG	6.8000	7.1068	2.6861	.2273	13.3727	2.532

**Paired Samples Test**

		df	Sig. (2-tailed)
Pair 1	FA - DAUG	6	.045

	fa	daug
1	46.70	47.20
2	49.80	46.40
3	55.10	45.10
4	54.90	56.00
5	56.80	37.30
6	50.20	41.50
7	49.60	42.00