

FINAL REPORT

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OPTIMAL USE

of

industrial ENGINEERING TECHNIQUES

in

**SHIPYARDS**

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In behalf of  
SNAME Ship Production Committee Panel SP-8  
on  
Industrial Engineering

Under the  
National Shipbuilding Research Program

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August 1989

# Report Documentation Page

*Form Approved  
OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE <b>AUG 1989</b>	2. REPORT TYPE <b>N/A</b>	3. DATES COVERED <b>-</b>		
4. TITLE AND SUBTITLE <b>Optimal use of Industrial Engineering Techniques in Shipyards</b>		5a. CONTRACT NUMBER		
		5b. GRANT NUMBER		
		5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S)		5d. PROJECT NUMBER		
		5e. TASK NUMBER		
		5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Bldg 192 Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700</b>		8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)		
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>				
13. SUPPLEMENTARY NOTES				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>	<b>SAR</b>	18. NUMBER OF PAGES <b>37</b>
				19a. NAME OF RESPONSIBLE PERSON

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Dedicated

to the memory of

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William S. Oakes

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## PREFACE

The National Shipbuilding Research Program is sponsored by the Maritime Administration, United States Department of Transportation, and by the United States Navy toward improving productivity in shipbuilding. An important part of this Program is carried out by SMAME Ship Production Committee Panel SP-8 on Industrial Engineering. This Task was requested by the Chairmn of that Panel (James R. Ruecker, NASSCO) in behalf of the Panel members.

The Task reportai herein (8-84-4) is a continuation of an earlier Task (EC-24) to investigate the Optimal Use of Industrial Engineering Techniques in Shipyards. The engineer performing the earlier Task passed away before completing it. Continuation of the Task was awarded to R-P-M. The Task was designed to determine what IE techniques are being implemented in the shipyard coxmunity, and what sort of assistance might be needed to implement the more advanced shipbuilding techniques such as Group Technology, Flexible Manufacturing, and Accuracy Control.

The Task was conducted by Rodney A. Robinson, Vice President of Robinson-Page-McDonough and Associates, Inc. Personal interviews were conductd with several representative members of the shipyard community to gain the necessary information. Conclusions and recommendations based on analysis of the findings are included in the report. The work, under NASCO Purchase Order No. MU124547-D, began in July 1988 and was completed in August 1989.

## **EXECUTIVE SUMMARY**

This Task has investigated the nature and extent of Industrial Engineering activities currently being carried out within the shipyard community. The Task was sponsored by Ship Production Committee Panel SP-8 on Industrial Engineering under the National Shipbuilding Research Program. The Task was designed to identify the specific IE techniques being applied in the shipyards relative to the present spectrum of possibilities. That is, if the available techniques are not being applied, then ways to place more emphasis on their implementation would be addressed.

Interviews were conducted in fourteen shipyards to determine present practices. 7 large shipyards, 4 medium size shipyards, and 3 small shipyards were selected to provide a representative cross-section of the industry. Findings reveal that the large shipyards are the most active in IE matters, with the Naval shipyards heavily increasing their involvement in these techniques over the past five years. Most of the small shipyards, and many of the medium size shipyards, are declining dramatically in their attention to IE, and \_ of them now have NO Industrial Engineers left on their staffs. This is no doubt due to the depressed nature of the shipbuilding and ship repair market in this Country and the absence of a workload in these shipyards sufficient to bear the expense of keeping IE's around. This situation is truly a paradox, because the very solution to the problem of gaining those productivity improvements needed to make a shipyard more competitive in the marketplace may well be found ONLY through the effective application of IE techniques.

During the past 15 years Panel SP-8 has made many important contributions toward improving the producibility of ships. The open professional atmosphere of Panel SP-8 activities and the ensuing technical projects and discussions have proven to be an effective voice throughout the industry. Panel SP-8 will continue to treat the vital issues facing the shipyards in this Country. The advantages gained from participation in the NSRP in general, and in Panel SP-8 matters in particular, deserves the consideration of all serious members of the shipyard community who are interested in preserving and improving our industrial base.

TABLE OF CONTENTS

	PAGE
<b>BACKGROUND</b> . . . . .	1
<b>OVERVIEW</b> . . . . .	1
DETAILED DISCUSSION OF FINDINGS . . . . . begins on	4
- INDUSTRIAL ENGINEERING ACTIVITY PROFILE . . . . .	5
- NAVSEA 07 INDUSTRIAL <b>ENGINEERING</b> INITIATIVE'S <b>AND</b> ACTIVITIES . . . . .	20
CONCLUSIONS EIZOM THE <b>FINDINGS</b> . . . . .	25
RIDIMMDATIONS FROM THE CONCLUSIONS . . . . .	26

APPENDIX A - Optimal Use of Industrial Engineering Techniques  
in Shipyards - Questionnaire

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**FINAL REPORT**

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**OPTIMAL USE OF INDUSTRIAL ENGINEERING TECHNIQUES IN SHIPYARDS**

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**BACKGROUND**

In the fall of 1985, a Request for Proposal was issued by Bath Iron Works Corporation in behalf of SNAME SPC Panel SP-8 for Task EC-24, "Optimal Use of Industrial Engineering Techniques in Shipyards". The Project was designed to produce information on analytical procedures available to shipyards through increased recognition and use of industrial engineering techniques. The Project would specifically address ways in which these procedures may & used to support the implementation of advanced shipbuilding techniques such as Group Technology, Product Work Breakdown Structure, Flexible Manufacturing, and Accuracy Control.

A contract for this Task was awarded to National Steel and Shipbuilding Company. The performing engineer would be William S. Oakes, an Industrial Engineer at NASSCO. Work on the Task began in 1986, with interviews being conducted at several shipyards. During 1987, however, the performing engineer was stricken by physical difficulties, and he passed away later in the year before completing the Task.

In February 1988, NASSCO (who had since replaced BIW for Panel administration) began arrangements which resulted in the Task, now designated 8-84-4, to be completed by R-P-M. Work on this second effort began in July 1988 and was completed in August 1989.

**OVERVIEW**

The notes taken by Bill Oakes and available for examination were studied in an attempt to gain meaningful information from them. Unfortunately this effort was to no avail; the information could not be interpreted and was therefore of no use. Additional interviews with shipyard people would be necessary to gain the information needed to support the project.

The next step in performing this Task was to identify and assess the IE activities currently being carried out within the shipyard community. Based on this information, the actions needed to sort the use of these techniques for the more advanced and extensive IE applications would be studied.

Interviews were conducted with representatives from 14 shipyards. Each interview was conducted on-site and face-to-face, in order to yield the most meaningful results. Interviews began in November 1988 and were completed in May 1989. The worksheet used during these interviews is attached as Appendix A. Detailed discussion of the findings begins on page 4.

Several important factors became apparent rather quickly, and were seen as having a Major impact on the final assessments:

IE activities in the Naval shipyards were growing rapidly, and were at significantly higher levels than they were a few years ago.

IE activities in the large commercial shipyards were continuing, nearly unchanged over the past few years.

IE activities in the medium size shipyards, and particularly in the SMALL size shipyards, were at greatly reduced levels, and were falling dramatically. The numbers of IE's in these shipyards were decreasing as well, if not already reduced to zero.

The major advances taking place in the Naval shipyards is seen as coupled to the personal leadership and support provided by RADM Roger B. Home in his capacity as NavSea 07, Deputy Comander of NavSea for the Industrial and Facility Management Directorate. A separate section of this report, beginning on page 20, describes current IE activities from the SEA 07 stipoint.

The major declines in IE activities taking place in the small shipyards, and in several of the medium size shipyards as well, is seen as a direct result of the generally depressed nature of the shipbuilding and ship repair market in this Country. Shipyard management simply cannot afford the cost of overhead personnel, which is usually the category into which IE's are placed, without a reasonable workload to support this expense.

In view of the present conditions in the shipyard community and their direct impact on IE activities, it was decided to concentrate on understanding the current posture of IE efforts in the several sizes of shipyards as a reasonable reference for future improvement efforts. The findings from the interviews have therefore been arrayed in a Table (on page 5) to provide a

rapid visual. profile of current IE activities in the shipyard community. This -file should be of use to the members of Panel SP-8 in their efforts to match the output of future IE projects to the real needs of the shipyards. It shows, for example, that such 'bread-and-butter' activities as Production Planning and Production Scheduling are quite low in the lineup of current IE activities in the shipyards. This situation invites Panel attention toward improving the ability of our shipyards to perform these essential functions. It also shows that although the techniques for a large number of IE activities are understood and are presently available, that the shipyard community in general seems to be in need of specific assistance in APPLYING these techniques under actual circumstances and conditions. In many shipyards this would first require the presence of a reasonable workload on which to apply the technique.

Conclusions reached from the findings are on page 25. Recommendation drawn from the conclusions are on page 26.

## DETAILED DISCUSSION OF FINDINGS

Several categories of Industrial Engineering activities were investigated, following the worksheet of Appendix A. Basic IE activities were examined first, leading to the more extensive and involved techniques later in the discussions. The general idea was to find out which of these activities were being done AS AN INDUSTRIAL ENGINEER WOULD DO THEM. That is, if a category of activity was being done, but not as an IE would do it, the data would show "no activity". Where possible, the group within the shipyard actually performing each activity was identified, along with the extent of their involvement in carrying out that effort. It was also noted whether they were doing that activity alone, or with the assistance of some other group. This determination was complicated by the differences in organization and in organizational terminology among the shipyards. However, the general location of the activity, and the general category of person doing it, were usually clear and are reported accordingly. The results are discussed below, categorized by size of shipyard:

Large - 5000 or more people - 7 interviewed (4 Naval)  
Medium - 1000 to 5000 people - 4 interviewed  
small - up to 1000 people - 3 interviewed

The display in the Table on the next page is intended to provide a rapid visual idea of the relative intensity of IE activities within the shipyard community. Such a profile should be of interest to SP-8 Panel members during future attempts to match specific projects with the front-line needs of the industry. The individual values (number of asterisks) assigned to each IE activity has been based on the detailed discussions held at the 14 shipyards interviewed, and represents the AVERAGE intensity of that activity within that size-group of shipyards. The more \*'s, the more intense the effort in that area .

Further, the ORDER in which the individual IE activities are listed in the Table has been based on the average intensity of effort across ALL shipyards . That is, the greatest average IE intensity across ALL sizes of shipyards is in the area of Capital Investment Analysis, the top item in the list; the least intensity is in the area of Behavioral Science Application, the lowest item in the list. If the 14 shipyards interviewed can be accepted as reasonably representative of the industry, the listing provides a profile of current IE involvement in the industry as a whole.

INDUSTRIAL ENGINEERING ACTIVITY	SHIPYARD SIZE		
	LARGE	MEDIUM	SMALL
Capital Investment Analysis	*****	*****	**
Energy Management/Conservation	*****	*****	*****
Statistical Analysis	*****	****	*****
Prep/Delivery Oral/Written Rpts	*****	****	**
Accuracy Control	*****	*****	**
Methods Improvements	*****	****	**
Computer Integrated Manufacturing	*****	**	*****
Engineering Economy	*****	**	**
Human Resources Accounting	****	*****	**
Work Measurements	*****	*****	**
Tools/Standards	*****	****	**
Project Management	*****	****	
Flex Manufacturing/Automation	*****	****	*
Learning Curve Concepts	*****	*****	**
Plant Layout	*****	****	
Plant Engineering	*****	****	
Production Planning	***	*****	**
Group Technology - Flow Lanes	*****	**	
Material Requirements Planning	*****	**	*
Manufacturing Engineering	*****	**	**
Production Scheduling	***	*****	**
Economics of Production	****	***	**
Product Work Breakdown Structure	*****	***	*
Human Factors/Ergonomics	**	****	**
Computer Simulation	*	**	****
Psychology of Sales	****	**	*
Value Engineering/Analysis	***	***	*
Operations Research	**		*
Behavioral Science Application			**

INDUSTRIAL ENGINEERING ACTIVITY PROFILE

Key: The more \*'s, the heavier the involvement in this activity.

A detailed discussion of each IE activity area follows, categorized by shipyard size. Topics are discussed below in the same order as during the interviews, and as they appear on the worksheet in Appendix .4.

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**Methods Improvements**

-Large- ALL of the large shipyards except one had extensive programs for methods improvements. Generally the work was being done by Production or Production Engineering or Manufacturing Engineering, all with IE assistance. One cited an additional methods improvement study in the Material/Supply area. One was using Quality Circles for this activity. The one large shipyard without an aggressive program said "We have the information and are considering it"; there was no evidence of this, however.

-Medium- Activity among the medium shipyards was a step down from the larger ones. Here also the activity was being done by Production with IE assistance, and in one case via Quality Circles, with one shipyard citing activity only in a limited trade area.

- small - Another step down from the medium size shipyards were the small ones. Only one described an extensive program by Production with IE assistance. Another said "we have done it, and My again". A third had no program at all.

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**Work Measurement**

-Large- Four shipyards cited on-going programs with heavy involvement by IE and Production. one of these said Planning and Estimating had applied this technique on a Limited scale, and might apply it again. A fifth shipyard was doing work sampling "in conjunction with other work". Two shipyards said they had no program at all, and were not considering setting one up.

-Medium - Three medium shipyards cited heavy activity in Electrical, Production, and Quality Assurance areas, respectively, with IE assistance in all cases. One had no program at all.

- Small - One shipyard had an extensive program under IE. One said Production had tried it once, but had no plans to try it again. The third had no program at all.

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#### Tools/Standards

-Large - This was an odd category, but it revealed several points about material standards,, including equipment and tools, and some information about labor standard in general. One commercial and one Naval shipyard had no programs in either area, (with the latter not maintaining the existing labor standard that are known to exist). The two other commercial shipyards had "substantial" programs for material standards involving Engineering, but not IE. The three other Naval shipyards were into the PIERS program (Production Industrial Engineering Resource System), one heavily, one modestly, and one "not much". In the first case, Class Estimating Standards (or Bid Standards) were prepared by Planning and Estimating, by Ship Work List Item number, with IE currently assisting to set up a more "total system". In the second case, labor standards were "continually developed", and were being applied " imperfectly" by Planning and Estimating. In the third case, a "standads group" consisting of Planning and Estimating, Production, and IE, were working to produce labor standards and to make the existing ones more valid. The technique was to make use of historical data, and to use time studies only when needed to "verify the range" of a doubtful standard.

-Medium - Two shipyards had no activity at all in these areas. One had estimated standards only, 10% to 20% coverage, in "peripheral areas". One had some material standards developed by Engineering and by Quality Assurance, with "some being used" .

- Small - One shipyard had an on-going program by IE for labor standards. The other two had no program at all in either area.

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#### Learning Curve Concepts

-Large - One shipyard reported an extensive and aggressive program of applying learning curves in Production. A second said Engineering had tried it once, and might again, but that Production used it "substantially, Program Management had "constant application on-going", and IE was using this technique extensively and was seeking even wider application. A third shipyard

said Planning was using the technique on whole ship performance (lead, follow, follow) . A fourth said there were problems using it because their workforce was not constant. A fifth said they were into the Conway methodology, but they were "too busy" for learning curve applications. The sixth said they had the information in IE and were considering it. The seventh said "No. We never learn!".

-Medium - Two shipyards said that they found the technique useful for ship-to-ship projections, the first in the Finance/Comptroller area, and the second in Planning, Estimating, and Scheduling. A third said that the Director of Manufacturing was using the technique "substantially". The fourth said that the whole shipyard had been "tuned in on WC", but that the supposition that workers could be hired "anytime off the street" proved to be disastrous in actual practice.

-Small - Only one shipyard had any program going, and that was in the Estimating area where the initial curve turned out to be "too steep".

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#### Manufacturing Engineering

-Large - Four shipyards reported extensive programs, two in Production, and two in IE. A fifth shipyard cited a Manufacturing Engineering group carrying out an extensive program with IE assistance. Two others had no programs at all.

-Medium - Only one of the four shipyards had applied these techniques on a limited scale, and might again. That one was in Engineering but "driven by Production".

- Small - Here, also, only one shipyard had a "substantial program" in Production with IE assistance. The other two had "nothing".

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#### Production Planning

-Large- The picture on this item was mixed. Two shipyards each reported an extensive and aggressive program in Production. A third said "we have nothing". A fourth was "just beginning" to try group technology in one shop". A fifth reported they had "bits and pieces, here and there". The sixth said IE's were now on the project team for Shipalt planning (only). The seventh

said "It depends on what the Shop wants. Some do it heavily themselves; others not. Planning and Estimating 'tempers' their output to the Shop's desires".

-Mediun - One shipyard said that their program was under the production and Inventory Control Manager, and that it was extensive. The second had a program "done by one man, using Multiplan, on-line, in several 'layers', and interactive". The third had tried it once with Planning and Scheduling, and "that turned out OK by trade, but lousy by the whole shipyard". The fourth had nothing.

-small- One small shipyard said "we do it, but not the IE way". Another said "Central planning does it, and then detailed planning is done by Production". This same shipyard rated himself as "O", however, in the overall. The third shipyard said that Production had tried it once, but probably would not try it again. He said that the Master Plan is published "once or twice", but added "They (Planning) go their own way".

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#### Production Scheduling

-Large- Four of the shipyards said that they have NO effective activity here. One added "It is still the same". The fifth shipyard said that his schedules follow the desires of the Shops. The sixth said that the Program Office publishes the first tier (Key Events), and that the second, third, and fourth tiers are published by a Production Planning and Scheduling group; he saw his program as aggressive and effective. The last shipyard reported that they do it all in Production, and that their system is extensive and good.

-Mediun - Here, as with Production Planning, one shipyard said that their system was under the Production and Inventory Control Manager, and that it was extensive. The second had a program done by one man, using Multiplan, on-line, in several 'layers', and interactive. The third had a system under Planning that was "substial". The fourth had nothing.

-small- One small shipyard said that their system was under Planning. A second shipyard said that Planning did the broad schedule, and then Production did the rest, but "not the IE way". The third simply said "we don't do it the IE Way".

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Plant Layout

- Large - The large shipyards all reported heavy activity with this item, although the specific groups involved differ among the shipyards. Three cited efforts by the IE group acting alone. The fourth shipyard had the activity located the in IE group, but with Production input and involvement. The fifth shipyard stated that the work was done by Production Engineering with assistance from IE and Production. The sixth shipyard said "Facilities/Public Works carries out what Production Engineering develops with Production assistance". He noted that there are IE's in both the Facilities/Public Works group and the Production Engineering group. The seventh shipyard did it all in Facilities/Public Works, with no mention of whether that group contains IE's.

-Medium - Two out of four shipyards had activities in this area, one by IE's acting alone, and one by IE's working in a team fashion with Production and Facilities/Public Works. The other two had nothing going on.

- Small - Each of the three small shipyards had no activity in this area.

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Plant Engineering

-Large - One shipyard stated that he had a Plant Engineering Department to handle this area. A second shipyard said Facilities/Public Works did it. The next four said IE's handled this area, with one shipyard stating that Facilities/Public Works was also involved. The seventh shipyard had no program in this area.

-Medium- Two shipyards reported activity with this item, one by the IE group and one by the Facilities/Public Works group. The other two shipyards had nothing going on.

-Small - All three shipyards had no activity in this area.

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Project Management

-Large- Two shipyards reported extensive programs in this area, one with a separate group under Operations for this purpose. A third shipyard said that the IE group handles this area, with Production Engineering just getting into it. A fourth shipyard reported ship management under Planning, with plant

projects under the IE group. The fifth shipyard said "We do project management, but the Navy way, not the IE way". The sixth reported their IE activities in this area as confined to hazardous waste, and not for ships. The seventh admitted to extensive involvement by the IE group, but explained that this area is done by a committee with Production in charge; the IE on the committee is "influential, but NOT in charge". He admitted that the influence by the IE was "vital" to the success of the program, but insisted that this did not mean that the IE must be "in charge".

-Medium - One shipyard had an extensive program under a Project Management group. A second shipyard reported a "substantial" program in Engineering. A third admitted that they kept track of the money spent vs. planned to be spent, and the number of plans issued vs. planned to be issued, but that they had no idea of the impact of changes and rework on their operations. They did not publish their findings routinely. The fourth shipyard had no activity in this area .

-small - There was no reported activity in this area in the three small shipyard.

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#### Preparation/Delivery of Oral/Written Reports

-Large- This area received mixed reports. One shipyard had "extensive" programs in Production, Production Engineering, and Engineering. A Second shipyard had "substantial" programs in Engineering, Planning, Estimatings Production, Project Management, Quality Assurance, IE, and Facilities/Public Works. Three others had "nothing, but it would be helpful". Conway was mentioned in the sixth shipyard, and Hicks in the seventh. The seventh also reported that Quality Circles had procedures on how to report/present/etc. He also noted that certain of the promotion announcements in his shipyard routinely include a paragraph requiring examples of ability in technical writing and presentations.

-Mediun - One shipyard had an on-going program in Production, Project Management, and IE, where clearer-writing workshops were attended under sponsorship of OPM. 1/3 of their staff had already attended. A second shipyard said that their Project Management group had a "substantial" program. The two other shipyards had no activity in this area.

-small - Only one shipyard had a "substantial" program in the IE group. The other two reported no activity.

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Computer Simulation

- Large - Considerable computer activity was reported, but not much real computer simulation. Production was using computer driven machines in most shipyards, with some computer usage noted in Planning and IE for various types of status reports. Personal computer usage was seen as growing in popularity, especially in the Naval shipyards. One shipyard said that computers were being used for some mockup work, but that there was insufficient confidence in computers to "go it alone".

-Medium- One shipyard reported computer extensive simulation in Engineering and in Planning. The other three had no activity.

- Small - One shipyard reported "substantial" computer simulation in Engineering. The second shipyard found "not much need for it", but cited considerable computer usage for certain calculations, financial applications, estimating, and environmental work relating to warehousing and inventory management. The third had no activity in this area.

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Psychology of sales

- Large - One shipyard reported on a Marketing Group that handles business development on a "limited scale". A second shipyard had activity in the area of Manufacturing Engineering where a separate group handles new business sales and development on a "substantial" basis. A third shipyard had "limited" IE activity in promoting foundry business via a brochure of capabilities. The other four had no activity to report. One Naval shipyard added a cement that their new business depended more on the "posture of the Shipyard Commander than on a formal proposal".

-Medium- One shipyard reported that a group called "Business Affairs" does their sales promotion. The other three had no activity in this area.

- Small - One shipyard cited a program on a "limited" scale, but added "everybody at (this shipyard) is in sales". The other two had no activity.

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-large- Six shipyards reported "limited" programs, five in IE, and one in Engineering and Production. One of these, a Naval shipyard, added "we wage constant warfare here". A seventh said Engineering and IE both had "constant application on-going".

-Medium - Only one shipyard had activity in this area, and that was "constant and on-going" in Production for steel, Material/Supply, and Facilities/Public Works. The other three had no activity.

- Small - One shipyard cited "substantial" programs, 30% in Production and 70% in IE. The other two had no activity.

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#### Economics of Production

Large - Two shipyards reported "constant application on-going", one in IE and the other in Production. Two other shipyards cited "limited" activity in IE. The remaining three had no activity.

-Medium - Only one shipyard reported "limited" effort in Engineering, Production, and IE. The other four had no activity.

-Small - One shipyard said some activity in this category was present during methods improvements work, but not with a pure financial focus. The other two had no activity.

#### **Committee, Panel 023-1 (Surface Preparation and Coatings).**

##### - Management and Conservation

-Large- Five shipyards reported extensive programs in Facilities/Public Works areas, with two of them noting IE involvement. A Sixth shipyard had "substantial" activity in Production Engineering. The seventh shipyard had no activity in this area.

-Medium - Three shipyards cited extensive programs under Facilities/Public Works. The fourth shipyard had no activity.

-small- Two shipyards had activity under Facilities/Public Works, one "limited" and the other "extensive and growing". The third had no activity.

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**Value Engineering and Analysis**

-Large- Only one shipyard reported an extensive program in this area, carried out by a separate group under Engineering. Two other shipyards had "limited" programs, one in Engineering with assistance from Material/Supply and IE, and the other under IE only. A fourth shipyard was "trying to get going again in Engineering, with IE help". Three other shipyards said that this area was "dead".

-Medium - One shipyard had a "limited" program involving Engineering and the Paint area of Production. The other three had no activity.

- Small - One shipyard cited a "limited" program in IE. The other two had no activity.

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**Capital Investment Analysis**

-Large - All seven shipyards reported extensive programs in this area, five placing the activity in IE, one in Facilities/Public Works, and one in Marketing.

-Medium - All four shipyards reported extensive programs in various locations, including IE, Production, Facilities/Public Works, Program Management, Welding Engineering, and in Informdion Systems where all requests for computer equipment were handled.

- Small - One shipyard cited a "limited" program in IE. The other two had no activity.

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**Human Resources Accounting**

-Large- Two shipyards reported aggressive and extensive programs, one in Production and IE, and the other in Production only. A third shipyard cited a modest program in Engineering and in Planning, but nothing in Production. Three other shipyards said there was isolated activity, such as occasional workload forecasting by shop (but not by trade or individual worker), with two of them Commenting that their Industrial Relations group SHOULD be active in

this area, but was not. The seventh shipyard had no activity.

-Medium - Here the picture was a bit different. One shipyard reported an extensive program in this area under Industrial Relations. Two others had separate groups involved in this area, one under the Director of Manufacturing and the other under a separate position Management Board. The fourth had no activity.

- Small - One shipyard reported a "limited" program under Industrial Relations with IE assistance. The other two had no activity.

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#### Human Factors/Ergonomics

-Large - Only one shipyard reported a "substantial" program under Facilities/Public Works. A second noted some activity as a part of OSH protective guards on machines, etc., but essentially the other six shipyards had no activity.

-Medium - Two shipyards reported "limited" activity, one in IE, and the other in Engineering and in Quality Circles. The other two shipyards had no activity.

-small- One shipyard had "limited" activity in IE. The other two shipyards had no activity.

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#### Behavioral Science Application

-Large- All seven shipyards reported no activity. One Naval shipyard made a particularly cogent comment, however. That comment was "Entering data via a (computer) terminal is more palatable to a mechanic than by doing it by paper and pencil - which he is not good at".

-Medium - All four shipyards reported no activity.

-Small- One shipyard reported on a "substantial" program being carried out by a consultant. The other two had no activity.

+++++

Flexible Manufacturing/Automation

-Large- - shipyard reported an extensive program in IE, but the "rest were being carried along". "Cells" were in place or under active treatment in three of the four Naval shipyards. Perhaps the most successful one attributed that fact to "a strong Production commitment, with IE assistance - that is, Production gets all the carrots". A Sixth Shipyard had an Advanced Technology Group in Engineering where a "substantial" program was active, and also reported a "limited" program in Facilities/Public Works with IE assistance. The seventh shipyard was just beginning a program in the welding engineering area of Production.

- Medium - One shipyard had a "limited" program in Production with CNC machines. A second shipyard was planning a program in Production, also with CNC machines. The other two shipyards had no activity.

-small - One shipyard had looked at the information, but had no application planned. The other two shipyards had no activity.

+++++

GroupTechnology/Flow Lanes

-Large- One shipyard cited an extensive program in Production. A Second shipyard had "constant application on-going" by IE, with the "rest being dragged along". A third shipyard reported a "limited" program in Manufacturing Engineering. Two other shipyards had "limited" programs in specific areas, such as in one Production Shop. One of these shipyards noted that kitting activity was going on within a 'cell', which he felt was an adaptation of this technology. The other two shipyards had no activity.

-Medium- One shipyard reported an extensive program in the steel area of Production. The other three had no activity.

-small- All three shipyards reported no activity. One of them noted that "We have to shift gears quickly, so this technology does not suit our needs. We are not on a three-year cycle".

+++++

Product work Breakdown Structure

-Large- One shipyard reported an extensive program in Production. A second Shipyard had a "limited" program in Planning. A third shipyard was considering the information in Planning and in Estimating, but had not tried to apply it anywhere as yet. A fourth shipyard had 10% of their work under the PWBS. A fifth acknowledged that they had used this technique, but that : "we had to convert to SWBS for internal shipyard consumption". The other two shipyards had no activity.

-Medium - Only one shipyard reported an extensive program in Planning, supported by Engineering and Production. The other three had no activity.

-small - One shipyard was considering the information in IE, with "application planned". The other two had no activity.

+++++

**Accuracy Control**

-Large - Two shipyards reported extensive programs in their Accuracy Control Groups, one located under Production, and one locatal under Production Control . A third shipyard reported that Engineering and Production were both considering application of this technology. A fourth shipyard reported on a process called Quality Measurement Tracking, where each shop has a Quality Improvement Technician who focuses on high cost work items toward lowering the cost of the more expensive items. Pareto charts are utilized to identify those areas where the largest savings can be realized quickly. At the same time, a database is being assembled toward identifying and correcting the basic causes of the high cost elements. The other three shipyards had no activity.

-Medium - All four shipyards reported activity in this area. One had an extensive program in IE. A second had a "substantial" program in Quality Assurance. A third had a "limited" program in Production for the steel area. The fourth had the information under active consideration in the Production/Industrial Management area and was planning application of it in the near future.

-small- One shipyard reported a "limited" program in IE. The two other shipyards had no activity, with one of them noting "We had some when our IE's were here".

+++++

Statistical Analysis

-Large- Four shipyards reported major applications of this technology, with two other shipyards "just beginning". The locations where this activity was being carried out were (heaviest to lightest) Production, IE, Quality Assurance, Engineering, Material/Supply, and Industrial Relations. In the latter case, pre-employment tests were being analyzed relative to EEO in order to ensure that they are not biased. The seventh shipyard had no activity because "there is no data" to support such analysis.

- Medium - One shipyard was attempting to apply this technology to performance returns, in order to find the percentage of effort in each stage of construction. It was also being used to validate rates for production performance, determine "how well we are budgeting functionally against performance", and to "compile scheduled performance by work package in numerical terms, even though we are not really organized statistically". A second shipyard was using this technology for "simple analyses" in the Quality Assurance area. The other two shipyards had no activity, although one of these noted "some limited across-the-board usage via Quality Circles".

-Small- One shipyard reported "constant application on-going" within IE in several areas such as material procurement, production performance, and accuracy control. A second shipyard cited "substantial" application in the Program Management area to analyze for hardware trouble spots and software problems. The third shipyard had no activity.

+++++

Computer Integrated Manufacturing

- Large - Two shipyards reported extensive programs, one in Production and one in Engineering. A third shipyard reported "substantial" programs in Engineering, Production) and IE with an active "cell" using computer integrated manufacturing techniques. Three other shipyards also had active "cells". The sixth shipyard had no activity.

-Medium- Only one shipyard was considering this information in Engineering. The other three shipyards had no activity.

-Small- One shipyard had a "substantial" program in Production. A second shipyard noted some CAD/CAM activity. The third shipyard had no activity.

+++++

## Operations Research

-Large- One shipyard had used these techniques in designing a warehouse, determining the number of loading docks, etc. A second shipyard said that IE was planning application in the near future. Two other shipyards had studied the information, one in Production and one in IE, but neither intended any application. The remaining three shipyards had no activity.

-Medium- No activity in the four shipyards.

-Small - One shipyard reported "limited" activity in Production and in IE. The other two shipyards had no activity.

+++++

## Material Requirements Planning

-Large- Four shipyards reported extensive activity in this area, two in IE, one in Material/Supply with IE assistasnce, and one in Engineering and Production. A fifth shipyard reported "substantial" activity in Production Engineering. This fifth shipyard added that they have a separate MRP group under Planning, but that the reports published by this group "are ignored by Production". A sixth shipyard reported "limited" activity in Planning and Estimating, Production, and Material/Supply, with IE "tying them all together via the IE's assigned to the Production/Group Offices". This latter effort was associated with a major "kitting" effort for a specific ship. The seventh shipyard had no activity.

-Medium- Only one shipyard had a "substitial" program underway, with Planning, Scheduling, Material/Supply, and IE all working together. The other **three shipyards had no activity. One of those with no activity commented that** "This is not a wealness. If we had a constant on-going flow of material, then MRP might be needed".

-small- One shipyard was planning application, with current activity in IE. The other two had no activity.

## **NAVSEA 07 INDUSTRIAL ENGINEERING INITIATIVES AND ACTIVITIES**

Within Naval Sea Systems Command Headquarters, the Industrial and Facility Management Directorate, SEA-07, has recently taken an aggressive role in establishing and promoting Industrial Engineering activities throughout the Shore Establishment. Under the vision and leadership of Rear Admiral Roger B. Home during his tenure as Deputy Commander of that Directorate, and with the dedicated efforts of the Industrial Engineering and Planning Division, NavSea 070, and the support of the Naval Shipyards, important contributions to the posture of Industrial Engineering in the Navy have accrued during the past five years. These contributions are worthy of separate discussion in this report, and are enumerated below.

Special note: In view of his contributions to the area of Industrial Engineering, RADM Home was selected by the Institute of Industrial Engineers to receive their 1988-89 Award for Outstanding Achievement in Management. The Institute has also presented an Award for Excellence in Productivity Improvement to Norfolk Naval Shipyard in recognition of the advances that have taken place there recently.

A. The Naval Industrial Engineering Steering Group (NIESG) has been established. This group is composed of the Code 380's from the Naval Shipyards and SEA 070 personnel. Meetings are held three to four times a year at various locations, sometimes in connection with a Symposium or a SNAME Ship Production Committee Panel meeting, or a similar industry activity. The NIESHG meetings have a regular agenda, and include formal presentations, problem solving sessions, discussions of actual items developed, and sessions on related IE topics. The Chairman is rotated among the principal attendees, and is usually a Code 380 from a Naval Shipyard.

- An important Subcommittee of NIESG was established to develop a plan for improving IE in the Naval Shipyards. This action was taken as a direct result of a briefing provided by SPC Panel SP-8 participants for RADM Home on recent accomplishments in the IE area. A field trip and briefing of the NIESG at Peterson Builders Inc. in Sturgeon Bay, Wisconsin, followed shortly thereafter, which RADM Home attended and personally directed. A select Subcommittee of six NIFSG members was then established and charged to develop a plan for improving IE in the Naval Shipyards, consistent with SEA 07 policy and recommendations. The findings of this Subcommittee have been published and are being pursued.

B. An Annual Naval Shipyard Industrial Engineering Symposium has been established. The first one was held in Washington, D.C. The second was held at Mare Island Naval Shipyard. The Symposium is designed to promote IE visibility and to establish IE credibility throughout the Naval Shipyard complex.

C. An Annual NavSea Shipyard Industrial Engineering Award has been established. This award consists of a monetary grant and considerable publicity for the winner. The contest is open to the Supervisor of Shipbuilding community also. The names of all Nominees are published along with the person selected for that year, since it is a distinct honor even to be nominated for this award. Scotty Afong from Pearl Harbor Naval Shipyard was the first winner this year.

D. The Code 380's in the Naval Shipyards have been requested to change the name of their Division from the Production Engineering Division to the Industrial Engineering Division, and to call the Head of this Division the Chief Industrial Engineer. Most have done so. This name change is intended to focus attention on the IE nature of the efforts carried out from this location.

E. Industrial Engineers from the Naval Shipyard Code 380 groups are being physically and permanently located in the Production Group Offices and Shop Offices. This action is designed to gain the acceptance by the Production Group and Trade Superintendents of these IE personnel and the activities in which they are involved. This is promotion of IE by actual observation and practice, and it has already proven to be effective in most locations.

F. The curriculum of the Naval Officer Engineering Duty School in Monterey, California, now includes a 2-hour class on "Introduction to Industrial Engineering", with emphasis on the Naval Shipyards. The instructor is a senior IE from either SEA 07 or a Naval Shipyard. This continuing training serves to acquaint the students with this important activity early in their careers.

G. A three-pronged training effort is being applied within the Naval Shipyards: training for IE resources; training for non-IE resources (such as Production Superintendents, Schedulers, etc.); and improvement of the Production/IE/Training interface. One Shipyard has taken on the task of treating this area in behalf of all the Naval Shipyards and SEA 07. The individual involved stays in touch with needs, current information/programs available, and which actions are working out well within the industry.

H. The production Industrial Engineering Resource System (PIERS) has been established. This system, an extension of the "CATS" system of Computer Aided Time Standards familiar to many, provides the Naval Shipyard complex with an in-house time standard database. It has been expanded to include tools and devices to aid the industry, and not only time standards. It will include simulation packages and similar state-of-the-art "tools" for IE use in improving shipyard capabilities.

1. The PIERS Quarterly Newsletter has been established. This publication is a voice of IE in the Naval Shipyard complex, which includes NavSea and the Ship Repair Station, Subic Bay. This newsletter began three years ago, and has a wide (unclassified) distribution to all levels. It focuses on products, processes, activities and improvements in the IE area. Articles are chosen from those submitted by many members of this community throughout the country, based on projected interest and benefit to the readers. Much information and many ideas have been shared through this effective channel.

J. A system has been established to identify and treat high cost ship work items. These 'high cost SWLINS' are individually targeted for examination and improvement. A person is assigned within each Naval Shipyard to be the focus of this effort, which is considered by many to be the location where the biggest potential payoff resides.

K. A Quality Measurement and Tracking System ( QM&T ) has been established. This is a NavSea system for statistical process control. It is being implemented in the Naval Shipyards toward improving performance.

L. The Production Management Information system (PROD MIS) is being developed. This is a management information system that is starting from ground zero to develop what Production managers within the Naval Shipyard complex truly need.

M. Class Estimating Standards (CES ) are being developed for submarines. These standards address large packages of work, and the resulting costs as estimated at each Shipyard. They are "SWLIN-level" standards based on return costs by various performers. A team (mostly Planners and Estimators) within the shipyard develops the CES, after standardizing the base work package content. This provides a Target for performance. The next step may be to do the same thing at the Key Operation level, bottom up, and then aggregate back to the SWLIN level. Further, the CEs can be merged with the high cost SWLIN program, which may enhance corrective action by the shipyards.

N. The CS<sup>2</sup> system continues to be used in many locations. This technique has been an effective tool, especially when properly interfaced with IE.

O. SEA 07 representatives regularly attend trade workshops for shipyard personnel (e.g. Paint Superintendents). As a member of SEA 07 put it, "These people are the primary customer of SEA 07, and as such need to understand what the Headquarters activity can do for them. We can tell them what we think they need to know about us, and learn from them what they want to have done so that things will improve". The presentation by SEA 07 regularly contains a resume of functions and capabilities, along with a mission statement and how it is to be carried out.

P. SEA 07 personnel are authoring articles for IE magazines and journals, This continuing action is designed to keep IE in general, and within NavSea in particular, in proper focus throughout the industry.

To Summarize the above, SEA 07 has demonstrate a profound interest in, and appreciation for, effective Industrial Engineering within the Naval Shipyard complex. The shipyards, in turn, are responding with enthusiastic and effective programs. All of this activity has occurred quite recently, and promises to grow dramatically in the near future. This is a most favorable harbinger of IE impact throughout the industry.

When asked about their future focus, a SEA 07 representative responded rather promptly with "We have levelled off on expansion and growth, and now have our focus in application and performance". This same person defined the "primary deficient area" as a lack of labor standards and their application for planning and scheduling. He added, "The biggest need is for industrial strategic and operational planning from the shipyard standpoint. This whole area is where IE's can help, but have not been real effective as yet. We must get 'acceptance' of IE first, then we can gain (their) confidence that bigger things can be tackled by IE's. We have pushed shipyard managers up the production application hill (with work sampling, process improvements, etc. ), we an build a plateau with labor standards, and then in a year or so start up the management and strategic planning mountain".

Although not specifically tied to SEA 07, there are two other actions that have taken place recently that bear on IE within the shipyard industry, and should be mentioned here. The first was a 1986 Executive Order by President Reagan to establish Federal Government Productivity Improvement. This program set a goal of 20% improvement in 5 years (by 1992). In 1988, another Executive Order called for annual improvement of 3% per year ( for continuous

improvement). This rippled through all Departments. The Navy answer was treated via a Performance/Productivity Improvement effort, one element of which is Productivity Gain Sharing. This Navy initiative includes a newsletter and an awards arrangement. SEA 07 is actively involved in this program. The second action is a Model Installation Program. This program is throughout the Department of Defense. It attempts to show "the way it should be done", and also infuse sense into the waiver world". Surely, IE has an important role to play in this effort.

## **CONCLUSIONS FROM THE FINDINGS**

IE activities within the Naval shipyard community are increasing rapidly and show promise of becoming major advantages for the prosecution of shipyard work. Current NavSea 07 involvement and support is both appropriate and effective. The placement of shipyard IE's in the Production Group/Shop Offices appears to be beneficial to both parties, and bodes well for future application and development of IE techniques in these areas.

The more 'traditional' IE activities are continuing in the large shipyards (Capital Investment Analysis, Plant Layout, Plant Engineering) along with a few of the newer activities (Statistical Analysis, Computer Integrated Manufacturing, Flexible Manufacturing/Automation) . These activities are proceeding satisfactorily in these shipyards despite differences in organizational location of the IE efforts involved.

Although extensive information exists concerning several other new and more sophisticated techniques (Group Technology - Flow Lanes, PWES, Computer Simulation), the shipyard community generally needs help in applying these techniques under real-world circumstances. It is unlikely that application of these known and presently available techniques will take place in the shipyards without 'outside;' assistance.

IE activities in the small and medium size shipyards are declining. Many of these shipyards currently have no IE personnel left on their roles. The declining IE posture in most of these shipyards appears to be a direct result of the depressed shipbuilding/ship repair market conditions in this Country, and it is unlikely to change unless these conditions improve.

All shipyards are paying too little IE attention to the mainstream demands of Production Planning and Production Scheduling. These functions are absolutely essential to shipyard operations and must be done efficiently and effectively for a shipyard to be productive, and therefore competitive in the marketplace.

## RECOMMENDATIONS FROM THE CONCLUSIONS

The members of Panel SP-8 should consider the current profile of IE activities when deciding on future projects, so that results will properly mesh with the real needs of the shipyard community. In this regard:

Immediate attention should be directed at improving the application of IE techniques for Production Planning and production Scheduling.

Attention should be directed at providing assistance to the shipyards for application of the newer and more complex techniques currently not being applied in the shipyards.

The members of Panel SP-8 should study the currently depressed market conditions facing most of the shipyards, and investigate ways to alleviate or correct their basic causes.

Overall, the focus of Panel SP-8 for the immediate future should be on the APPLICATION and development of the IE techniques that are currently available to the industry.

APPENDIX A

Optimal Use of Industrial Engineering Techniques in Shipyards

+ + +

QUESTIONNAIRE

TASK 8-84-4  
(formerly EC-24)  
OPTIMAL USE OF I. E. TECHNIQUES IN SHIPYARDS  
- - -  
QUESTIONNAIRE

Shipyards Coded I dent \_\_\_\_\_

Note: Shipyard identity will not be revealed in the published report.

General Information

Shipyards Name and Location \_\_\_\_\_  
\_\_\_\_\_

Main Person Contacted \_\_\_\_\_

Position/Title \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_ Phone Number ( ) \_\_\_\_\_

Shipyards Size (#) \_\_\_\_\_ Production **Workers** (#) \_\_\_\_\_

Total Planning Personnel (#) \_\_\_\_\_ I.E.'s (#) \_\_\_\_\_

Ship Types \_\_\_\_\_  
\_\_\_\_\_

New Construction (Y/N) \_\_\_\_\_ Repair (Y/N) \_\_\_\_\_ Union (Y/N) \_\_\_\_\_

Current Workload Size \_\_\_\_\_  
\_\_\_\_\_

Other Persons Contacted \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Shipyard  
Code \_\_\_\_\_

IE ACTIVITIES

SHIPYARD DEPARTMENT

Not Applicable / Key

Engineering

Planning

Estimating

Scheduling

Production

Project Mgmt

Material/Supply

Quality Assurance

Industrial Engineering

Industrial Relations

Information Systems

Facilities/Public Works

Maintenance

Finance/Comptroller

Other

IE ACTIVITIES	Not Applicable / Key	Engineering	Planning	Estimating	Scheduling	Production	Project Mgmt	Material/Supply	Quality Assurance	Industrial Engineering	Industrial Relations	Information Systems	Facilities/Public Works	Maintenance	Finance/Comptroller	Other
Methods Improvements																
Work Measurement																
Tools/Standards																
Learning Curve Concepts																
Manufacturing Engineering																
Production Planning																
Production Scheduling																
Plant Layout																
Plant Engineering																
Project Management																
Prep/Del Oral/Writ Rpts																
Computer Simulation																
Psychology of Sales																
Engineering Economy																
Economics of Production																
Energy Mgmt/Conservation																
Value Engrg/Analysis																
Capital Investmt Analysis																
Human Resource Accounting																
Human Factors/Ergonomics																
Behav Sci Application																
Other																

Shipyards  
Code \_\_\_\_\_

**ADVANCED ACTIVITIES**

	SHIPYARD DEPARTMENT	Not Applicable / Key	Engineering	Planning	Estimating	Scheduling	Production	Project Mgmt	Material/Supply	Quality Assurance	Industrial Engineering	Industrial Relations	Information Systems	Facilities/Public Works	Maintenance	Finance/Comptroller	Other
Flex Mfg/Automation																	
Group Tech - Flow Lanes																	
Product Work Brkdn Str																	
Accuracy Control																	
Statistical Analysis																	
Computer Integrated Mfg																	
Operations Research																	
Material Reqmts Planning																	

## LIST OF FIGURES

Page

Key	Rating	Description
0		No interest / knowledge
1		Interested; will gather information
2		Have information; considering it
3		Have studied information; no application intended
4		Information looks useful; application planned Applied once; no further application seen
6		Have applied on limited scale; may apply again
7		Have applied substantially; technique useful
8		Constant application on-going; technique valuable
9		Need more information; wider application

POSSIBLE RATING SYSTEM FOR STUDY PARTICULARS