AFIT/GSM/LAS/93S-11

AN INVESTIGATION OF INTEGRATED PRODUCT DEVELOPMENT IMPLEMENTATION ISSUES: A CASE STUDY OF BOSMA MACHINE AND TOOL CORP.

THESIS

F. Paul Khuri, Captain, USAF

Howard M. Plevyak, Jr., Captain USAF

AFIT/GSM/LAS/93S-11

The views expressed in this thesis are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

AFIT/GSM/LAS/93S-11

AN INVESTIGATION OF INTEGRATED PRODUCT DEVELOPMENT IMPLEMENTATION ISSUES: A CASE STUDY OF BOSMA MACHINE AND TOOL CORP.

THESIS

Presented to the Faculty of the School of Logistics and Acquisition Management

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Systems Management

F. Paul Khuri, B.S.

Captain, USAF

Howard M. Plevyak, Jr., B.S.

Captain, USAF

September 1993

Preface

This thesis provides a case study of an industry success story to enhance the Air Force's understanding of Integrated Product Development (IPD). Lessons learned from this case study may be helpful to Air Force Material Command (AFMC) System Program Offices (SPOs) starting or continuing their transition to IPD. It is intended that this thesis be used as educational material for those Air Force organizations attempting to transition to IPD and a teaming structure.

Our case study subject, Bosma Machine and Tool Corp. and its team members provided invaluable assistance and detailed information throughout the research effort. We especially wish to recognize Mr. Ben Bosma, Vice President of Engineering, for his assistance and cooperation. We wish to thank all team members who shared their knowledge with us. Due to the promise of anonymity we cannot thank them by name, but without their cooperation this research could not have been completed.

We would like to thank our sponsors, Mr. Mitch Cary and Ms. Donna Milam of AFMC headquarters, for providing valuable input. We also wish to recognize our advisors, Lt Col Michael Heberling and Maj Scott Graham. They provided leadership, support, and created a working environment which allowed us to retain pride of ownership. Finally, and most importantly, we wish to thank Penelope Khuri and Linda Plevyak for their patience and understanding during the long hours we spent in each other's homes, jockeying for computer time and begging for free food.

Paul Khuri

Howard Plevyak

Table of Contents

Page

List of Figures

List of Tables

Abstract

This thesis investigated Integrated Product Development (IPD) implementation issues. Research emphasis focused on teams used in IPD, particularly self-directed work teams (SDWTs). The areas addressed in the study were: Work Environment, Team Organization, Training and Education, Group Dynamics and Communication, Motivation, Rewards and Incentives, Measurements, and Contracts. Data was collected using interviews and presented as a case study.

The most significant findings on work environment were that the organization's leadership should commit to the teaming idea and sell it to the organization's members. Teams should be organized by choosing members carefully and defining all roles. Personnel should be trained in technical skills and human relations. Group interaction should be ensured by establishing open communication in a non-attribution setting. The greatest motivator of personnel is pride of ownership. A measurement baseline should be established at the outset against which productivity, efficiency, and morale may be measured. Finally, team members should be allowed to provide inputs to any contract which involves them.

AN INVESTIGATION OF INTEGRATED PRODUCT DEVELOPMENT IMPLEMENTATION ISSUES: A CASE STUDY OF BOSMA MACHINE AND TOOL CORP.

I. Research Objective

Introduction

The cancellation of major weapon systems, such as the A-12 aircraft, indicate significant problems exist within the Department of Defense (DoD) product development process (1:18). In 1986, the President's Blue Ribbon Commission on Defense Management noted that weapon systems take too long to develop, cost too much to produce, and often do not perform as promised or expected (2:xxii). At the same time, private industry was attributing its success in the competitive global market to its use of new initiatives such as Integrated Product Development (IPD) (2:116). The United States Air Force defines IPD as:

> A philosophy that systematically employs a teaming of functional disciplines to integrate and concurrently apply all necessary processes to produce an effective and efficient product that satisfies customer's needs. (3).

Following the recommendations of the Institute of Defense Analysis (IDA) report R-338, the Under Secretary of Defense for Acquisition (USD(A)) directed that the DoD implement IPD in weapons system acquisition (4,5). The Air Force Materiel Command (AFMC) is in the process of implementing IPD into its system program offices (SPO). Rather than implement IPD simultaneously command-wide, AFMC identified certain SPOs within Aeronautical Systems Center (ASC) as test beds for IPD. During this experimental phase, AFMC is concerned with identifying key implementation strategies for successful transition to IPD.

Lack of understanding of the philosophy, processes, tools, practices and applications of IPD is the major barrier to successful implementation within the DoD (1:20). Several areas for additional research were identified by the IDA report, including documentation of IPD decision processes, lessons learned about IPD processes, and training of IPD team members (6:V-3). It is imperative that the DoD and defense industry understand what IPD is, how IPD is accomplished, who is responsible for accomplishing IPD, and the benefits and pitfalls of IPD (1:24). The database on IPD implementation will be enhanced significantly by examples from private industry.

Specific Problem

The purpose of this research is to provide a case study of one Dayton, Ohio company's implementation of IPD -- Bosma Machine and Tool Corp. (Bosma). This in-depth study investigated a profit-oriented, DoD-related company to include restrictive effects of DoD-unique regulations on IPD implementation. This case study will enhance the Air Force's understanding of IPD and facilitate the transition to IPD.

Investigative Questions. To document Bosma's IPD implementation, the following areas will be investigated:

1. Identify changes to the work environment resulting from implementation.
2. Describe how teams were organized.
3. Describe the type of training used.
4. Describe group dynamics of the new team.
5. Describe the rewards, incentives, and other sources of motivation used.
6. Describe measures used to assess the success of the team.
7. Describe how contracts were written.

Scope

The case study method was chosen because of the descriptive nature of the research. This case study, unlike an experiment, does not seek to establish causality to explain relationships among variables (7:141). Rather, the case study performs in-depth analyses to provide important insight on IPD for evaluation and problem-solving (7:143). This study is not intended to provide a definitive implementation guide, but rather to provide a series of IPD lessons learned from private industry.

According to Dr. W. Edwards Deming, a pioneer in the field of quality, one of the obstacles to implementation of a quality program, such as IPD, is the "search for examples" which companies undertake to find a procedure they can follow instead of planning their own route (8:19). Lessons learned from the case study may be used to educate AFMC SPOs starting or continuing their transition to IPD. The study considered only profit-oriented, DoD-related companies to include external restrictions, such as Federal Acquisition Regulations (FAR), on IPD implementation. Bosma was chosen for its experience and publicized success in IPD, as well as for their understanding of the problems of implementing IPD and their accessibility. More specific sampling issues are discussed in Chapter Three.

Overview

This thesis begins with a review of the literature on IPD. The review documents the historical evolution of product and process design, and describes events leading to implementation of IPD within the DoD. The research methodology is presented in Chapter Three. The methodology section describes the method of research, the population and sample, the research instrument development, data collection plan, and data analysis approach. Chapter Four examines the data obtained from interviews conducted within Bosma. Finally, Chapter Five presents lessons learned and recommendations.

II. Literature Review

Introduction

The purpose of this literature review is to document the historical evolution of IPD and describe events leading to implementation of IPD within the DoD. The United States Air Force defines IPD as:

> A philosophy that systematically employs a teaming of functional disciplines to integrate and concurrently apply all necessary processes to produce an effective and efficient product that satisfies customer's needs.
>
> Product, in this sense, is not only what is delivered to your customer, but also processes which make the product possible. Products range from complete weapon systems to individual end items and from request for proposals to briefings, as well as policies like those for the Integrated Acquisition Strategy Process and the Configuration Control Board (9).

IPD integrates the design of a product and its manufacturing and support processes by developing multifunction product teams to improve the DoD acquisition process.

Scope

This literature review describes the evolution of IPD from private industry to initial implementation in the USAF. Barriers to DoD IPD implementation are outlined, as are potential solutions. Finally, a summary of the literature review main issues is presented.

Evolution of IPD

Erosion of US Industrial Base. The DoD maintains a strong interest in the competitiveness of the industrial base because that competitiveness affects the ability

to equip military forces (10:5). Within the last decade, the ability of some US industries to compete globally has been questioned. Other industries reported they have increased competitiveness by adopting new practices.

After World War II, most decision-makers in American business and government pursued mass production (11:177). To keep their huge factories working, US industries were stockpiling inventory at enormous costs. Mass production evolved slowly after World War II (see Figure 2.1) and Japan, a crippled nation after this war, was a contributor in its development. Japan looked to the US for fresh ideas on rebuilding its industries. The Japanese noted weaknesses of mass production and adopted a new approach called "lean production".

> Eiji Toyoda and Taiichi Ohno at the Toyota Motor Company in Japan pioneered the concept of lean production (1950). The rise of Japan to its current economic preeminence quickly followed, as other Japanese companies and industries copied this remarkable system (12:11).

Lean Production. Lean production was developed with the goals of improved quality, higher productivity, agile production, and faster product development. Lean production uses less of everything compared with mass production - half the human effort in the factory, half the manufacturing space, half the investment tools, and half the engineering hours to develop a new product in half the time (12:13). One technique separating lean production from mass production in product development is simultaneous development or "concurrent engineering" (CE) (12:116). According to the US Army Communications-Electronics Command, concurrent engineering is

> ...a teaming concept. All of the people who normally get involved in the product come together as a team. They work together, trading ideas and

> ensuring what they decide now will not adversely affect what they have to do later. Everything is addressed simultaneously.(1:18)

CE techniques have been used to decrease a product's development time dramatically. CE was later renamed to IPD within the USAF to avoid confusion with a previous acquisition concept called concurrency. Reasoning for renaming is discussed later in Chapter 2.

The President's Blue Ribbon Commission on Defense Management noted that weapon systems take too long to develop, cost too much to produce and often do not perform as promised or expected (2:44). Similar problems existed in the automobile and electronics industry using mass production. Companies which were prospering in the affected industries were using CE principles (Figure 2.1). Successful use of CE by leading US companies, such as Boeing Aerospace and Hewlett-Packard, resulted in improved quality of design, reduced manufacturing costs, shorter product development time, and less scrap and rework.

The IPD concept, in one form or another, has existed for many years. Evidence suggests that CE is not a new approach to engineering a system (1:19). According to Evanczuk, "many would call concurrent engineering sheer common sense development practice" (13:16). The development of early systems engineering theories formed the basis of modern concurrent engineering. In Wilton P. Chase's book, Management of Systems Engineering, he defines early concepts of systems engineering as including "the integrated, concurrent design of products and their related process" (14:15). In the 1960s, systems engineering concepts were based on "shaping a series of macro level interfaces" (15:12). Weapons system design of this age was still relatively simple. As

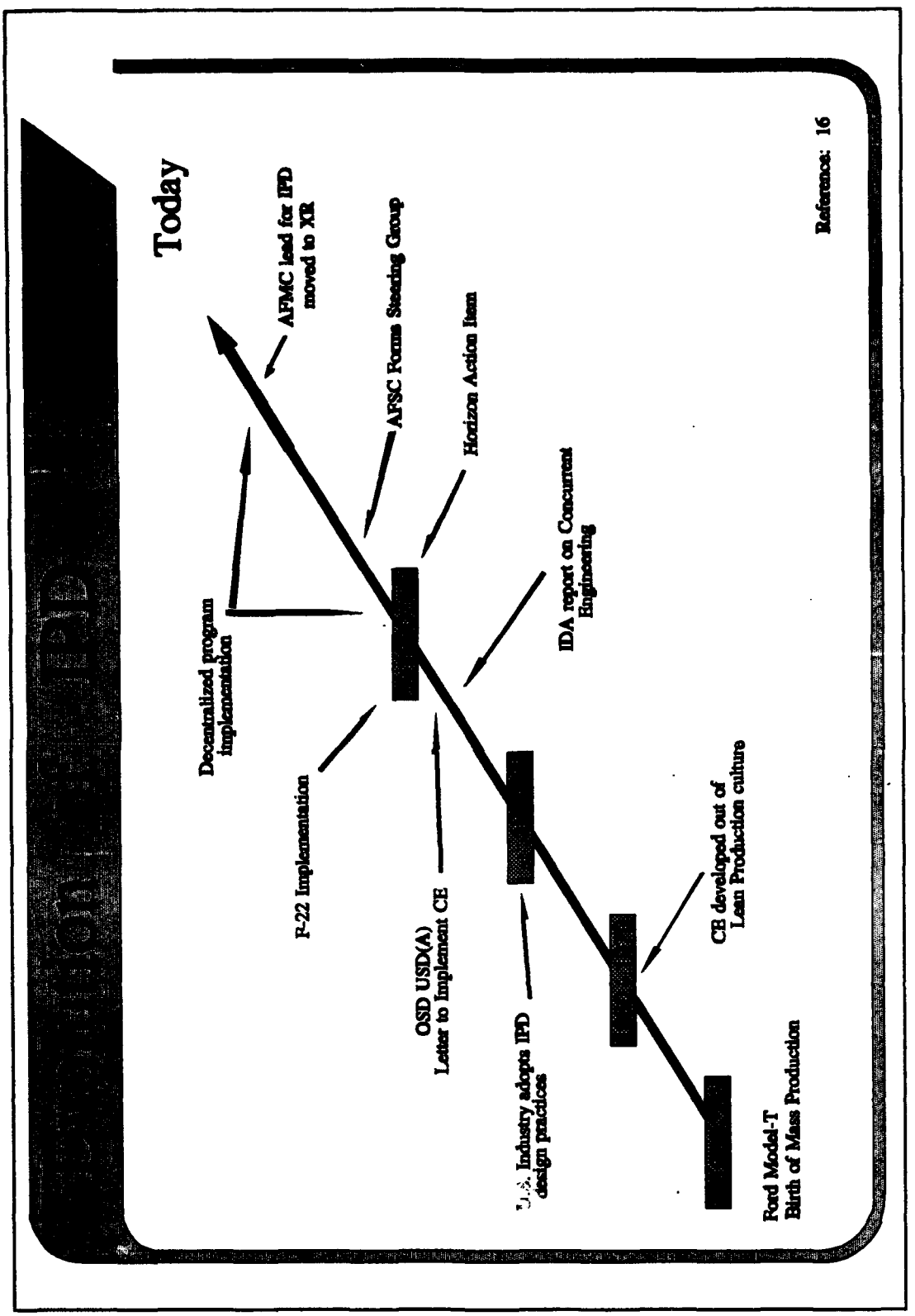

Figure 2.1: Evolution of IPD.

aircraft and missile designs increased in complexity, interface control and communication between engineering specialties degraded. This breakdown in communication resulted in failure of the theoretical concepts of systems engineering as originally defined and envisioned (14:21). Integration of inputs from all engineering specialties into the design process was never realized. Current system engineering practices result in fragmented, sequential design processes leading to impractical and defective products. Concurrent engineering as implemented by the Japanese seeks to reestablish communication between all product development specialties.

IPD in the DoD. In response to initial reports from several companies, the Under Secretary of Defense for Acquisition (USD(A)) directed that the Institute for Defense Analyses (IDA) investigate concurrent engineering and its possible application to weapons system acquisition (10:1). Specifically, the IDA was tasked to determine (10:v):

1. Were publicized benefits typical of those achieved by others who tried CE?
2. Could DoD expect similar results if defense contractors implemented CE in the weapons system acquisition process?
3. What had to be done to encourage defense contractors to use CE?

Concurrent Engineering (CE) was defined by the IDA as (10:v):

> A systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements.

The principle findings from the IDA's report were as follows (10:vii):

1. Companies that implemented CE reported production of higher quality products at lower cost and less time than before.

2. Significant cultural and management changes underlie the successful implementation of CE. As a consequence, considerable time (2-4 years) is needed before benefits are realized from CE.

3. Concurrent engineering requires top-down leadership and involvement to succeed with continual reinforcement through training, backing, interest, and dialogue throughout the total weapons system acquisition process.

4. Significant differences exist between the commercial marketplace and the DoD domain. Despite these differences, case studies of the implementation of CE by several defense contractors suggest that CE can be successfully applied in the DoD environment.

The major recommendation was that the DoD take positive steps to encourage the use of concurrent engineering in weapons system acquisition (10:vii).

Dr. Robert Costello, while DoD Under Secretary of Defense for Acquisition, realized the usefulness of CE as an implementation mechanism for total quality management (10:31). He acted on the IDA's recommendations and required the services to begin implementation of CE (4,5).

IPD in the USAF. Within the USAF Air Force Systems Command (AFSC), Lt General Loh, former Aeronautical Systems Division (ASD) Commander, established a Critical Process Team (CPT) on concurrent engineering as a total quality initiative. Lt General Loh requested the CPT create a culture to integrate CE into the acquisition process (17). The team was tasked to define and recommend (18:1):

1) Integrated development and integrated management processes for concurrent design and verification of products and their manufacturing and support processes.

2) A process for improving technology transition as it relates to IPD.

3) Incentives for industry to embrace IPD.

In addition, the CPT recommended concurrent engineering be renamed IPD in the USAF. The CPT argued that the word "concurrent" was being confused with a previous acquisition concept called concurrency. Concurrency sometimes fielded a product without proper attention to manufacturing and support (19,3:4). The term "engineering" was inappropriate since CE was not an engineering-only process. CE involved all functional areas from the start including finance, marketing, manufacturing, logistics, etc. The name Integrated Product Development was used by the CPT to emphasize the change from an engineering-only approach to the integrated teaming concept.

The team completed the study in December of 1990 and subsequently published several white papers on topics relating to IPD implementation (3:4). The papers discussed Integrated Product Teams (IPTs), the impact on matrix management, business and management issues, and technology transfer (9,20-25). After the team finished its review, AFSC proceeded with decentralized IPD implementation where specific implementation issues were left to the discretion of the product centers (3:5).

In mid 1990, the Advanced Tactical Fighter System Program Office (ATF-SPO) adopted IPD. During the Air Force Systems Command Horizons Conference that year, General Ronald Yates, commander of AFSC, directed command-wide implementation of IPD by 1994. This directive also required the formation of a Steering Group, at that time chaired by AFSC/EN, to facilitate timely resolution of IPD implementation issues within the command.

IPD in AFMC. IPD matured further during the new Air Force Materiel Command's (AFMC's) development of the Integrated Weapon Systems Management (IWSM) concept. General Yates declared in a white paper titled "IWSM in AFMC" that the SPOs will use a management philosophy known as IPD (26). He identified Integrated Product Development as the fourth key element (Figure 2.2) of the IWSM philosophy (27). In addition, General Yates designated the Deputy for Development Planning (AFMC/XR) as his lead for the command-wide implementation of IPD (9).

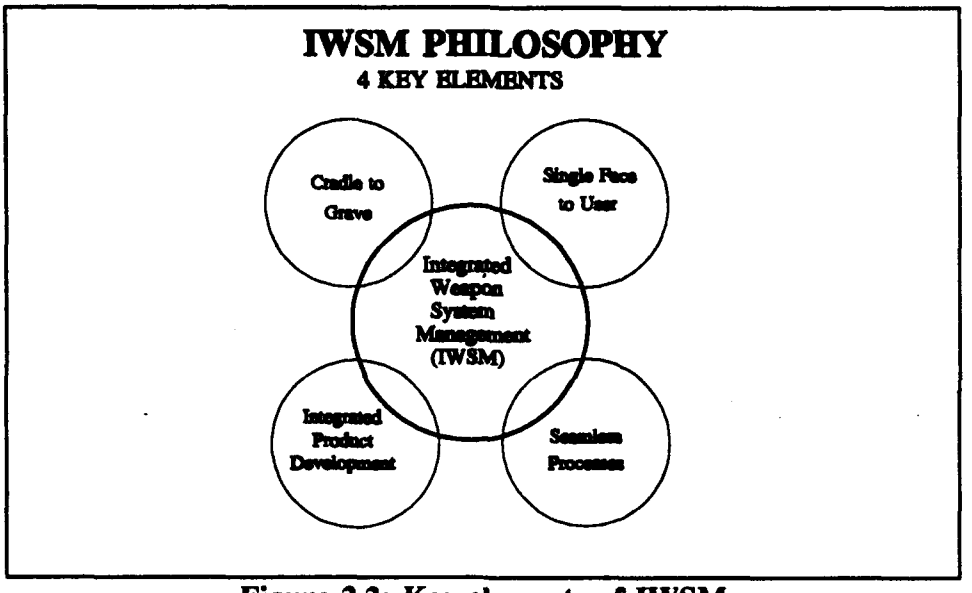

Figure 2.2: Key elements of IWSM

Understanding IPD. Implementation of IPD requires understanding of its tenets (9):

a) IPD requires a product focus and a complete understanding of the processes required to optimize the product.

b) IPD will encompass all products and processes, regardless of the point in their life cycle.

c) The life cycle of a product or a process will be integrated through thorough, upfront planning that must include all functions, customers, and suppliers.

d) All functions that impact the achievement of the customer's requirements should be applied concurrently, in a team fashion, throughout the life of a product or process.

e) A framework must be established which relates products and processes at all levels to demonstrate dependency and interrelationships. This hierarchial interrelationship must be understood and appropriate partnerships established to ensure that all decisions are optimized toward the ultimate user's end product.

f) Decisions must be driven to the lowest possible level commensurate with risk. Resources should be allocated at levels consistent with authority, responsibility, and ability of the people.

g) People must function as a team. Team success, facilitated by rapid, open communications, must be emphasized and rewarded. Management relationships must be developed which are consistent with and focused on achieving the team's measurable goals and objectives.

h) Embracing the IPD philosophy requires purposeful, multi-disciplined teamwork. The sequence of focus for IPD should be:

1) The customer
2) The product
3) The process
4) Organizational structure

Barriers to IPD Implementation

IPD evolved from concurrent engineering. Pilot programs, selected by each product center to implement IPD, eventually ran into barriers (3:5). During their July 1991 meeting, the IPD Steering Group brought in several functional leaders to identify barriers to IPD implementation and to develop a plan to address these barriers (28).

Four working groups were established to address barriers to IPD implementation. The working groups were tasked to perform the following functions (9):

a) Facilitate the identification and resolution of issues.
b) Recommend policy and guidance.
c) Examine metrics.
d) Identify and facilitate initial education and training.
e) Keep the field informed on all issues relating to IPD.
f) Provide a recommended approach for each of these topics to the steering committee for review and approval.

IPD Challenges. To ensure successful implementation of IPD concepts within the DoD environment, several unique challenges must first be overcome. A concurrent engineering workshop, held in January of 1991, outlined seven barriers to implementing IPD concepts within the DoD (29:38). These included:

1. Trust
2. Leadership
3. Resistance
4. Resources
5. Contracting
6. Measurement
7. Understanding

Trust must be built between government and contractor personnel. Leadership is required at all levels of acquisition to support IPD concepts. Resistance from engineering specialty groups must be overcome. Early resource commitment (i.e. time, people, and funding) at adequate levels to implement IPD is needed. Contracting techniques must be changed to support IPD implementation. Tools to measure success must be devised. Finally, and most significantly, universal understanding of the philosophy, processes, tools, and applications of IPD must be developed. According to Dr. Lake, Professor of Systems Engineering at the Defense Systems Engineering College,

> Understanding IPD concepts is not only one of the problems that has the strongest influence on lessening the other barriers, but is the primary barrier that must be overcome. It is imperative that the DoD and industry work forces understand what IPD is, how it is accomplished, who is responsible for accomplishing it, and its expectations. It is imperative that a common body of knowledge be established to define what a person must know to be able to accomplish concurrent engineering. (1:22)

Potential Solutions to Implementing IPD in the DoD

Solutions to the barriers of implementing IPD concepts in the DoD were derived at a DoD workshop on CE during January 1991. The five key solutions were:

1. Initiation of dialogue within constituencies on IPD
2. Top management support of IPD education
3. Education of the infrastructure
4. Establishment of IPD education opportunities
5. Design of curricula for IPD (1:23)

All of these solutions attempt to improve the universal understanding of IPD through education. Systems engineering and engineering management education must include courses on the philosophy, processes, tools, and applications of IPD. This thesis seeks to provide a case study of an industry success story to enhance the Air Force's understanding of IPD. It is essential that case studies of IPD be included in curricula to provide an awareness of IPD philosophy to top management, an understanding of IPD to mid-level engineering managers, and a working knowledge of IPD to all team members.

IPD in Bosma

The principles of IPD, with its concept of teaming, represent a general framework which may be tailored to the specific needs of an organization. It may be

helpful to draw an analogy to manufacturing a car. All cars have the same basic purpose - to provide transportation. They share several common features such as wheels, doors, seats, and an engine. Each car manufacturer takes the basic idea of "car" and determines design, performance, features, and color. In the same way, Bosma Corp. used the basic principles of IPD to implement a teaming approach to product development. Within Bosma, the teams are referred to as Self-Directed Work Teams (SDWT). A self-directed work team integrates personnel from all areas involved in manufacturing a product to address problems, work together, and exchange ideas. SDWTs also empower employees to take on more responsibility and make decisions in areas previously reserved for management.

Conclusion

From the literature reviewed, it can be concluded that IPD is not a new idea. Integrated Product Development has evolved from previous definitions and practices of systems engineering. The use of IPD in commercial industry has resulted in successful and efficient product development. The benefits of IPD within industry sparked the DoD's interest. The DoD initiated a study on the feasibility of implementing CE or IPD on weapons system programs. This study outlined several barriers to implementing IPD concepts within the DoD. These barriers included trust, leadership, resistance, resources, contracting, measurement, and understanding. Of these, understanding IPD was considered the most important and had the greatest influence on overcoming the other six. To improve understanding of IPD, five solutions were

derived from a DoD workshop: 1) initiation of dialogue among constituencies on IPD, 2) top management support of IPD education, 3) education of the infrastructure, 4) establishment of IPD education opportunities, and 5) design of curricula for IPD. The last solution contained four topics that must be integrated into an IPD curriculum: philosophy of IPD, IPD processes, IPD tools, and applications of IPD. It is essential that case studies of companies that have implemented IPD concepts be included as examples of the application of IPD. Case studies increase the data base of IPD applications, and provide a source for an IPD curriculum essential to further the understanding of IPD principles. The universal understanding of these principles is the key to overcoming the barriers to implementation of IPD within the DoD.

III. Research Methodology

Introduction

The research question for this thesis is: How has one product team within Bosma Machine and Tool Corp. (Bosma) successfully implemented Integrated Product Development (IPD)? This thesis uses a case study approach to examine the implementation of IPD within Bosma. This chapter justifies the use of the case study as the research instrument, discusses population and sampling issues, and describes research questionnaire development, interview development, data analysis procedures, and limitations of the research design.

Case Study Justification

According to Yin, research design choice should consider the following criteria: form of the research question, requirement of control over behavioral events, and degree of focus on contemporary events (30:17). This research seeks to document a specific method of implementation, is concerned with reporting and not controlling behavioral events, and focuses on a contemporary rather than historical issue. These three characteristics lead to the choice of a case study as the research method (30:17).

Population and Sampling Issues

Population. The population of interest was limited to profit-oriented, DoD-related companies to include the effects of the Federal Acquisition Regulations (FAR)

on IPD implementation. According to IDA Report R-338, the FAR has been a major obstacle to successful IPD implementation (10:12). Further, companies were evaluated based on their experience in IPD implementation, and their accessibility to the research team. Only companies with two or fewer years' experience in IPD were chosen to capture data on the early phases of transition to IPD.

Sample. Because of the nature of a case study, there is no desire or justification for statistical generalization to a population parameter. Additionally,

> Case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes. In this sense, the case study, like the experiment, does not represent a "sample", and the investigator's goal is to expand and generalize theories (analytic generalization) and not to renumerate frequencies (statistical generalization). (29:21)

The research conducted uses nonprobability sampling to report a range of conditions under which IPD is successfully implemented. The case study uses purposive judgement sampling to focus on a team within Bosma that has successfully implemented IPD. The results from this sample size of one cannot be generalized across all of Bosma, nor is that the intention of the research. The intention of the research is to add lessons learned to the DoD IPD database.

Selection Process. In a multi-team sample, the features of all teams within the sample are considered rather than an individual team's features. This causes an average effect which ultimately produces bias within the data. The choice of a single team eliminates this average effect by focusing on the unique features of that team. Team choice was driven by three criteria: time in place, size, and budget. Upper

management inputs were also sought for an overall qualitative assessment to provide a final decision. The team chosen was the M-1 Tank Ammunition Door team.

Respondent Selection. Within the Ammunition Door team there were two functional areas, machining and painting. Each of these areas represent populations within the sample, thus respondents from each functional area were chosen to provide a representative sample of their respective populations.

Research Instrument Development

The researchers chose a structured interview as the research instrument. The interview was developed in four phases: interview scope, historical data review, questionnaire development, and interview development.

Interview Scope. Three areas addressed in the interview scope are who to interview, type of interview questions and length of interview. The candidates for the interviews were:

1) Upper management of Bosma
2) Team members of M-1 Tank Ammunition Door team

Both types of candidates were chosen to reflect upper management level and team member level views. This selection facilitated an in-depth analysis which would yield widely applicable results.

The researchers chose open-ended interview questions to match the exploratory nature of the case study. Open-ended questioning allowed the respondents to elaborate on their answers and provide insight regarding significant issues which were unknown to the researcher. This method added valuable information to the study.

> Other reasons for using open-ended responses include the need to measure sensitive or disapproved behavior, to discover saliency, or to encourage natural modes of expression. (7:457)

Length of interview was determined after considering the open-ended nature of questions and time constraints of the respondents. A target length of one hour per respondent was chosen to minimize interference with respondents' schedule.

Historical Data Review. The second phase of the research instrument development was a review of existing historical data. Included in this review was an analysis of Bosma literature, the Integrated Weapon System Management (IWSM) bulletin board (BB) and inputs from the AFMC IWSM office for IPD related issues. Based on analysis of these three areas, question topics were chosen.

Question Development. The researchers developed questions using the matrix shown in Table 3.1. After identifying the major topics of interest, questions were specifically formulated to address each of the topics and provide feedback from both management and workers. Interview questions are presented in Appendix B.

Quality of Research Instrument. According to Yin, the quality of any descriptive case study may be judged by two logical tests. The two tests are summarized below:

1) Construct validity: establishing correct operational measures for the concepts being studied;
2) Reliability: demonstrating that the operations of a study - such as the data collection procedures - can be repeated, with the same results. (30:40,41)

In this study, construct validity was established by the matrix in Table 3.1. Each question used addressed a particular topic of interest. Indicators of team success were quantified when possible. If the findings are similar then the analytical

TABLE 3.1
QUESTION DEVELOPMENT MATRIX

	Management	Workers
Work Environment		
Question 1	X	X
Question 2	X	
...		
Team Organization		
Question 1	X	X
Question 2		X
...		
Motivation		
Question 1	X	X
...		

generalization is reinforced. To ensure the reliability of the case study, the researchers documented question development and interview technique to permit reproduction of the case study using the same subjects. All concepts were operationally defined to minimize errors and biases in the study.

Interview Development. The research team developed the interview after considering five areas: type of interview, interviewer training, interview technique, data recording, and non-attribution statement.

Type of Interview. The researchers used personal interviews as the primary approach. When the respondent could not be reached due to schedule conflicts, a telephone interview was performed. A personal interview was chosen since, according to Emory and Cooper,

> The greatest value lies in the depth and detail of information that can be secured. It far exceeds the information secured from telephone and mail surveys... Interviewers can note conditions of the interview, probe with additional questions, and gather supplemental information through observation. The interviewers also have more control than with other kind of interrogation... Finally, interviewers can make adjustments to the language of the interview because they can observe the problems and effects that the interview is having on the respondent. (7:320)

Personal interviews allow the researcher to note subtle changes in the respondent that convey attitudes, sincerity and interest. These factors are weighed against the responses to the interview questions.

Interviewer Training. Training of the interviewers was performed in order to minimize data gathering errors. Interviewer training involved two phases; a review of literature on interviewing techniques, and a discussion with an experienced interviewer. Discussions with the interviewer focused on the issues of consistency, bias, style, non-attribution and data recording. Practice interviews were performed to refine technique.

Interview Technique. Several key areas of interview technique were examined: dress, researcher roles, formality, motivating the respondent, probing and clarification techniques, and follow-up questions.

Each interviewer wore the USAF uniform to provide a consistent image to the respondent. The standardized appearance minimized bias in responses.

Roles for each researcher were clearly defined before each interview. One member of the interview team would ask the questions while the second took notes on respondents' remarks and behavior. To assure consistency and reduce interviewer bias, the same team member served as the interviewer throughout the study.

To provide a credible environment to the respondent, the interview was well-structured, professional, and informal. An informal atmosphere was maintained to allow the respondent to answer freely.

Motivation of the respondent is important in order to minimize bias and errors. Kahn and Cannel describe two types of motivation, extrinsic and intrinsic.

> Extrinsic motivation is used when the interviewer is perceived as a person who can bring about change himself, or he may be seen as an agent who can make some indirect contribution to a desired change. (31:45)

Extrinsic motivation was established by informing the respondent at the beginning of each interview that the data gathered would be used to help in the transition to IPD within the USAF. Intrinsic motivation is defined as:

> An individual is motivated to communicate with another when he receives gratification from the communication process and the personal relationship of which it is a part. Such motivation sometimes occurs because the interview offers the respondent an opportunity to talk about topics in which he is interested but which usually do not obtain adequate opportunity of expression.(31:46)

Intrinsic motivation was established by keeping the respondent actively involved in the interview. Open-ended questions allowed the respondent to reply in any way he or she saw fit, and encouraged elaboration on any significant points.

The researchers used probing and clarification to provide a better understanding of the respondent's answers. The researchers used probing to gain detailed information in certain areas, and clarification to define specifically the respondent's meaning or view on a topic.

Follow-up questions were used at the end of the interview only. These permitted the respondents to elaborate on secondary topics not directly related to the initial questions.

Data Recording. The researchers used tape recorders and written notes to gather necessary data. The use of tape recorders ensured a comprehensive compilation of answers, and provided a more accurate rendition of the interview than any other method. Respondents were informed that the tape recorder would only be used to ensure data accuracy, and that the tapes would be erased after completion of the research.

Non-attribution Statement. The researchers incorporated a non-attribution statement at the beginning of each questioning session to assure anonymity to the respondents. While statements may be attributed to certain functional areas, no specific persons would be identified.

Pre-Interview Procedures. A pre-interview was conducted to obtain a provisional release. The researchers discussed disguise of the study with Bosma executives and defined the purpose of the case. Interview respondents were contacted and given a questionnaire. The questionnaire allowed the respondents to prepare in advance for the types of questions which would be asked. This increased the amount of relevant information collected and improved the reliability and validity of the data.

Data Analysis Procedure

The researchers performed data analysis by developing a descriptive framework for organizing the case study. This framework provided a method to examine, categorize and evaluate all interviews. The amount of information included from each interview was limited by its significance within the topic category. Leenders and Erskine state:

> Cases must be long enough to describe the situation in real life terms. At the same time, the case writer must be selective because all the facts observed cannot be included. (32:45)

Three steps were performed in analysis of the data: data examination, data categorization, and data evaluation.

Data Examination. All recorded interviews were transcripted, examined and synopsized. Interview synopses are provided in Appendix C.

Data Categorization. The researchers categorized the data collected based upon areas addressed. All answers and comments were grouped under each of the topic areas outlined in the original question matrix (Table 3.1). This classification system facilitated analysis of the responses.

Data Evaluation. After categorization, the researchers condensed all answers and comments into the most representative issues. An issue was considered representative based on the frequency of analogous interview responses (30:102). Occasional answers which presented unanticipated, but significant, issues were also presented.

Limitations of the Design

There are several limitations to the design of the research effort. These limitations may be grouped into environmental peculiarities and research bias.

Environmental Peculiarities. Bosma implemented SDWTs in August, 1992, thus answers to interview questions represent the respondents' experiences after nine months of implementation. The results of the research should be analyzed with this in mind. The researchers wished to capture the ideas and experiences of a company in the early- to mid-stage of transitioning to an IPD environment. This approach would provide results that would be most directly applicable to Air Force organizations, the majority of which are in the early stages of IPD implementation.

Research Bias. Despite all attempts to capture all respondents' answers and contexts, research bias is inevitably introduced. According to Emory and Cooper, "there is a constant potential for response error" (7:329). The researchers may have inadvertently influenced respondents by tone, reaction, or phrasing of any follow-up questions. Additionally, researcher bias may have been introduced during data synopsis. Paraphrasing or summarizing an answer may not have captured the intent of the respondent.

Summary

This chapter presented a detailed description of the methodology of the research effort. Case study justification, sampling issues, research instrument development, data analysis procedure, and limitations to the design were discussed. The next section analyzes the results of the interviews conducted within Bosma.

IV. Results

Introduction

The chapter presents the results of all personal interviews. The first section discusses the approach taken to present the data. The remaining sections provide results grouped by research objective: Work Environment, Team Organization, Training & Education, Group Dynamics & Communication, Motivation, Measurement, and Contracts.

Interview Data Presentation

The respondents were grouped according to whether they were upper management or team members. Upper management consisted of the Vice-President for Engineering, the Chief Executive Officer, the plant manager, and the team leader. Each respondent was asked the same set of questions. Answers and comments were condensed into the most representative issues. Issues were considered representative based on the frequency of analogous responses. Occasional answers which revealed unanticipated but significant issues are also presented. A table is provided in each section summarizing the major points discussed in that section. Interview synopses are provided in Appendix C.

Work Environment

Respondents were asked to describe the working environment that existed before the use of SDWTs and the change which resulted from the switch. Table 4.1 lists the significant issues discussed.

TABLE 4.1

WORK ENVIRONMENT

Management Concluded a Change Was Needed
SDWTs Chosen Based on Management Research
Barriers to SDWTs

Management Concluded a Change was Needed. The M-1 Tank Ammunition Door project was Bosma Inc.'s first venture into a long term production contract. Previously, the company operated mainly as a job shop. At first, Bosma assigned a program manager to the M-1 tank ammunition door contract. As the project evolved, upper management concluded that the existing organizational structure had become unproductive. The program manager was overwhelmed by the level of detail associated with the project. Foremen were both running and supervising machines. There was a distinct morale problem, high employee turnover, absenteeism, and general apathy from the workers. Management decided that a change was needed.

SDWTs Chosen based on Management Research. Upper management learned about SDWTs from a consultant and conducted further research by visiting other companies. Management wanted to concentrate on improving job satisfaction as well as productivity. They concluded that a production contract lent itself to a teaming environment and decided to switch to SDWTs.

Barriers to SDWTs. Team members reported a major barrier to SDWTs was accepting the idea of acting without obtaining management approval. At first, the team members were not certain that they were fully empowered to make decisions which impacted the project. Only through encouragement from management were the team members finally convinced that they were empowered. Another major barrier reported by team members was lack of communication within the team. Team members were initially hesitant to voice their opinions for fear of retaliation. Some team members tended to dominate the early team meetings, while others were withdrawn. This problem was overcome by a change of attitude on the part of team members and reinforcement of a nonattribution environment during team meetings. A third barrier involved team members' taking the initiative to change the process. Team members were accustomed to following specific procedures from a foreman, and consequently were not motivated to improve the process. Under the SDWT structure, team members concentrated on improving, rather than simply repeating, established procedures. The use of SDWTs instilled ownership of the process within the team members.

Upper management reported a major barrier to SDWTs was releasing traditional management control over the workers. Under SDWTs, management no

longer dictated procedures to workers. Management's lack of specific knowledge of team member activities was difficult to accept, at first. As productivity and processes improved, management gained confidence in the abilities of team members to manage themselves. Another barrier was convincing team members they were truly empowered. Management overcame this barrier by encouraging team members to take responsibility and supporting their decisions.

Both team members and upper management reported the problem of lack of definition of foremen's roles during team start up. Team members were unsure of who they were to report to, the team leader or shop foreman. In addition, shop foremen believed they still controlled team members. This barrier was overcome after upper management defined clearly the roles of both team members and non-members.

Team Organization

Respondents were asked to describe how the team was organized and the roles of the team members. Also, respondents were asked to compare the level of planning required before and after SDWTs were implemented. Table 4.2 lists the significant issues discussed.

Setting Up a Team. The team was set up by upper management. Upper management mapped out the steps involved in manufacturing the ammunition doors and identified those persons qualified to accomplish each step. In choosing team members, management considered technical expertise as well as personal demeanor, with an emphasis on the latter. At the first team meeting, management presented an

TABLE 4.2

TEAM ORGANIZATION

Setting Up a Team
Roles of the Team Leader
Roles of the Team Members
Roles of Others
Project Planning Requirements

SDWT framework to the team members. Members were then asked for inputs to management's ideas. All necessary information on the project, such as schedule and costs, was provided to the team. The team members decided whether any features of the existing manufacturing process needed improvement. Management and team members then collaborated to establish the team focus and set quality and productivity goals.

Roles of the Team Leader. Team members defined the roles of the team leader as team motivator, troubleshooter, team representative to outside vendors and customers, goal setter, and facilitator. As motivator, the team leader encouraged members to continuously improve their processes and maintained the team focus. As troubleshooter, the leader worked with team members to solve any problems beyond members' control that may degrade team performance. The team leader also represented the team to the customer to address customer requirements and product

concerns. As the contact to outside vendors, the team leader ensured timely delivery of material and parts required by the team. Finally, the team leader established goals for the team and facilitated the team's progress toward those goals.

Upper management described the team leader's roles as communicator, facilitator, problem solver and motivator. As communicator, the team leader relayed ideas between team members and management. As facilitator, the team leader tackled any obstacles outside the team members' direct control. The team leader was also a problem solver beyond the scope of the project, addressing personnel issues, conducting reviews, and scheduling. Finally, as motivator, the team leader encouraged team members to deal directly with vendors and suppliers whenever possible.

Roles of the Team Members. Team members described their role as being responsible for all aspects of their job, including product quality and machine maintenance. Team members worked together and supported each other. They were responsible for bringing process and product innovations to management's attention. Team members must take the initiative to set the schedule to meet goals set by upper management, and increase proficiency by cross training. Finally, the team members must be committed to satisfying their customer, who members defined as the next person receiving their product.

Management's definition of the role of team members paralleled the members'. These roles included cross training within sections and communication amongst members. Upper management also believed team members should consider all member suggestions equally, regardless of the suggestor's status. To encourage such open

communication, the team should deemphasize the role of the individual. Both management and team members believed they could be part of more than one team if each member's primary team schedule were not impacted.

Roles of Others (Consultants, Suppliers, Customers). Though not official team members, consultants, suppliers, and customers were an important part of team activity. Consultants were used for independent evaluation of team progress and for future team training. Suppli[illegible] were made aware of the SDWT and their responsibilities to team members. These included supplying detailed information about their products to team members to enhance quality control. Customers were in contact with each team member on a one-to-one basis, and were fully aware of each team member's responsibilities. The customer quality inspector was considered an informal team member.

Project Planning Requirements. Team members reported project planning requirements were simplified due to less direction from middle management and more open communication between team members. Some members reported more planning was required because they were responsible for more aspects of their job under SDWTs.

Upper management reported more advanced planning was required under SDWTs, since all aspects of the project were considered up front, rather than incrementally as work progressed. Planning in advance decreased the amount of planning required at later stages. Some management personnel reported less planning

was now required, because under SDWTs more responsibility was being delegated to team members.

Training and Education

Respondents were asked to describe the type of training used to educate them on SDWTs, and how that training was administered. Table 4.3 lists the significant issues discussed.

TABLE 4.3

TRAINING AND EDUCATION

Type of Training Used
How Training was Administered

Type of Training Used. The primary type of technical training used for team members was on-the-job training. Team members reported that training in Statistical Process Control (SPC) was most valuable. Team members were also cross trained whenever possible. Plant, vendor, and customer tours were performed to highlight the relationship between the team, vendor, and customer. Both upper management and team members considered plant trips significant in encouraging innovation. Training evolved from being process-centered to team-centered. Team member training focused

on environmental issues such as conflict resolution, positive attitudes, and communication of ideas to the company.

Upper management first attended training in Total Quality Management and leadership principles. Management then researched SDWTs in literature and attended seminars on teaming. Finally, management visited other companies using SDWTs.

How Training was Administered. Upper management used consultants to learn about SDWTs, and gained further insight on their implementation from interaction with companies already using SDWTs. They then conducted in house training for team members on the basic principles of SDWTs and on how to hold team meetings.

Group Dynamics and Communication

Respondents were asked to describe how team members interacted, and how communication was encouraged. Table 4.4 lists the significant issues discussed.

TABLE 4.4

GROUP DYNAMICS AND COMMUNICATION

Guidelines for Team Interaction
Communication Within the Team
Barriers to Communication
Communication Between Teams

Guidelines for Team Interaction. Upper management established several guidelines for team interaction. Among these were how to run a meeting, length of the meeting, and confidentiality in the meeting room. Management stressed participation from all, and mandated that all ideas would receive equal consideration. All issues, both personal and technical, were to be addressed and resolved before the end of each meeting.

Communication within the Team. Management stressed the need for open communication within the team. Team members were taught the responsibilities they had to each other, and the necessity of continuous flow of information. Status boards were developed to allow any team member to track the ammunition doors and parts. To ensure communication in the early stages of the team, management declared weekly meetings mandatory. Team members were also encouraged to learn about each other's jobs and fill in when needed.

Barriers to Communication. Before SDWTs, real communication was not encouraged. The forced use of the chain of command filtered worker inputs to upper management, causing mistakes due to misinterpretation, and delaying decisions. Many workers complained that concerns and suggestions were not addressed in a timely manner, or were lost in paperwork. Additionally, many ideas from workers were ignored by management. The previous autocratic management style also inhibited feedback from workers for fear of retaliation.

After SDWTs, many of these barriers were overcome. Although upper management mandated open lines of communication, they still found some team

members unwilling to make decisions for fear of retribution. With the transfer of responsibility to team members, upper management found it had less specific knowledge of team member activity; however, management reported such specific knowledge was no longer necessary. Management considered formal suggestion procedures disempowering; workers would not submit suggestions unless they had reasons to believe they would be incorporated. The open lines of communication to management under SDWTs overcame this problem.

Communication between Teams. Team progress was reported to company personnel in several ways. Team information was publicized in company level meetings, and through a monthly company newsletter. The company's monthly suggestion rewards were publicized. In addition, informal communication between team leaders helped to relay lessons learned between teams.

Motivation, Rewards, and Incentives

Respondents were asked to describe the rewards, incentives, and other sources of motivation used in SDWTs. Table 4.5 contains the significant issues discussed.

Internal Team Motivation. When the SDWT concept was first introduced, there were mixed reactions from team members. Some members were highly motivated about employee empowerment and the opportunity to express themselves, while others were skeptical of the new approach. As implementation progressed and positive results realized, motivation rose across all team members. Team members reported that motivation level had remained consistently high. They cited experience as

TABLE 4.5

MOTIVATION, REWARDS, AND INCENTIVES

Internal Team Motivation
External Team Motivation
Promotion in SDWTs
Commitment to Quality
Hiring and Firing

the key to overcoming early skepticism toward SDWTs. Team members continuously motivated each other to achieve team goals. The demanding production schedule made each member dependent on another; any deficiencies in a specific area were quickly brought to the attention of all. Most team members felt confident that any deficiencies could be remedied by direct confrontation at the team level, while a few still felt hesitant to approach others personally. Some team members reported that the company-wide profit sharing policy motivated them to meet the delivery schedule with a quality product. Others were motivated by more simple compensation, such as a pat on the back or satisfaction in meeting a goal.

External Team Motivation. Upper management stated that early team attitudes toward SDWTs were mixed. Some members were highly motivated by the novelty of the concept. Others resisted due to fear and unfamiliarity with SDWTs. Team member hesitation was overcome by proof that the concept worked. Positive feedback from

customers and results of the new process placed motivation quite high. Most importantly, upper management's consistent support of the team members silenced any skepticism and proved company commitment to SDWTs. Upper management did not intervene in cases of below standard performance of team members, allowing problems to be solved at the team level. When the ammunition door team was first assembled, upper management discussed an incentive structure with team members. Due to unforeseen budget constraints, these incentives were never formally established. Many team members were disappointed, expressing disaffection over broken promises. Although no formal rewards were established at the team level, management had several ways of motivating team members. These included top pay when cross training was completed, updates of sales figures in the company newsletter and on a sales thermometer in the shop, and pay raises tied to individual performance. According to upper management, the best motivators were the team members themselves. Team members were self-motivated to do a good job, and demanded much more of themselves than management.

Promotions in SDWTs. Team members reported that SDWTs, by emphasizing the team rather than the individual, did not diminish promotion opportunities. Promotions and raises within the company were still tied to individual performance. Additionally, team members felt that there were more opportunities for recognition and advancement within SDWTs, since it is easier to be recognized in a smaller group.

Upper management stated that promotions within SDWTs would only be a concern if all members were paid equally and pay raises were tied to team

performance. Rather than a threat to power, SDWTs were credited with freeing the team leader to conduct strategic planning and support activities.

Commitment to Quality. Team members were convinced that SDWTs renewed their commitment to quality and continuous improvement. All team members understood that they were responsible for their own work as well as the whole team's product. Members' names were placed on each completed item, and pride of ownership insured the high quality of the final product.

Upper management believed that SDWTs emphasized quality to team members and resulted in significantly improved products. There were no quality control inspectors on the team; team members were held personally responsible for the quality of their product.

Hiring and Firing. The introduction of SDWTs resulted in several personnel reassignments. Some skeptical workers quit, stating that the level of responsibility required of them was too great. Others were transferred off the team but remained within the company. New workers were hired for the team as a result of expansion and increased workload. The new hires were excited about empowerment, and displayed positive attitudes about working in a team environment.

Measurements

Respondents were asked to describe measures used to assess the success of SDWTs. Table 4.6 contains a list of the significant issues discussed.

TABLE 4.6

MEASUREMENTS

Measuring Success of SDWTs
Measurement Tools
Measuring Customer Satisfaction

Measuring Success of SDWTs. In determining the success of SDWTs, upper management began with the company vision and mission statements. The vision statement was a long term goal for the company. The mission statement explained how the vision would be achieved. Management then quantified the mission statement by setting long and short term goals, and specified the measurements used to track each goal. After graphically flowcharting the manufacturing process, management chose several measures to track progress. These measures were later reevaluated to determine their usefulness. Measures determined not useful by team members and management were checked only periodically or discarded altogether.

Team members were responsible for tracking the measurements on a daily basis. Items tracked included number of rejects, productivity, quality, cost, and schedule compliance. Team members reported success of SDWTs was evident by a decrease in the number of rejects, increased productivity, and improved quality. Schedules were met and exceeded, and costs decreased significantly.

Measurement Tools. SPC was used extensively by team members to track part tolerances at each work station. Charts were reviewed by upper management to ensure

continuous quality improvement. Deviations from established standards were continuously monitored until they were no longer significant. At this point, they were measured only periodically. Other tools used by management included long term schedule charts and accounting reports. Long term schedule charts tracked compliance to the delivery schedule and forecasted the likelihood of meeting future deliveries. Accounting reports were used to show time spent on the job as well as cost and repairs. Productivity measures, such as dollars per person per year, were provided as part of the financial audit.

Measuring Customer Satisfaction. Customer satisfaction was measured through direct feedback from the customer to the team. The team established an unwritten rule to meet any customer need. The ultimate measure of customer satisfaction used by the team was acceptability of the product. Team members were not aware of any formal customer satisfaction surveys used by the company. Team members visited the M-1 Tank Plant to discuss expectations of their customer regarding the quality of the ammunition doors.

Upper management maintained open lines of communication with customer personnel in contact with team members, and measured customer satisfaction through quality surveys. The surveys were independently constructed by a consultant to avoid bias. Since implementation of SDWTs, survey results have been extremely positive. The results, although encouraging, were not helpful in identifying areas for improvement.

Contracts

Respondents were asked to describe how contracts were written, and how contractual requirements are used to track project progress. Table 4.7 lists the significant issues discussed.

TABLE 4.7

CONTRACTS

Writing the Contract
Use of Contract to Track Projects

Writing the Contract. Contracts for new projects were written by upper management. The customer provided basic specifications and management decided on specific procedures. Team members indicated they would eventually like to be involved in the contractual process as advisors, providing inputs to pricing, scheduling, and production processes.

Use of Contract to Track Projects. Not all team members were aware whether contractual requirements were used to track their project. Upper management stated that several process controls mandated within the contracts were tracked. Specifications and delivery schedules were also tracked to ensure contractual compliance, although the customer did not have specific information on how the items were being assembled.

Summary

This chapter presented the results of all personal interviews. The respondents described issues relating to work environment, team organization, training, group dynamics, motivation, measurement, and contracts. The next section uses the information discussed in this chapter to provide a generic framework for implementing integrated teams in an organization. A summary of lessons learned is also provided, along with recommendations for future research.

V. Conclusions and Recommendations

Introduction

This chapter presents a generic team implementation framework, lessons learned, recommendations, and conclusions. The framework outlines steps for initiating an integrated team based on the results of the case study. Lessons learned from the case study are then presented for both management and team members. In addition, lessons learned for the USAF IPD effort are provided. Recommendations are then provided for future research. Finally, a summary of conclusions for each research objective is presented.

Teaming Framework

The results of the case study were used to compile a generic sequence of steps for implementing an integrated team. The steps are presented in Table 5.1. A brief description of each step is provided.

Step 1: Develop vision and mission statements. Management must establish a clear vision and mission statements to give the company a strategic goal.

Step 2: Learn about teaming concept. Management must research literature, attend seminars and visit other companies to learn specific details of teaming.

Step 3: Conduct feasibility study. Management must assess the practicality of implementing teaming within the organization.

TABLE 5.1

STEPS FOR TEAM SETUP

1. Develop vision and mission statements.
2. Learn about teaming concept.
3. Conduct feasibility study of teaming concept.
4. Commit fully to teaming.
5. Sell the teaming approach.
6. Identify pilot product team.
7. Chart process to identify key team members.
8. Recruit team players.
9. Identify team leader and define his/her roles.
10. Define roles of team members.
11. Define roles of all other personnel.
12. Set guidelines for team interaction.
13. Train team members.
14. Establish motivation, rewards, and incentives program.
15. Begin team on project.
16. Cross train team members.
17. Seek continuous improvement.

Step 4: Commit fully to teaming. Once the decision is made to implement teams, management must commit fully or teaming will fail.

Step 5: Sell the teaming approach. Management must sell the teaming approach to company members. The company culture must change to accommodate the new approach.

Step 6: Identify pilot product team. Select one product to demonstrate the advantages of teaming to the company and to highlight weaknesses.

Step 7: Chart process to identify team members. The process used to manufacture the product must be flowcharted to identify all personnel involved.

Step 8: Recruit team players. Team players must be chosen based on technical competence and personality, with an emphasis on the latter.

Step 9: Identify team leader and define his roles. A team leader must be chosen from within the organization and his role clearly understood by all team members.

Step 10: Define roles of team members. All team members should be identified to each other and their relationship to the overall process should be defined clearly.

Step 11: Define roles of all other personnel. Roles of all personnel within the company who may have an impact on the team must be clearly defined.

Step 12: Set guidelines for team interaction. Establish and reinforce open communication among team members and management. Eliminate any barriers to communication.

Step 13: Train team members. Team members should be trained in the methods used for successful teaming. This includes technical training, particularly in SPC, and human relations training.

Step 14: Establish motivation, rewards, and incentives program. Identify rewards and incentives, both internal and external, that are to be used to motivate the team .

Step 15: Set team goals and begin project. Goals related to the company vision and mission must be established by all team members prior to project initiation.

Step 16: Cross train team members. Team members should be cross trained as soon as team confidence is established.

Step 17: Seek continuous improvement. Management must encourage continuous improvement of the processes and products developed by the team. This includes developing measurements to track progress of improvements.

Lessons Learned

The case study provided several lessons learned on the implementation of integrated teams. These lessons were categorized under management policies and general policies. Management policies describe recommendations specific to management, as reported by upper management in the case study. General policies describe recommendations not specific to any one group, and represent inputs from both management and team members in the study.

Management Policies

1. Management must fully commit to teaming. Anything less than full commitment by management will result in failure of the team.

2. Management can only empower team members by example. Upper management is reluctant to allow team members to be autonomous. Management must accept the fact that those closest to the work know how to accomplish it.

3. The transition of management style is difficult but essential for integrated teams to work. Under teams, management's job is to lead more and manage less. Roles of former supervisors and foremen must be redefined to avoid conflicts.

4. Executives should conduct self and peer evaluations to measure their effectiveness.

5. Flatten the organization. Management layers increase the probability of operator error. Communication through a chain of command filters out valuable information from both ends of the chain.

6. Never present rewards and incentives to team members which management cannot fulfill. Broken promises create frustration and mistrust of management by team members.

General Policies

1. Communication between all levels is a top priority. Direct communication between management, team members, and customers encourages innovation. Management and the team must consider all suggestions from team members.

2. Train all company members in teaming and human relations. Jealousy of nonteam members can be avoided by management definition of their roles in the teaming plan.

3. Training should mix members from different teams to increase organization cohesiveness. No limit should be set on education and training.

4. A baseline series of measures must be established against which the success of the teams may be gauged.

5. Choice of team members is crucial to team success. Members should be chosen based on technical expertise and ability to work in a group. Teams should be allowed to hire and fire members to maintain team effectiveness.

6. Assemble teams as early as possible. Ideally, teams should be set up prior to contract award.

7. Allow time for employees to adjust to the teaming approach. Responsibilities should be given to team members incrementally. Teaming is not for everyone. Some workers are not comfortable without direct supervision.

8. Pride of ownership improves motivation and product quality. Management should present strategic goals to workers and let them determine how to meet them.

9. Responsibilities and priorities must be defined for those who support multiple teams.

Recommendations for Future Research

The following areas are recommended for future research:

1. What are the motivation, rewards, and incentives being used by System Program Offices for their teams? How effective are they?

2. Conduct a case study of an organization with a mature team in place. Document the long term effects of teaming on an organization.

3. How have middle managers reacted to the new teaming approach? What has been the effect on their work level and productivity? How has their morale been affected?

4. What metrics do System Program Offices use to measure the success of the switch to integrated product teams?

5. How have integrated product teams been implemented in non-SPO environments? Conduct a study on test centers (Edwards AFB, Eglin AFB), Air Logistics Centers, and Air Force Laboratories.

Benefits to USAF IPD Implementation

The purpose of this research is to enhance the USAF's understanding of IPD and facilitate the transition to IPD. To enhance the USAF's understanding of IPD, the researchers provided a detailed description of the evolution of IPD in Chapter 2. To facilitate the transition to IPD, the researchers presented a generic implementation framework that may be tailored by specific USAF organizations as the transition to IPD. Policies and guidelines for successful implementation of integrated teams were also presented for both management and team members. Finally, the recommendations for future research provided will further enhance the USAF's successful transition to IPD.

Summary

This study provided a detailed report of the implementation of an integrated product team. The purpose of this research was to enhance the Air Force's understanding of integrated product teams and to facilitate their implementation. The areas addressed in the study were work environment, team organization, training, group dynamics, motivation, measurements, and contracts. The most significant findings on work environment were that the organization's leadership should commit to the teaming idea and sell it to the organization's members. Teams should be organized by choosing members carefully and defining all roles. Personnel should be trained in technical skills and human relations. Group interaction should be ensured by establishing open communication in a non-attribution setting. The greatest motivator of personnel is pride of ownership. A measurement baseline should be established at the outset against which productivity, efficiency, and morale may be measured. Finally, team members should be allowed to provide inputs to any contract which involves them.

The results of this study will be provided to the AFMC IWSM office to enhance their database on IPD implementation.

Appendix A: Definitions

AFB: Air Force Base

AFIT: Air Force Institute of Technology

AFMC: Air Force Materiel Command

AFSC: Air Force Systems Command

ASC: Aeronautical Systems Center

ASD: Aeronautical Systems Division

Bosma: Bosma Machine and Tool Inc.

CE: Concurrent Engineering

CPT: Critical Process Team

DOD: Department of Defense

FAR: Federal Acquisition Regulations

IDA: Institute for Defense Analyses

IPD: Integrated Product Development

IPT: Integrated Product Team

IWSM: Integrated Weapon System Management

M-1 Tank: Army battle tank built by General Dynamics

SDWT: Self Directed Work Team

SPC: Statistical Process Control

SPO: System Program Office

TQM: Total Quality Management

USAF: United States Air Force

USD(A): Under Secretary of Defense for Acquisition

Appendix B: Interview Questions

GENERAL INFORMATION

1. How long have you been working with Bosma?

2. What is your job?

3. How much experience do you have in your particular job?

4. Do you have any prior experience working in a team environment?

Additional Comments:

WORK ENVIRONMENT

1. How did you know a change was needed?
   - Internal drivers
   - External drivers

2. How did you decide SDWTs were the best alternative?

3. What were your top two barriers you overcame to make SDWTs work? How did you overcome each?

Additional Comments:

TEAM ORGANIZATION

1. How were the teams set up?

- Who decided? (bottom up or top down directed)
- Who decided on the team's purpose? (focus)
- What are the criteria for success?

2. What is the team composition? How was the composition determined?

3. How is the team leader chosen?

4. What are the roles of the team leader?

- Does he/she lead others to lead themselves (facilitator)? Or is he/she more directive?

5. What are the roles of team members?

6. What are the roles of consultants?

7. What are the roles of suppliers?

TEAM ORGANIZATION (cont)

8. What are the roles of customers?

9. At what point in the process is the team activated?

- Does the team start from initiation of product idea/competition? Or does team start at contract award?

10. Can you be part of more than one team at a time?

11. Is there a change in the degree of planning required for a project? If so, what kind?

Additional Comments:

TRAINING/EDUCATION

1. What type of training/education (T/E) was used to learn about SDWTs?

2. What type of T/E was used to make SDWTs work?

3. What T/E was valuable? What was less valuable?

4. How was training administered?

- Individually? As a team? In house personnel used? External consultants used?

5. Did the T/E center on the team or its environment?

6. What environment issues were addressed? Which were more pertinent?

Additional Comments:

GROUP DYNAMICS/COMMUNICATION

1. How are group dynamics handled in the team?

- Were guidelines established up front? If so, how and are they followed?

2. Was communication within the team encouraged? If so how?

- How is this different from before SDWTs?

3. Were there barriers to communication before SDWTs? If so what?

4. Are there barriers to communication using SDWTs? If so what?

5. What type of decision process is used in SDWTs?
(Team approach or individual)

6. What is the process for expressing concerns/suggestions within the team/company?

7. How do other teams learn about things that work/don't work in the team environment?

Additional Comments:

MOTIVATION/REWARDS/INCENTIVES

1. How do you ensure everyone pulls their own weight?

2. What does the team do when someone does not do their job? (free riders)

3. What rewards or incentives are used to increase productivity?
   Company level?
   Team level?
   Individual level?
   Punishment?

4. In flattening the organization are there any concerns of how you will get ahead in the new structure?

5. How do you convince those that believe SDWTs are a fad?

6. Do you feel more committed to quality as a result of the change?

7. Do you feel it will enhance quality? Why or why not?

MOTIVATION/REWARDS/INCENTIVES (cont)

8. How was motivation affected? Initially and over the long term?

9. Did people have to be let go to accommodate the change?

10. Were new people hired? If so, what was the affect on attitudes? Job commitment? Job satisfaction? Attitudes toward quality?

Additional Comments:

MEASUREMENTS

1. How do you measure success of the switch to SDWTs? (Individual teams and company)

2. What specific measurements are being performed to conclude that SDWTs are indeed successful? (Schedule, Cost, Quality of products?)

- Are you using attitude surveys of workers and customers?

3. Who develops the characteristics to measure?

- Who measures?

4. How do you know the measurements you are tracking are the proper measurements to track?

5. How do you integrate the measurements you track to the vision/goals of the company?

6. What tools do you use to manage your efforts?

7. Do you measure customer satisfaction? If so how?

Additional Comments:

CONTRACTS

1. Who writes the contracts?

Is the customer involved in writing the contract?
Is the team involved in writing the contract?

2. Are the requirements specified in the contract used to track the project?

Additional Comments:

Appendix C: SDWT Research Findings

ENVIRONMENT

1. How did you know a change was needed?

Worker Level

o Bosma directed it.
o A presentation was given.
o It was Ben's idea.
o It was a new product, untried with lots of unknowns and seemed like the best way to deal with a new product in a production setting.
o It was decided from higher ups.
o I was all for it when it happened due to previous experience. It's better than union directed.

Management Level

o A production contract seemed to lend itself to a teaming environment.
o It just came up, it seemed logical to have a team for a long term production contract.
o Morale problem, apathetic attitude, turnover rate, absenteeism. Wanted to concentrate on morale (the human element) more than lost dollars.
o Too busy to micromanage the project.
o Not enough managers to handle everything
o Overwhelmed the program manager to do the project because of the level of detail.

2. How did you decide SDWTs were the best alternative?

Worker Level

o Personal opinion.
o Didn't personally decide to be on the team.
o Previous experience.
o Better work atmosphere.
o Sounded logical.
o Liked the idea of eliminating middle management.

Management Level

o Didn't look at competing alternatives in any depth.
o Visited other companies to see how they did it.
o Knew that people had to be tied up anyway, teaming was a logical outgrowth.

o An involvement in personal development training, learned about them from a consultant.
o The process based system was unproductive (foreman had to run and supervise machines).
o Didn't know it was the best alternative, but had to try something.
o Decided to try it after reading about it.

3. What were your top two barriers you overcame to make SDWTs work? How did you overcome each?

Worker Level

o Deciding and acting without an ok from management.
o Going against the grain, meaning taking an initiative to change the process yourself.
o Conflicting definitions on supervisor roles at first.
o Communication between team members.

Overcame by:

o Team meetings.
o Just getting your feet wet and doing it.
o A personal attitude change.

Management Level

o Newness of idea.
o Communication between upper management and team members.
o Defining who was in charge at the beginning.
o Apprehensiveness on the part of team members to take charge.
o Team ability to reach a consensus.
o Convincing people that they are truly empowered and accountable.
o Getting enough funding to get the tools necessary for the team.
o Previous autocratic culture of company.
o Lack of knowledge of SDWT.

Overcame by:

o Showing people and following through with your commitments.
o Mediating team meetings.
o Encouraging members to take responsibility.

TEAM ORGANIZATION

1. How were the teams set up?

Worker Level

o Top down directed.
o People were already in place.
o Went through the entire assembly process and identified those involved. These were the team members chosen.
o Quality was more critical than timeliness

Management Level

o Top down directed.
o Team members and functions were already in place by the process.
o Team had inputs to the management ideas.
o Mapped out all processes involved and identified those qualified to be on the team.
o Management decided on the team focus.
o Goals were set in the first meeting.
o All information was provided and the team decided if it needed improvement.

2. What is the team composition? How was the composition determined?

Worker Level

o It was already in place.
o The team was made up of paint shop personnel and machinists.
o Management decided who specifically was to be on the team.
o Tracked the process and took inputs from team members.
o Comptroller used as necessary.
o Mostly constant team size, expanded as necessary.

Management Level

o Team size is constant.
o Increase hours to meet production schedule.
o Machinists and painters.
o Individual attitude (emphasized) and technical expertise considered.
o Composition determined by product.
o Ideally, teams should pick their own members through interviews and have authority to hire or fire.

3. How is the team leader chosen?

Worker Level

o Within the team, all members have equal voice.
o A program manager was already in place and familiar with all aspects of the team.
o Seniority and level of experience used by upper management.

Management Level

o Assigned by management.
o Chosen from within the organization based upon experience.
o Based on character, training, personal demeanor, education, and intelligence.

4. What are the roles of the team leader?

Worker Level

o Motivator of the team.
o Maintains team focus.
o Troubleshooter.
o Keep in close contact with outside vendors.
o Represents team to the customer.
o More a facilitator than director.
o Sets a goal and lets team determine how to achieve it.
o Administrative and schedule tracking.
o Handles "business" end.
o Never tells the team how to do something.

Management Level

o Communicator between team and management.
o Facilitator for the team.
o Allows team to make decisions.
o A tie breaker.
o Problem solver beyond project - personnel, reviews, scheduling.
o Communicates with buyer on teams behalf.
o Sets goal for the team.
o Initially, highly directive then transitions to non-directive when team is in place.
o Encourage team to deal directly with vendors and suppliers.

5. What are the roles of team members?

Worker Level

o Look for any problems and bring to the attention of other members.
o Responsible for quality of product, machine maintenance, all aspects of the job.
o Work together and support each other.
o Take care of the customer. The customer is the next person who gets the product.
o Be efficient and keep the schedule.
o Bring innovations to attention of the managers.
o Cross train.
o Set the schedule to meet goals set by upper management.

Management Level

o Cross train within sections.
o Communicate among themselves.
o Work as long as it takes to meet the schedule.
o Be a team, deemphasize the individual role.
o Consider all contributions equally, regardless of position.

6. What are the roles of consultants?

Worker Level

o No external teaming consultants used.
o Upper management conducted all team training.
o Lord Precision Machine & Tool was observed.

Management Level

o Consultants are used for training management team and personal development.
o Program manager was trained before the team.
o Went to Lord Precision to see a demonstration on SDWTs.

7. What are the roles of suppliers?

Worker Level

o Considered a part of the team but no direct contact except through the program manager or designated team member.

o Not brought into meetings but still part of overall process.
o Part of overall team.
o Informal part of the team.

Management Level

o No real supplier meetings.
o Not quite at the point where vendor talks to worker on the team directly.
o Trying to establish partnerships with suppliers.
o Suppliers may be brought in as needed.
o They are not official members per se. But are considered part of the team and aware of the SDWT setup.

8. What are the roles of customers?

Worker Level

o They are in contact with each team member on a one on one basis.
o They come in and inspect the doors.
o Informal part of the team.

Management Level

o Quality inspectors are considered a part of the team.
o Customer supplies a list of vendors to use.
o Customer knows all team members and communicates regularly (at least weekly).
o Customer knows what is happening and who is responsible for what.

9. At what point in the process is the team activated?

Worker Level

o Bring the teams together prior to contract award.
o Seek dedication from team members up front.
o As early as possible.

Management Level

o Once a team is fully developed, teams should be put together before contract award. (TAPE LEE)
o Should be started at the quoting stage as early as possible.
o Currently the teams were not started before contract award because Bosma is not paid to bid like the prime contractor.

10. Can you be part of more than one team at a time?

Worker Level

o Not very effectively. Problems splitting time between competing projects.
o Yes, no problem.
o Yes, only if primary work is complete first.
o Why not as long as you prioritize on the primary team.

Management Level

o Yes, the SDWT concept allows management to have more time for other projects.
o Yes, but if they have time and qualified/cross trained.
o Yes, but should prioritize according to team's responsibilities.
o You may work between departments to facilitate delivery as needed.

11. Is there a change in the degree of planning required for a project?
If so, what kind?

Worker Level

o More simplified due to less middle management and less communication problems.
o Less planning and all information is shared.
o More planning because you are now responsible for more aspects.

Management Level

o More planning is required because all factors are considered up front.
o Increase in up front planning decreases amount required at later stages.
o Less planning required for the upper management, planning is now delegated to the workers.

Additional Comments:

Worker Level

o Customers and suppliers should be on the team. It helps to understand the significance of certain requirements/specifications.
o Regular team meetings at first helped due to the fluid schedule and were very productive.

Management Level

o Team members feel good about being empowered to talk to the suppliers.
o There is jealousy from other non team members.
o Experts do not improve productivity, only the team can do that.
o Management must trust the team to manage time and resources.
o Ownership promotes savings. The team acts like they are paying for door materials themselves.
o A basketball team has a captain, how much does he direct?

TRAINING/EDUCATION

1. What type of training/education (T/E) was used to learn about SDWTs?

Worker Level

o On the job training.
o In house training from management.

Management Level

o None for the individual team members.
o On the job training.
o Plant visit to Lord Precision Machining Corp.
o Program managers attended a seminar on teaming.
o Books were read. The Team Handbook was used extensively.
o Learned more from interaction from people who already had SDWTs in place.

2. What type of T/E was used to make SDWTs work?

Worker Level

o Encouragement to work together from upper management.
o Emphasis on Statistical Process Control Training and quality.

Management Level

o No real classes were used to make it work for team members.
o On the job training for the team members.
o Motivational management training, teaming exercises, how to train team members.
o Management initiating team member training this summer on interpersonal skills, brainstorming, problem solving, and how to hold a meeting.

3. What T/E was valuable? What was less valuable?

Worker Level

o Statistical Process Control training was most valuable.
o Weekly status meetings for team members aided problem solving.
o Team members commented would like to receive human relations training.

Management Level

o Plant, vendor and customer tours were performed to highlight the relationship between team, vendor and customer. Direct communication with customer encourages innovation.
o Management believes classroom education may be too sterile and less valuable.
o Tom Peters In Search of Excellence considered good course. Thriving on Chaos not considered valuable.

4. How was training administered? Individually? As a team? In house personnel used? External consultants used?

Worker Level

o By in house individual to the team as a whole.

Management Level

o By in house individual to the team as a whole.
o External consultants were used to train upper management in background of SDWTs.
o Future training will mix team members with other teams.

5. Did the T/E center on the team or its environment?

Worker Level

o It was team centered and concentrated on interaction of team members.

Management Level

o Management training centered on the environment.
o Team training focused on attitudes, conflict resolution, airing ideas to the company.
o Training is initially product centered, evolving to process centered and later team dynamics.

6. What environment issues were addressed? Which were more pertinent?

Worker Level

o Communication was modified.

Management Level

o We are weak in this area presently, because not everyone in the company is in an SDWT. Although all want to become part of one.
o Emphasis on attitude adjustment, teamwork, and eliminating rivalry between members.

Additional Comments:

Worker Level

o People have to believe a difference. That they can make a change.
o Cross training is important to fill any voids.
o Some workers are uncomfortable in a free rein team environment.
o Didn't know how many people were needed on a team until work was started.

Management Level

o There is more than one way to train the teams. There is no one correct way.
o Responsibility shyness was evident.
o Apprehension in dealing with outside sources on a one to one basis.
o Team member training is scheduled to begin in June.

GROUP DYNAMICS/COMMUNICATION

1. How are group dynamics handled in the team? Were guidelines established up front? If so, how and are they followed?

Worker Level

o Stressed open communication between team members up front.
o Informal guidelines established.
o Recognize that conflicts were inevitable. Agreed to talk about them as they occur.
o Use the program manager to facilitate problems rather than to stop work.
o Eliminate the middle man by going directly to the source.
o Problems are to be addressed and solved by the group.

Management Level

o Certain guidelines were established including: How to run a meeting, length of the meeting, participation from all, emphasis of never a bad idea and confidentiality in the meeting room.
o All issues both personal and technical should be aired and resolved before the end of the meeting.
o Communication between team members was stressed.

2. Was communication within the team encouraged? If so how? How is this different from before SDWTs?

Worker Level

o Yes, highly encouraged to communicate within the team. Workers were taught the responsibility they have to each other.
o Status boards were developed to track the doors and show team members where the product was.
o Big emphasis on communication and empowerment to change things.
o Previously, members had to use the chain of command to get things changed.
o Weekly meetings were used. Team members were encouraged to learn other members jobs.
o Before SDWTs, team members operated in a vacuum without a plan.

Management Level

o Emphasized there was no such thing as a bad idea.
o Communication was mandated by mandatory meetings.
o Previously communication was done only through a mediary.

3. Were there barriers to communication before SDWTs? If so what?

Worker Level

o No real encouragement of communication.
o Communication delayed due to forced use of chain of command.
o Complaints and concerns were not addressed in a timely manner.
o Many concerns were lost in the shuffle.

Management Level

o Fear of speaking up.
o Ideas from workers were not really directly used.
o Use of the chain of command filtered out a lot of concerns.
o There were a lot of disconnects between upper management and workers.

4. Are there barriers to communication using SDWTs? If so what?

Worker Level

o Dependence on vendors impacts the schedule.
o Access to the vendors is being pursued.
o No real barriers remaining.
o Still afraid of controlling the big bucks.

Management Level

o Accounting Department involvement has provided the link between the team, program manager, and upper management, however, team members still uncertain about the bottom line.
o Upper management has less specifics of what is going on, but that is not considered important.
o Still some resistance to making decisions due to fear of retribution.

5. What type of decision process is used in SDWTs?
(Team approach or individual)

Worker Level

o Depends on who it effects.
o Individual level for lesser problems, group for larger ones.

Management Level

o The individual who is most technically competent handles the problem. If not, the program manager is used.
o At first dominant personalities took over. The process became more democratic but stronger personalities still prevailed. This area will be addressed during summer training.

6. What is the process for expressing concerns/suggestions within the team/company?

Worker Level

o Suggestions/concerns are brought up during the meetings.
o Status boards are used to bring up any concerns to the teams.
o Approach the person directly.
o If team decides on something together, they present it to the program manager, who presents it to the CEO of the company.
o Can approach team leader directly with suggestions.

Management Level

o Many ideas come up from the meetings.
o Accounting reports to upper management explain trends (eg; productivity due to a suggestion)
o Formal suggestions were considered disempowering.
o Early on (before SDWT) workers didn't feel their suggestions were being taken, so became discouraged.
o Suggestions box is checked weekly. ($25 /suggestion)
o Team is encouraged to bring up ideas to management.

7. How do other teams learn about things that work/don't work in the team environment?

Worker Level

o Publicized in company level meetings.
o No formal contact yet, but program manager would tell other program managers.

Management Level

o Newsletters published monthly.
o Through word of mouth among workers.
o Companies monthly suggestion rewards are publicized.

Additional Comments:

Worker Level

o Its difficult to track parts with the vendors.
o Would like to communicate directly with the subs on a one to one basis, rather than depend on the program manager to follow it up.
o Take comments from the team members seriously; don't just give lip service to suggestions.
o Problem with upper management allowing team members to be truly autonomous.
o Regular team meetings should still be held even if some members do not have any issues to bring up.

Management Level

o Don't bring up incentives without the intention of following through with them.
o Group dynamics evolved along with the team.

MOTIVATION/REWARDS/INCENTIVES

1. How do you ensure everyone pulls their own weight?

Worker Level

o No real problems with it.
o Team leader may pick up the slack after individual addresses another team member.
o Peer pressure.
o Can't escape notice because of heavy schedule reliance.

Management Level

o Treat the team fairly.
o Realize people want to do a good job.
o Team members are harder on themselves than management.
o Motivated people were chosen for the team.
o Its not up to upper management, its up to the teams.
o Peer pressure.

2. What does the team do when someone does not do their job? (free riders)

Worker Level

o Has not been a problem.
o Handle within the team first, if all else fails, bring it up to management.
o Confront directly.
o Call team meeting and discuss among members.
o Still feel reluctant to bring it up.

Management Level

o Its up to the supervisors not management level.
o Its all done at the team level.
o At least a small group meeting to achieve a consensus.
o One on one conferences for personal problems.

3. What rewards or incentives are used to increase productivity? Company level? Team level? Individual level? Punishment?

Worker Level

o A pat on the back.
o Team satisfaction.

o Profit sharing (company wide).
o Write ups for bad performance.
o $25 for suggestions.
o Profit sharing motivates people to meet the schedule with a quality product.
o Frustration over lack of incentives, discussed at the beginning of the program.
o Reviews and raises are individual based, nothing on a team level yet as far as raises.
o Some mistrust and disaffection over early broken promises.

Management Level

o No formal rewards, top pay given when cross training completed.
o Raises are tied to individual performance.
o Employees are praised often.
o Employees are empowered to continuously improve productivity, they are always coming up with good ideas.
o Team level gain sharing is being considered.
o Sales thermometer in the shop displays status to employees.
o Newsletter updates sales information.

4. In flattening the organization are there any concerns of how you will get ahead in the new structure?

Worker Level

o Trying to keep competitiveness down between team members.
o Stressed that all are working for a common goal.
o No real concern since raises and promotions are still on an individual basis.
o Better chance for recognition and advancement in a team, since its easier to be recognized in a smaller group.
o Teaming concept does not diminish recognition.
o Opportunities to better yourself, taking any classes.

Management Level

o Everybody is equally considered for promotions.
o Team/peer evaluation is under consideration, also company executive evaluation.
o Only a concern if all members are paid the same and pay raises are based on team performance, which they are not.
o Training people to see that power does not equate with happiness.
o Its not a threat to power for the program manager, since it frees him up to do strategic planning and support work.

5. How do you convince those that believe SDWTs are a fad?

Worker Level

o Better like it or else.
o Any company that has tried it, it has worked.
o Show concrete evidence, such as metrics.
o Solid backing from management.
o Team members will realize it works after going through the motions.

Management Level

o Action. It is important to start and continue a pilot program.
o Inform all of the organization, that's what company policy will be and keep all informed on the progress.
o Look at success of other teams.
o Set the example up top with total commitment.
o Management must lead and not manage as much.
o The top level must buy into the idea and sell it to the company.

6. Do you feel more committed to quality as a result of the change?

Worker Level

o Definitely, responsibility motivates a better quality product.
o You're responsible for your work and the whole team's product.
o Personal responsibility, your name is on the product.

Management Level

o Definitely, team is totally responsible for quality.
o There are no quality control inspectors.
o Items are self inspected.
o Upper management has always been committed to quality.

7. Do you feel it will enhance quality? Why or why not?

Worker Level

o Absolutely, because of pride of ownership of product.
o Higher emphasis on quality.
o Personal responsibility for product.

Management Level

o It will enhance quality, people want to do a good job.
o The more responsibility a person has for a job, the more involved they will be in the quality of the product.
o Contractually complied to mandate with SPC specs.
o Emphasis on getting it right the first time, not depending on the next guy to catch it.

8. How was motivation affected? Initially and over the long term?

Worker Level

o Initially low motivation because people were skeptical. As the concept progressed and results realized, motivation was high.
o Initially excited about the opportunity to express yourself and employee empowerment.
o High level of motivation at the beginning has stayed high.
o Motivation has increased significantly.

Management Level

o High motivation initially and in the long term.
o Low motivation initially. Upper management inspired the workers because they believed the workers could do it.
o Motivation increased over the long term.
o Resistance at first, due to fear. But fear overcome by proving the concept works.
o The new idea was motivating. Incentives can still be motivational.
o Feedback from customer and long term results put motivation quite high.

9. Did people have to be let go to accommodate the change?

Worker Level

o No.
o Some conflicts with functional verses team leader at the beginning.
o People reshuffled within the organization.

Management Level

o Some couldn't handle "spending the companies money." So they quit.
o Many skeptics quit.
o Some stayed in the company but left the team.

o Options given to move to another position.

10. Were new people hired? If so, what was the affect on attitudes? Job commitment? Job satisfaction? Attitudes toward quality?

Worker Level

o People hired because of company expansion.
o Excited about being in the team environment.
o More motivation to come to work and create a quality product.
o New hires are excited about empowerment and display a very positive attitude.

Management Level

o New people hired from expansion of business due to higher quality.
o People were hired by the team, for the team.

Additional Comments:

Worker Level

o Workers are more motivated on a personal level, rather than just a number in the organization.
o Higher motivation from independence, instead of constant direction.
o Give strategic goals to workers and allow them freedom in how to reach the goal.
o Must dump all paradigms.
o Large motivation comes from simple compensation

Management Level

o Current evaluation system is not reflective of individual performance.
o Should give group the power to fire any underachievers.
o Management acknowledges this is the weakest are in the company. Must tie productivity of team to compensation, not just pay.
o Must trust all team members, work with all suppliers, and have competence in dealing with vendors and customers.

MEASUREMENTS

1. How do you measure success of the switch to SDWTs? (Individual teams and company)

Worker Level

o Productivity increased significantly.
o Team members are more motivated.
o Check quality and schedule.
o Front office personnel provide production figures.
o On an individual level you see more production on the machine.

Management Level

o Profits, Attendance, and Efficiency (length of time to do a job).
o There are financial audits and productivity measures such as dollars per person per year.
o Contract requirements were surpassed.

2. What specific measurements are being performed to conclude that SDWTs are indeed successful? (Schedule, Cost, Quality of products?) Are you using attitude surveys of workers and customers?

Worker Level

o Statistical Process Control is used extensively.
o Company costs are monitored.
o Delivery schedule is tracked.
o Number of rejects.
o Material use is tracked qualitatively due to the small amounts involved.
o No attitude surveys of workers used. Just asked.

Management Level

o Productivity and efficiency specific to each area.
o No attitude surveys of workers used. Just asked.
o Customer vendor surveys are used.

3. Who develops the characteristics to measure? Who measures?

Worker Level

o SPC tracking sheets are measured by each team member at his station.

o Program manager provides schedules and goals from the contractors.

Management Level

o Upper management develops the characteristics and team members perform the measurements.

4. How do you know the measurements you are tracking are the proper measurements to track?

Worker Level

o Workers go by the specifications on the drawings.
o All measurements are viable at first, fine if they help productivity. Discard those determine not to be value added (or don't track as often).

Management Level

o Used a lot of measures in the beginning, some were paired down, some added. Determine the relationship of measure to the product/process.
o Monitor deviations until they flatten, then only measure periodically.
o Start with the engineering estimates and improve to the best possible level.

6. How do you integrate the measurements you track to the vision/goals of the company?

Worker Level

o Schedule and quality measurements follow what has been set by the contract/company.

Management Level

o Start from a vision to the mission, to goals and measures.
o Its in the company's interest to show a common goal.
o Commitment on the work team level is mirrored on the company level.

7. What tools do you use to manage your efforts?

Worker Level

o SPC is the biggest tool used to monitor the product.
o Talk of setting up self evaluations.

o Schedule is used.
o Team initiative to place tags on the doors to keep track of who, what, when to improve direct traceability.
o Feedback is used on the team level to manage efforts.

Management Level

o Team uses in house experts as consultants on problem areas.
o Scheduling and long term charts are used.
o Track the tooling being bought by the team.
o Accounting reports used to show time spent on the job, as well as cost and repairs.
o SPC used.
o Graphic flowcharting of the process by upper management.

8. Do you measure customer satisfaction? If so how?

Worker Level

o Yes, by direct feedback from the General Dynamics (G.D.) representative.
o Team has unwritten rule to meet any customer need.
o Open lines of communication ensures timely feedback.
o Team visited Lima Tank plant to see what is expected of their product.
o Ultimate measure is customer acceptance of product.
o Complaints and rejects are tracked at the office level.
o No real metrics other than memos.

Management Level

o Surveys on quality of product.
o Continuous evaluation and feedback of vendors.
o The surveys are independently constructed by a consultant to avoid bias.
o Regular trips to the Lima plant to check on the G.D. Rep.
o Plant for team members to see their product.
o C.E.O. talks with G.D. personnel in contact with the team. Surveys the sales manager and executive regarding any problems.

Additional Comments:

Worker Level

Management Level

o Team members are evaluated by the project manager (team leader).
o Current surveys are fire walled because of the high quality. Fire walled surveys are not helpful.
o There are vendor surveys but they may produce bogus results.
o Worker satisfaction survey is being planned.
o Absenteeism is not a problem.
o Most workers arrive about an hour before the supervisors do.
o Teaming frees up the managers to do more marketing, sales, etc., and concentrate on establishing the companies position in the market.
o More than profits, job pride, is a mission and company goal.

CONTRACTS

1. Who writes the contracts? Is the customer involved in writing the contract? Is the team involved in writing the contract?

Worker Level

o Upper management.
o The team would eventually like to be involved in an advisory role to submits inputs to pricing, schedule, processes, etc.

Management Level

o CEO/VP Engineering.
o Customer is involved and provides basic specifications, then company comes with the specific process.
o Eventually, would like to involve the team members in the contract proposal.

2. Are the requirements specified in the contract used to track the project?

Worker Level

o Don't know, I have not seen the contract.
o Yes, absolutely.

Management Level

o Yes, tolerances, SPC, and delivery schedule are used to track the project.
o Saw competitors products on plant trips and aimed to beat them.
o Specifications are tracked.
o Process controls are tracked due to contract requirements.
o Customer does not have specific information on how the doors are being assembled.

MISCELLANEOUS GENERAL COMMENTS

Worker Level

o Keep an open mind to all suggestions.
o Communication should be the No. 1 priority.
o Impress on the worker the right to make a decision.
o Encourage and support the worker.
o Cut out the middle man and flatten the organization. Simple tasks do not require layers of management.
o The worker knows best.
o Management layers increase the probability of "operator error".
o Choice of team members is very important. Must select motivated workers.
o Assemble teams as early as possible.
o Accept the team as the norm.
o Ensure top management backing at the highest possible level for support and credibility of the team.

Management Level

o Upper management must be able to let go of their authority.
o There must be an organization wide commitment to SDWT and team decision making.
o Should include upper management in the team meetings.
o Encourage direct communication to avoid any watering down of ideas.
o Recognize that people are reluctant to undergo such a major change. Allow plenty of time.
o The transition of management style is difficult but essential for SDWTs to work.
o Company books are now more open. Employees can see what's happened to the company and why.
o Teams are not the best option for everything, only on long term projects.
o Upfront training is vital.
o Look at other plants and see how they are doing it.
o Train 100% of the people in team work and responsibility.
o Absolutely cannot have uneducated team members.
o Should not set limits on education and training.

Bibliography

1. Lake, Jerome G. "Concurrent Engineering: A New Initiative," Program Manager, 18-26 (September-October 1991).

2. President's Blue Ribbon Commission on Defense Management. A Quest for Excellence, Final Report to the President by the President's Blue Ribbon Commission on Defense Management, June 1986. Washington: GPO, 1986.

3. HQ AFMC/EN. "Integrated Product Development and Supporting Initatives." Paper. 20 July 1992.

4. OSD/USD(A). Memorandum for Secretaries of the Military Departments--Subject: Concurrent Engineering--A Total Quality Management Process. Washington DC, 9 March 1989.

5. SAF/A(A). Memorandum for AF Acquisition Policy on Concurrent Engineering: A Total Quality Management Process - ACTION MEMORANDUM. Washington DC, 2 February 1990.

6. Dieroff, David A. and Karen J. Richter, Concurrent Engineering Teams, Volume I: Main Text. IDA Paper P-2516. Alexandria, VA: Institute for Defense Analyses, November 1990 (AD-A236093).

7. Emory, William C. and Donald R. Cooper. Business Research Methods (Fourth Edition). Boston: Richard D. Irwin Inc, 1991.

8. Walton, Mary P. Deming Management at Work. New York: Putnam Publishing Group, 1990.

9. HQ AFMC/XR. Memorandum of Integrated Product Development Philosophy and Identification of its Underlying Tenets. Wright-Patterson AFB OH, 12 January 1993.

10. Institute for Defense Analyses. Role of Concurrent Engineering in Weapons System Acquisition. IDA Report R-338. Washington: GPO, December 1988.

11. Port, Otis. "Moving Past the Assembly Line", Business Week 1992 Bonus Issue, (December 1992).

12. Womack, James P. and others. The Machine that Changed the World - The Story of Lean Production. New York: Macmillan Publishing Company, 1990.

13. Evanczuk, Stephen. "Concurrent Engineering-The New Look of Design," High Performance Systems, 16 April 1990.

14. Chase, Wilton P. Management of Systems Engineering. New York: Wiley, 1974.

15. Alberts, Henry C. "Operations Researching the Systems Engineering Process," Program Manager, May 1990.

16. Bucher, Tom, Col, SMC/SDS and Col Tom Brown, HQ AFMC/XR-WS Integrated Product Development Steering Committee. Unpublished briefing to IPD Working Group, 2 February 1993.

17. ASD/CC. "Integrated Product Development Critical Process Team Mission Statement-Lt Gen Mike Loh", 27 July 1989.

18. AFSC/ASD. "Results of the Aeronautical Systems Division Critical Process Team on Integrated Product Development." ASD-TR-90-5014 Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson AFB OH, 1990.

19. Menker, Lavern J. Deputy Chief of Staff, Integrated Engineering & Technical Management, ASC/EN, WPAFB OH. Telephone Interview. 5 March 1993.

20. ASD White Paper, Guidelines for Creating and Managing an Integrated Product Development Process, 16 January 1990.

21. ASD White Paper, Formulation of Integrated Product Teams.

22. ASD White Paper, Matrix Product/Process Staff Organization Review.

23. ASD White Paper, Business Requirements and Management Issues, 16 January 1990.

24. ASD White Paper, Information Integration Technologies, 25 January 1990.

25. ASD White Paper, Technology Transition, 25 January 1990.

26. AFMC/CC White Paper, Integrated Weapon System Management in Air Force Materiel Command, 28 January 1992.

27. AFMC/CC White Paper, Integrated Weapon Systems Management (IWSM) Model for Single Managers in AFMC, 1 November 1992.

28. Minutes of 17-19 July 1991 IPD Steering Group Meeting, 6 August 1991.

29. Defense Systems Management College. Report on the DoD Workshop on Concurrent Engineering. Washington: GPO, 1991.

30. Yin, Robert K. Case Study Research: Design and Methods. Newbury Park: Sage Publications, 1989.

31. Kahn, Robert L. and Charles F. Cannel. The Dynamics of Interviewing. New York: Wiley, 1957.

32. Leenders, Michiel R. and James A. Erskine. Case Research: The Case Writing Process. London Ont: University of Western Ontario, 1989.

Vita

Captain Paul Khuri was born on 23 May 1966 in Beirut, Lebanon. He graduated from Kinkaid High School in Houston, Texas in 1983 and attended Texas A&M University, graduating with a Bachelor of Science in Aerospace Engineering in December 1987. Upon graduation, he received a regular commission in the USAF and served his first tour of duty at Wright-Patterson Air Force Base, Ohio. He began as a Flight Stability and Control Engineer in the Deputy for Engineering in Aeronautical Systems Division, where he conducted engineering analyses on a variety of aircraft programs including the F-16, F-15E, KC-10, KC-135, and Tacit Rainbow missile. In August 1991 he was reassigned to the F-16 System Program Office as the lead handling qualities engineer, where he was responsible for integrating and planning various flight test programs at Eglin AFB and Edwards AFB. Additionally, he served as the lead flying qualities engineer for the SEEK EAGLE stores certification program and the In-Flight Refueling Probe modification. He entered the School of Logistics and Acquisition Management, Air Force Institute of Technology, in May 1992.

Permanent Address: 11807 Wink Rd
Houston, Texas 77024

Vita

Captain Howard M. Plevyak Jr. attended the University of Cincinnati in Ohio and graduated with a Bachelor of Science degree in Aerospace Engineering. Upon graduation, he received a commission in the United States Air Force by completing Reserves Officer Training School. He was then assigned to the 6510th Test Wing at Edwards AFB, California. At Edwards AFB, he worked in the 6516th Test Squadron as a stability and control flight test engineer and project test manager until acceptance into the Air Force Institute of Technology, in May 1992.

Permanent Address: 1448 Hanes Rd.
Beavercreek, OH 45434

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1993	Master's Thesis

4. TITLE AND SUBTITLE
AN INVESTIGATION OF INTEGRATED PRODUCT DEVELOPMENT IMPLEMENTATION ISSUES: A CASE STUDY OF BOSMA MACHINE AND TOOL CORP.

5. FUNDING NUMBERS

6. AUTHOR(S)
F. Paul Khuri, Captain, USAF
Howard M. Plevyak Jr., Captain, USAF

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology, WPAFB OH 45433-6583

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GSM/LAS/93S-11

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Ms Donna Milam
AFMC/XRM
WPAFB OH 45433

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
This thesis investigated Integrated Product Development (IPD) implementation issues. Research emphasis focused on teams used in IPD, particularly self-directed work teams (SDWTs). The areas addressed in the study were: Work Environment, Team Organization, Training and Education, Group Dynamics and Communication, Motivation, Rewards and Incentives, Measurements, and Contracts. Data was collected using interviews and presented as a case study. The most significant findings on work environment were that the organization's leadership should commit to the teaming idea and sell it to the organization's members. Teams should be organized by choosing members carefully and defining all roles. Personnel should be trained in technical skills and human relations. Group interaction should be ensured by establishing open communication in a non-attribution setting. The greatest motivator of personnel is pride of ownership. A measurement baseline should be established at the outset against which productivity, efficiency, and morale may be measured. Finally, team members should be allowed to provide inputs to any contract which involves them.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Air Force Materiel Command, Integrated Weapon Systems Management, IWSM, Organization Theory, Teams	110
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

AFIT Control Number AFIT/GSM/LAS/93S-11

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: DEPARTMENT OF THE AIR FORCE, AIR FORCE INSTITUTE OF TECHNOLOGY/LAC, 2950 P STREET, WRIGHT PATTERSON AFB OH 45433-7765

1. Did this research contribute to a current research project?

a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Please estimate what this research would have cost in terms of manpower and/or dollars if it had been accomplished under contract or if it had been done in-house.

Man Years _____ $ _____

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3, above) what is your estimate of its significance?

a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments

_____ _____

Name and Grade Organization

_____ _____

Position or Title Address