

AD-A139 075

PRODUCTIVITY ENHANCEMENT PROGRAM (PEP) FOR THE POWER
PLANT DIVISION NAVAL..(U) NAVY PERSONNEL RESEARCH AND
DEVELOPMENT CENTER SAN DIEGO CA T P ENDERWICK ET AL.

1/1

UNCLASSIFIED

FEB 84 NPRDC-TR-84-24

F/G 5/1

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A139075

MAR 19 1984

84 03 19 014

**PRODUCTIVITY ENHANCEMENT PROGRAM (PEP) FOR THE POWER PLANT DIVISION,
NAVAL AIR REWORK FACILITY, NORTH ISLAND, SAN DIEGO:
PRELIMINARY DATA REQUIRED**

T. P. Enderwick
E. J. Ferguson

Reviewed by
R. Penn

Approved by
R. Blanchard

Released by
J. W. Renard
Captain, U.S. Navy
Commanding Officer

DTIC
ELECTE
S MAR 19 1984
A

Navy Personnel Research and Development Center
San Diego, California 92152

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NPRDC TR 84-24	2. GOVT ACCESSION NO. AD-A239075	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PRODUCTIVITY ENHANCEMENT PROGRAM (PEP) FOR THE POWER PLANT DIVISION, NAVAL AIR REWORK FACILITY, NORTH ISLAND, SAN DIEGO: PRELIMINARY DATA REQUIRED		5. TYPE OF REPORT & PERIOD COVERED Technical Report Spring 1981-Summer 1982
7. AUTHOR(s) T. P. Enderwick E. J. Ferguson		6. PERFORMING ORG. REPORT NUMBER 16-23-7
9. PERFORMING ORGANIZATION NAME AND ADDRESS Navy Personnel Research and Development Center San Diego, California 92152		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS Navy Personnel Research and Development Center San Diego, California 92152		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Z1457SL.01
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE February 1984
		13. NUMBER OF PAGES 27
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		16. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Productivity enhancement Workload impediment		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides preliminary information needed for the development of a productivity enhancement program (PEP) at PPD, NARF North Island.		

DD FORM 1473
1 JAN 73EDITION OF 1 NOV 68 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

FOREWORD

This effort was conducted as the initial phase of a development project to implement a productivity enhancement program (PEP) at the Power Plant Division (PPD), Naval Air Rework Facility, North Island, San Diego, California. The objectives of this phase were to describe the current organization and shop operations within the PPD. The results provide a basis and a perspective by which project personnel can develop an individualized PEP for the PPD.

This work is part of a continuous program to improve civilian work force productivity. Similar programs have resulted in increased productivity of key punch operators and supply workers. Because of the varying nature of the work in various areas, a PEP must be tailored for each area.

Appreciation is expressed for the high level of support and coordination received from the management and work force of the PPD, especially the following:

- Mr. Pegas and Mr. Lee, PPD Directors, for their full support during the time of data collection.
- Mr. Cohee and Mr. Charvat, General Foremen, for their day-to-day support during the entire data collection period.
- Support group personnel, for their willing assistance whenever requested.

J. W. RENARD
Captain, U.S. Navy
Commanding Officer

J. W. TWEEDDALE
Technical Director



Accession For	
NTIS CARD	
DTIC TAB	
Unannounced	
Justification	
By	
Distribution/	
Availability Codes	
Avail and/or	Special
Not	
A-1	

SUMMARY

Problem

→ The Navy Personnel Research and Development Center has developed productivity enhancement programs (PEPs) for key punch operators and purchasing clerks within selected naval shipyards and is developing PEPs for other naval activities. Before a PEP can be developed for an organization, it is necessary to obtain information concerning its structure, operations, and workflow and any impediments to that workflow. The current plan is to develop a PEP for the Power Plant Division (PPD), Naval Air Rework Facility (NARF), North Island, San Diego.

Objective

→ The objective of this effort was to obtain the necessary information needed before a PEP can be developed for the PPD.

Approach

↑ Eight shops were selected to participate in the effort. For these shops, data were collected as follows:

1. PPD management and workers were interviewed to obtain general organizational information and to identify impediments.
2. Workflow charts were prepared for representative engine units that are processed through the eight selected PPD shops.
3. The controlling and accounting materials used within the shops were reviewed.
4. Foremen were asked to complete a mini-survey indicating the degree to which their shops met various criteria.

Results were analyzed to determine which shops should serve as experimental shops in the forthcoming PEP and which should serve as control shops.

Results

The selected shops reasonably meet the criteria for successfully developing a PEP; that is, worker productivity was sufficiently under his/her own control and the workload was sufficient to warrant an increase in productivity. Fourteen impediments were identified that either do or could cause workflow problems, but should be manageable or eliminated during PEP development.

Conclusions

It appears that PPD's structure, operations, management, and workflow make it a sound candidate for a PEP. The management and the workforce have demonstrated an active willingness to participate in the development effort. The PPD repair operations are complex and extensive but are organized and conducive to performance measurement, which is one of the keys to developing a successful PEP.

CONTENTS

	Page
INTRODUCTION	1
Problem and Background	1
Purpose	1
APPROACH	1
PPD Organization	1
Selection of Shops	1
Data Collection	3
Analysis	3
RESULTS	3
PPD Function and Workload	3
Labor Force	4
Support Groups	4
Planning and Estimating (P&E)	5
Operation Analysis (OA)	5
Methods and Standards (M&S)	8
Production Control (PC)	8
Examination and Evaluation (E&E)	12
Engineering	12
Quality Assurance (QA)	12
Controlling Documents	14
Flow Process Charts	16
Mini-survey Results	20
Recommended Experimental and Control Shops	20
Impediments to Productivity	21
CONCLUSION	22
DISTRIBUTION LIST	23

LIST OF FIGURES

	Page
1. Power Plant Division organization	2
2. Master data record (MDR)	6
3. MDR CIN structure assembly chaining	7
4. MDR with changes indicated	9
5. Standard data application record	10
6. Uniform automated data processing (UADP) card	11
7. Slant-three quality report chit	13
8. Labor report	15
9. Critical shortage chart	16
10. Hi-burner report	17
11. Flow process chart	18

LIST OF TABLES

	Page
1. Workload Percentages Required by Representative Unit by Selected PPD Shops	19
2. Degree to Which PPD Shops Meet Criteria	20
3. Recommended Experimental and Control Groups	20

INTRODUCTION

Problem and Background

The Navy Personnel Research and Development Center has developed productivity enhancement programs (PEPs) for key punch operators and purchasing clerks within selected naval shipyards and is currently developing PEPs for other naval activities. The current plan is to develop a PEP for artisans working in the Power Plant Division (PPD), Naval Air Rework Facility (NARF), North Island, San Diego. Before a PEP can be developed, however, information is needed on the structure and operations of the organization, the workflow, and any impediments to that workflow. This information is used to determine whether (1) the workload is large enough to withstand an increase in productivity without running out of work, (2) there is some reasonably reliable and valid means of measuring workers' productivity, (3) management--from shop foremen to top levels--will support the program, and (4) any punitive actions (e.g., negative incentives) could result from the program.

NARF North Island is one of six NARFs in the United States. Although each NARF processes a different variety of aircraft, their general purpose is to dismantle, inspect, and repair aircraft that have come from the fleet after a tour of duty for scheduled maintenance or because major problems have developed. The PPD at NARF North Island is responsible for the rework/overhaul of jet engines, which is a highly involved process. At any given time, the PPD is processing from 15 to 20 jet engines, each of which has between two and eight thousand parts. PPD is responsible for tracking these parts, as well as performing machining, coating, welding, and other rework operations.

Purpose

The purpose of this effort was to obtain the necessary information needed before a PEP can be developed for the PPD.

APPROACH

PPD Organization

The PPD is organized in the traditional hierarchical structure. As shown in Figure 1, the PPD has two branches, each branch has two sections, and each section has approximately five shops. It should be noted that Figure 1 reflects a recent reorganization that changed the organization from being "process"-oriented to one based primarily on "products" (i.e., engines and their components). This means that each shop is responsible for all or most of the rework considered necessary to produce the product that is reflected in its title. For example, shop number 96314 is responsible for T64 small engine rework and test. The actual tasks performed by the artisans have not changed but some artisans now work under different foremen, have different position descriptions (PDs), and/or have been moved to different locations. For example, a new PD for "pneudraulics" mechanics was introduced to classify mechanics who work on components associated with fluid and air controls.

Selection of Shops

At first, through discussions with PPD management, seven shops under Code 96400 (Engine Accessories and Processing Branch) were selected for inclusion in this

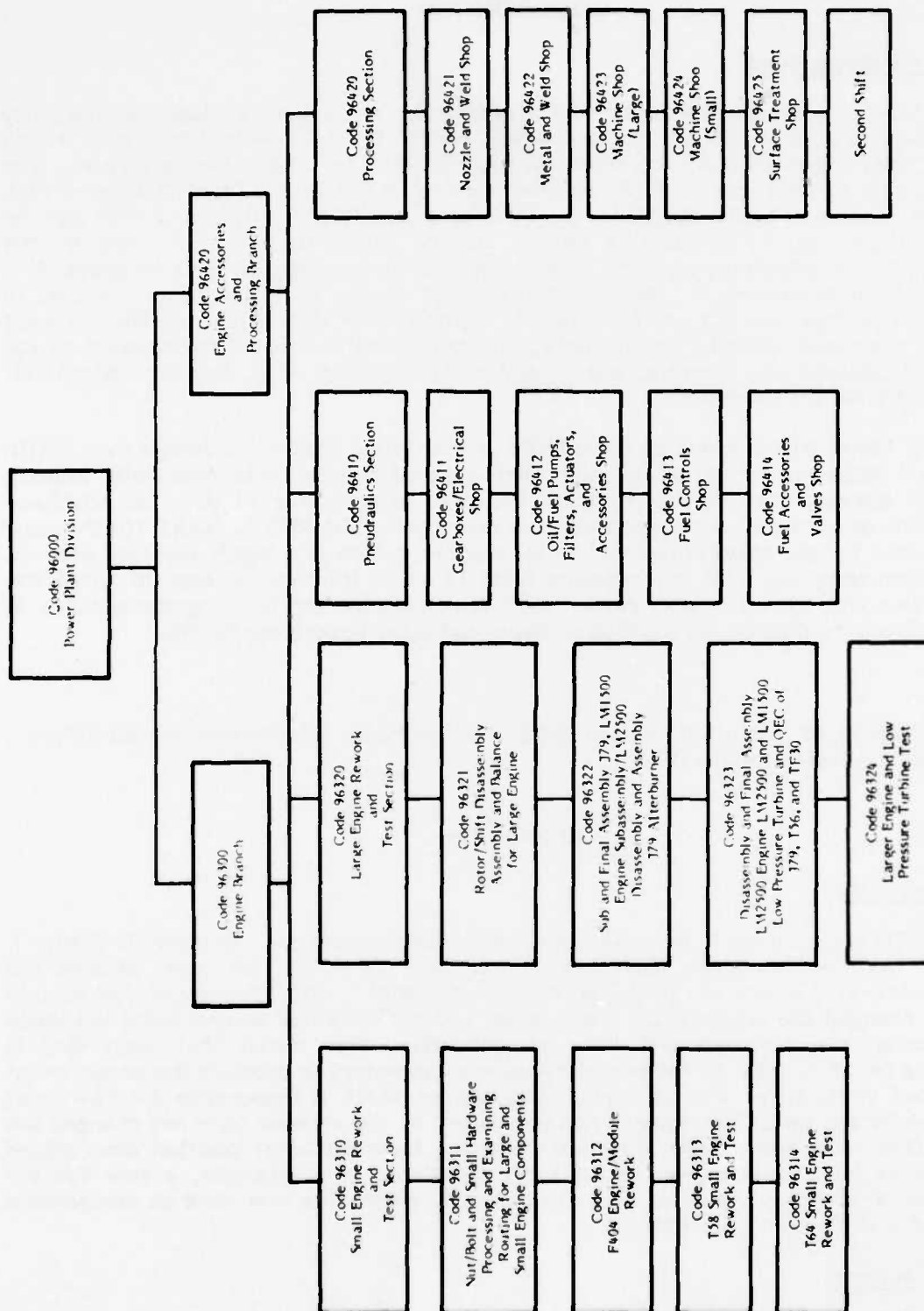


Figure 1. Power Plant Division organization.

effort--Nos. 96411, 96412, 96413, 96414, 96421, 96422, and 96424. Later, one shop under Code 96300 (Engine Branch)--No. 96314--was added. It was considered that one shop was sufficient since the primary distinction among Code 96300 shops is product line (types of engines). The shop processes are similar; namely, disassemble, inspect, assemble, test, and sell an engine.

Data Collection

Data were collected as follows:

1. PPD management and workers were interviewed to obtain general organizational information and to identify impediments.
2. Workflow charts were prepared for representative engine units that are processed through the eight selected PPD shops.
3. The controlling and accounting materials used within the shops were reviewed.
4. Foremen were asked to complete a mini-survey indicating the degree to which their shops met the following criteria:
 - a. Work is measured objectively (covered by standards).
 - b. Work could be measured objectively.
 - c. Valid performance standards are in place.
 - d. Performance is tied directly to a specific individual.
 - e. Work is recurring in nature.
 - f. Work pace is controlled by the individual.

Analysis

Results were analyzed to determine which shops should serve as experimental shops in the forthcoming PEP and which should serve as control shops. The objective was to have the experimental and control shops as similar to one another as possible in terms of:

1. Percentage of criteria (see above) met by each shop.
2. Percentage of the workload covered by the workflow charts.
3. The number of people in the respective shops.
4. The ratio of flow process steps to transactions.

In regard to 4 above, it should be noted that there were no restrictions on what a foreman wished to call a "step" in describing a process. However, responses do provide a rough indicator for the shop comparisons.

RESULTS

PPD Function and Workload

When an engine arrives at PPD for rework, it is examined and all maintenance reports and schedules, relevant engineering change orders, and other related documents are reviewed to determine which engine components will be reworked and which will be sent

to a holding pool. Based upon results of the examination, component parts can follow one of three different routes:

1. Parts that do not need reworking are sent to a holding pool for that component.
2. Parts that do need reworking are sent to the appropriate shops for machining, coating, or any other number of possible operations.
3. Parts that are beyond repair are scrapped and replacement part ordered.

In summary, a jet engine that goes into the PPD is disassembled, reworked, reassembled, tested, and returned for another tour of fleet duty. The PPD reworks six different jet engines and an assortment of other aircraft parts (e.g., refueling nozzles). Four of the six engines--J-79, T-58, T-64 and F-404--are aircraft engines, while the other two--LM 1500 and LM 2500--are used in Navy surface ships. Each aircraft engine has several modified versions that requires variations in the rework processes. Also, since the F-404 is a new addition to the PPD's workload and has recently been subjected to a pilot program, there will be frequent adjustments to the rework processes until sufficient experience is gained in reworking the F-404. Finally, other nonengine aircraft parts regularly come in for rework from the NARF rework hangars. In some shops, reworking these parts represents a substantial part of the workload.

Labor Force

The PPD labor force comprises 369 artisans, trained in the following skills required to rework jet engines:

1. Sandblaster.
2. Electroplate worker (cleaner).
3. Buffer and polisher.
4. Welder.
5. Shop peener.
6. Heat treater.
7. Preservation packaging mechanic.
8. Aircraft engine mechanic.
9. Aircraft metalsmith.
10. Machinist.
11. Painter.
12. Aircraft electrician.
13. Aircraft engine metal worker.
14. Pneudraulic mechanic.

Skill levels within the labor force range between Wage Grades 8 and 10, with lesser wage grades for apprentices and trainees. The work force is predominantly male and ranges in age between 18 and 66 years, with an average of 41. Overall, members of the work force gave no indication of having any unusual attitudes toward any group or management.

Support Groups

Six primary support groups directly influence PPD's workflow, although they are not directly controlled by PPD management. These groups are listed below; their rules and functions in regard to PPD workflow are described in the following paragraphs.

1. Planning and Estimating (P&E).
2. Operational Analysis (OA).
3. Methods and Standards (M&S).
4. Production Control (PC).
5. Examinators and Evaluators (E&E).
6. Engineering.
7. Quality Assurance (QA).

Planning and Estimating (P&E)

The P&E group is responsible for developing the internal workload plans and schedules, based upon the number and types of engines scheduled for each quarter. Although PPD's engine program manager negotiates with the Naval Logistic Supply Center as to the number and kinds of engines that will be reworked by the PPD annually, the actual working time frame is quarterly. The engines come from two main sources: (1) the NARF rework hangars, where entire airplanes are reworked, and (2) the supply system itself ("trade-ins" from the fleet). Using the schedule of planned engine arrivals, the P&E group schedules the engines and determines when, during the quarter, the engine will be inducted, based on such factors as material and equipment availability, required overtime if any, etc.

The planners use the master data record (MDR), which is prepared by the OA Group (see below) for each type, model, and series (TMS) of engine, to determine the actual direction of the work flow through the shops. They also consider the process times required by the various shops, as well as the within and between shop transport times.

Numerous circumstances make scheduling (and/or rescheduling) a continuous activity. Engines do not always arrive at the PPD as scheduled; in some cases, they do not arrive at all. There are many reasons for this: An aircraft's deployment schedule can be changed, funds for rework on a given TMS engine may be withdrawn, or ordered parts may not be available. Since any given jet engine includes between 2000 to 8000 parts, it is not surprising that there are availability problems. Although the amount of supplies stored are determined based on how frequently a part is replaced, this practice has its shortcomings. For example, when an engine part with a long wear cycle must finally be replaced, none is available and the workflow schedules can be disrupted.

Operation Analysis (OA)

This group establishes and maintains the MDR, which, as mentioned earlier, is used to route an engine through the various shops. The MDR lists all required processes for a complete rework of an engine, including identification of all parts, processes, and shops needed to perform the work. The 12-digit component identity number (CIN) (see upper left-hand corner of Figure 2), identifies all sections, assemblies, subassemblies, and sub-subassemblies of the engine. Figure 3 presents the MDR CIN structure in terms of three groups of numbers. The first digit of the first group represents the section of the engine being worked on; and the last three digits, the assembly. The middle group of four digits is not used. In the last group, the first digit represents the subassembly; and the remaining three, sub-subassemblies and their parts. The MDRs for a "new engine" pilot program are established before the first engine arrives at the NARF for rework, based on engineering documents provided by the manufacturer and government directives.

PREVIOUS ISSUES OF THIS FORM ARE OBSOLETE

MASTER DATA RECORD **AUG 27 1961**

CONTRACT GROUP 27102		COMPONENT QUANTITY NO 11007000000		MOD LOC 101		INDUCED FEDERAL STOCK NUMBER		PART IDENTIFICATION GROUP MODIFIED FEDERAL STOCK NUMBER		MODEL CODE F404		QUANTITY NP01		PRODUCTION CODE Y		DATE 07-23-61	
MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE	
MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE		MOD CODE	

LOAD AND SCHEDULE GROUP										OPERATION DESCRIPTION									
MOD LOC	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD LOC	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE
201	96222	6	MX	63	24	000	02	02	16	301	01	01	01	01	01	01	01	01	01
202	96222	6	MX	63	24	000	02	02	16	302	01	01	01	01	01	01	01	01	01
203	96222	6	MX	63	24	000	02	02	16	303	01	01	01	01	01	01	01	01	01
204	96222	6	MX	63	24	000	02	02	16	304	01	01	01	01	01	01	01	01	01
205	96222	6	MX	63	24	000	02	02	16	305	01	01	01	01	01	01	01	01	01
206	96222	6	MX	63	24	000	02	02	16	306	01	01	01	01	01	01	01	01	01
207	96222	6	MX	63	24	000	02	02	16	307	01	01	01	01	01	01	01	01	01
208	96222	6	MX	63	24	000	02	02	16	308	01	01	01	01	01	01	01	01	01
209	96222	6	MX	63	24	000	02	02	16	309	01	01	01	01	01	01	01	01	01

MISCELLANEOUS INFORMATION GROUP										TECHNICAL DATA GROUP									
MOD LOC	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD LOC	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE	MOD CODE
201	96222	6	MX	63	24	000	02	02	16	301	01	01	01	01	01	01	01	01	01
202	96222	6	MX	63	24	000	02	02	16	302	01	01	01	01	01	01	01	01	01
203	96222	6	MX	63	24	000	02	02	16	303	01	01	01	01	01	01	01	01	01
204	96222	6	MX	63	24	000	02	02	16	304	01	01	01	01	01	01	01	01	01
205	96222	6	MX	63	24	000	02	02	16	305	01	01	01	01	01	01	01	01	01
206	96222	6	MX	63	24	000	02	02	16	306	01	01	01	01	01	01	01	01	01
207	96222	6	MX	63	24	000	02	02	16	307	01	01	01	01	01	01	01	01	01
208	96222	6	MX	63	24	000	02	02	16	308	01	01	01	01	01	01	01	01	01
209	96222	6	MX	63	24	000	02	02	16	309	01	01	01	01	01	01	01	01	01

Figure 2. Master data record (MDR).

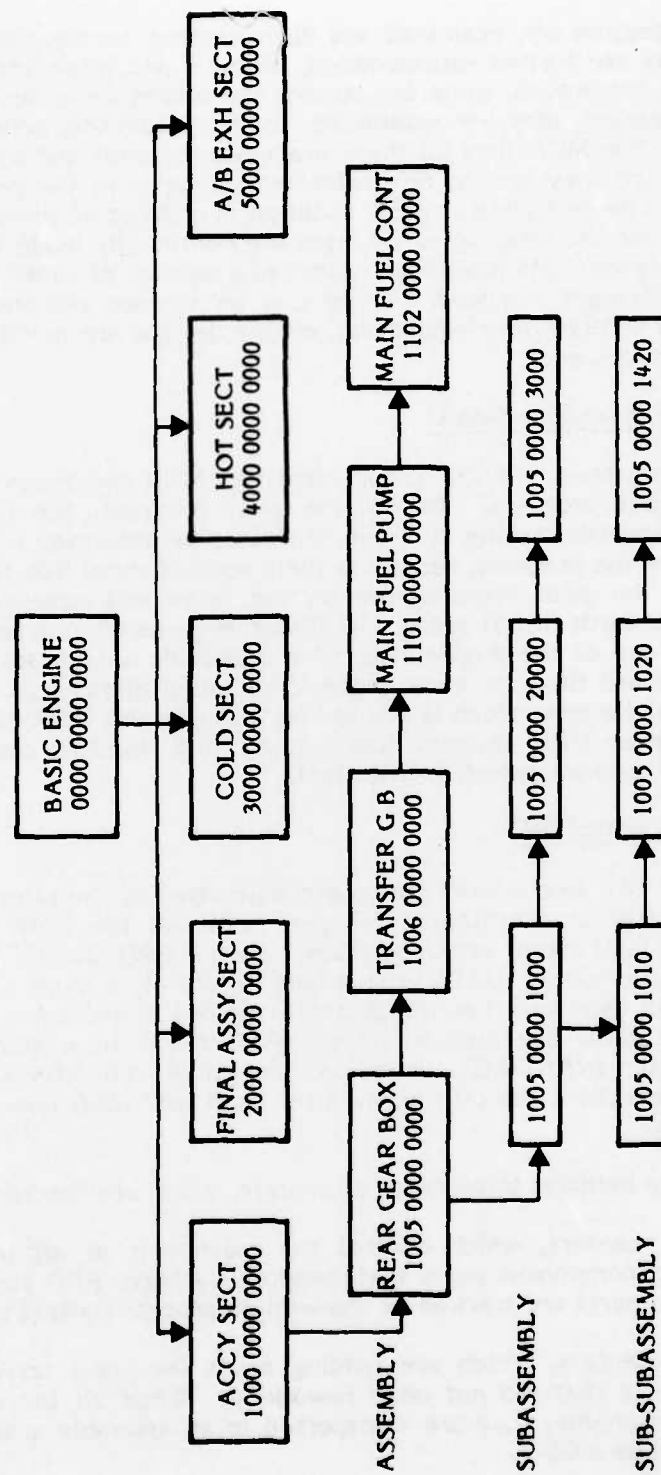


Figure 3. MDR CIN structure assembly chaining.

After the engines are examined and disassembled, sections are routed to the various shops where they are further disassembled, cleaned, and inspected for wear. Some parts are then routed for rework, some are stored, and others discarded and replaced. When all the parts are readied, they are assembled, tested, inspected, accepted, and returned for final assembly. The MDR lists all these processes, by code and a brief descriptive title in the order in which they are to be performed, along with the performing shop and the standard time. One component (part) could go in and out of the same shop several times before it leaves for the final time. Changes are continually made to the MDRs even after the engines of a given TMS have been reworked a number of times. The example in Figure 4 shows some changes required. There can be various reasons for the changes; for example, a shop receives new equipment, engine designs are modified, an artisan suggests improved procedures, etc.

Methods and Standards (M&S)

As indicated above, the OA group identifies MDR processes prior to the start of a "new engine" pilot program. During the pilot program, the pilot team verifies the methods and standards making up those processes by observing artisans performing each task called for by the processes, recording their performances (see Figure 5), and analyzing results. When the pilot team agrees on the tasks and subsequent task motions, the Methods and Standards (M&S) group establishes engineered standard times for each task by referring to one of the engineering time standards data bases. The net result is an engineering standard time for each process, including allowances for personnel, fatigue, and supplemental factors, which is printed on that engine's MDR cards. The M&S group is also consulted when MDR changes also require time standard changes (e.g., when new, more automated shop equipment is installed).

Production Control (PC)

The PC and E&E (see below) groups are supervised by the same branch head, although they perform different functions. PC personnel use the MDR as a "map" to route components and their parts within and between the PPD shops. They also use uniform automated data processing (UADP) cards (see Figure 6), a more convenient form of the MDR that can be used with the transactor to record actual time used by an artisan per process. UADP cards are ordered by the P&E group from the Navy Regional Data Automation Center (NARDAC), which provides MDR computer services to the NARF. The PC group sorts the cards into packets for each individual component and gives them to the E&E group.

The PC group includes three types of centers, which are described below:

1. Routing centers, which control the movement of all incoming and outgoing engines, including component parts that temporarily leave PPD for rework elsewhere at the NARF. These parts are tracked by the work in process control system (WIPCS).
2. Kitting centers, which are holding areas for parts arriving from the rework processes and parts that did not need reworking. When all the components and parts arrive for a given engine, they are transported to an assembly area. A kitting center is usually supervised by a GS-7.

THESE VOLUMES ISSUED OF THIS FORM ARE OBSOLETE

9

Figure 4. MDR with changes indicated.

STANDARD DATA APPLICATION RECORD DA Form 8220/6 (7-66) S/N 0102-LF-810-2380						FILE REFERENCE		
SHIP NO.	ORGANIZATION TITLE	TECHNICIAN	ACTIVITY	DATE				
6315	NIFE	Lindquist	NI	7-25-76				
TECHNICAL REFERENCE		OPERATION	PART NUMBER					
		Gage Dove Tail						
JOB DESCRIPTION			PART NAME					
Ch. dovetail & dial indicator J79 2nd Stg.			Blade Turb. 2nd Stg J79					
NO.	DESCRIPTION	CODE	QUANTITY		GROSS	OCC	ALLOWED	
			1ST	ADD				
1	Prep to check				268	5100	268	
1	Get parts of blades LYT.	DMH-LA-02	2		38			
2	Additional work	DMH-40-01	4		36			
3	Arrange N.A.	DMH-LA-0A	6		30			
4	Get gage	DMH-LA-0B	1		12			
5	Open box	AGF-DU-LC	1		73			
6	Adjust dial - zero	BAL-KD-03	8		40			
7	Get empty tote pan	DMH-LA-0A	4		20			
8	Set stand	BDM-55-02	1		19			
B Ch. dovetail.					60	9700	5830	
1	Get side position in gage	DCH-PD-0A	1		12			
2	Lead dial	DIT-EV-0A	1		12			
3	Rem. blade & turn for opp. side	DCH-PD-0A	1		12			
4	Lead dial	DIT-EV-0A	1		12			
5	Aside blade to tote pan	DMH-LA-0B	1		12			
C. Blade work					167	300	338	
1	Set stand	BH-55-02	1		19			
2	Get part of blades	DMH-LA-02	2		38			
3	Move to conveyor	BDM-40-01	4		36			
4	Prep area	T6J 1J PA	1		76			
TOTAL					1426			
PERSONAL 5 %					FATIGUE 7 %			
					SUPPLEMENTAL 4 %			
ALLOWANCE HOURS					1028			
BPM (HR) D 000.74 or					7454			
44.72 min.								

Standard figure of 85% of blades on bars

© U.S. Government Printing Office: 1970-000-015-0000 2-1

Figure 5. Standard data application record.

Being assigned to the PC group was once considered a promotion for shop artisans. However, during past reorganizations, PDs were changed so that nonmechanics are now being assigned to the PC group. This result has become somewhat of a controversial issue at the NARF. Some feel that a competent PC person must have a mechanic's background, especially when situations occur requiring detailed physical identification of materials.

Examination and Evaluation (E&E)

E&E personnel (1) review all the documents associated with the engine and its components (i.e., the engine section of the aircraft maintenance log book, the MDR and UADP cards, local engineering change directives, and other routine directives concerning the engine's rework) and (2) visually inspect the engine and its components to determine the degree of rework needed. They send the components that do not need rework to a holding area (kitting center) where all the parts for that particular engine eventually arrive, and the components that do need rework to the appropriate shop after deleting any unnecessary operations from the appropriate sets of UADP cards. Shop personnel then disassemble the components to make internal examinations and evaluations, and delete any unnecessary part rework processes from the UADP cards. E&E personnel are senior mechanics who are promoted from the various PPD shops.

Engineering

The PPD's Engineering group does engineering on an "as needed" basis. Its primary function is to provide engineering solutions to problems encountered during the rework process. Such solutions eventually result in a change to the manufacturer's maintenance manuals used in the shops, officially called a local engineering change (LEC). These LECs, which, in turn, result in changes to the relevant MDRs, can be issued when (1) an incorrect procedure is discovered, and the Engineering group either corrects it or establishes an alternative one, (2) the group finds that an alternate procedure suggested by an artisan is an improvement over the original procedure, or (3) some wording in a manual needs to be clarified. The Engineering group's job of "keeper of the manuals" is a continuous one. LECs can be made even after 10 years of reworking a particular engine. Although a pilot engine needs little reworking at first to return it to service condition, the amount of reworking needed increases as a function of the engine's age. Some rework processes may not be performed until years after the engine has been in service and through the NARF PPD many times.

Quality Assurance (QA)

The Quality Assurance (QA) group consists of two different subgroups, one for quality verification (QV) and the other, for quality engineering and analysis (QE&A).

1. Quality Verification (QV). This subgroup usually makes product quality checks at the end of rework jobs. Although some QV checks are occasionally made on a sampling basis while work is in progress, the in-process quality of work is primarily the responsibility of the artisan. The frequency of sampling is determined by the importance of the process; that is, whether it is classified as critical, important, and nonimportant (types 1, 2, and 3 respectively). Type 1 processes are listed on "quality check lists" (QCLs) given to the artisans. Thus, artisans always request a quality check for those jobs (i.e., 100% checking). Artisans are not aware of the actual sampling plans for types 2 and 3 processes, which are proportional to their relative importance.

Also, the QV subgroup uses an audit to check on (1) an artisan's work procedures, (2) the tools, equipment, and documentation used, and (3) the physical work environment. During an audit, the QV specialist addresses all items in a checklist related to procedures, tools, etc. If all the items on that list check out favorably, it is assumed that a quality product will result.

If a QV specialist observes an artisan following incorrect procedures, he completes a "slant-three" chit (see Figure 7) with the relevant information about the discrepancy, and provides a copy to the artisan, the PC group, and the foreman. When the discrepancy has been corrected, the QV person issues a "no defect" chit to the three parties involved.

1. UPR NO.		12. PART NAME		13. JOB NO.		15.	
QA51493		SUP RT ANG 9		9620TH			
6. QTY		8. QTY		11. BU NO		14. STA	
0 A		0 0 0 1		9		97M	
10. RES. CODE		11. SEC. CODE		12. BU NO		14. STA	
97331265		X T58		973312307		97M	
16. PROC. CODE		17. PROC. CODE		18. PROC. CODE		19. PROC. CODE	
0 3		9 0 4 1 1		0 2 3		7 7 6 6 5 0	
20. PROC. CODE		21. PROC. CODE		22. PROC. CODE		23. PROC. CODE	
0 3		9 0 4 1 1		0 2 3		7 7 6 6 5 0	
24. JULIAN DATE		25. JULIAN DATE		26. RESP. CERTIFIER		27. DATE COMP.	
24		25		26		27	
28. PROC. CODE		29. PROC. CODE		30. PROC. CODE		31. PROC. CODE	
28		29		30		31	
32. PROC. CODE		33. PROC. CODE		34. PROC. CODE		35. PROC. CODE	
32		33		34		35	
36. PROC. CODE		37. PROC. CODE		38. PROC. CODE		39. PROC. CODE	
36		37		38		39	
40. PROC. CODE		41. PROC. CODE		42. PROC. CODE		43. PROC. CODE	
40		41		42		43	
44. PROC. CODE		45. PROC. CODE		46. PROC. CODE		47. PROC. CODE	
44		45		46		47	
48. PROC. CODE		49. PROC. CODE		50. PROC. CODE		51. PROC. CODE	
48		49		50		51	
52. PROC. CODE		53. PROC. CODE		54. PROC. CODE		55. PROC. CODE	
52		53		54		55	
56. PROC. CODE		57. PROC. CODE		58. PROC. CODE		59. PROC. CODE	
56		57		58		59	
60. PROC. CODE		61. PROC. CODE		62. PROC. CODE		63. PROC. CODE	
60		61		62		63	
64. PROC. CODE		65. PROC. CODE		66. PROC. CODE		67. PROC. CODE	
64		65		66		67	
68. PROC. CODE		69. PROC. CODE		70. PROC. CODE		71. PROC. CODE	
68		69		70		71	
72. PROC. CODE		73. PROC. CODE		74. PROC. CODE		75. PROC. CODE	
72		73		74		75	
76. PROC. CODE		77. PROC. CODE		78. PROC. CODE		79. PROC. CODE	
76		77		78		79	
80. PROC. CODE		81. PROC. CODE		82. PROC. CODE		83. PROC. CODE	
80		81		82		83	
84. PROC. CODE		85. PROC. CODE		86. PROC. CODE		87. PROC. CODE	
84		85		86		87	
88. PROC. CODE		89. PROC. CODE		90. PROC. CODE		91. PROC. CODE	
88		89		90		91	
92. PROC. CODE		93. PROC. CODE		94. PROC. CODE		95. PROC. CODE	
92		93		94		95	
96. PROC. CODE		97. PROC. CODE		98. PROC. CODE		99. PROC. CODE	
96		97		98		99	
100. PROC. CODE		101. PROC. CODE		102. PROC. CODE		103. PROC. CODE	
100		101		102		103	
104. PROC. CODE		105. PROC. CODE		106. PROC. CODE		107. PROC. CODE	
104		105		106		107	
108. PROC. CODE		109. PROC. CODE		110. PROC. CODE		111. PROC. CODE	
108		109		110		111	
112. PROC. CODE		113. PROC. CODE		114. PROC. CODE		115. PROC. CODE	
112		113		114		115	
116. PROC. CODE		117. PROC. CODE		118. PROC. CODE		119. PROC. CODE	
116		117		118		119	
120. PROC. CODE		121. PROC. CODE		122. PROC. CODE		123. PROC. CODE	
120		121		122		123	
124. PROC. CODE		125. PROC. CODE		126. PROC. CODE		127. PROC. CODE	
124		125		126		127	
128. PROC. CODE		129. PROC. CODE		130. PROC. CODE		131. PROC. CODE	
128		129		130		131	
132. PROC. CODE		133. PROC. CODE		134. PROC. CODE		135. PROC. CODE	
132		133		134		135	
136. PROC. CODE		137. PROC. CODE		138. PROC. CODE		139. PROC. CODE	
136		137		138		139	
140. PROC. CODE		141. PROC. CODE		142. PROC. CODE		143. PROC. CODE	
140		141		142		143	
144. PROC. CODE		145. PROC. CODE		146. PROC. CODE		147. PROC. CODE	
144		145		146		147	
148. PROC. CODE		149. PROC. CODE		150. PROC. CODE		151. PROC. CODE	
148		149		150		151	
152. PROC. CODE		153. PROC. CODE		154. PROC. CODE		155. PROC. CODE	
152		153		154		155	
156. PROC. CODE		157. PROC. CODE		158. PROC. CODE		159. PROC. CODE	
156		157		158		159	
160. PROC. CODE		161. PROC. CODE		162. PROC. CODE		163. PROC. CODE	
160		161		162		163	
164. PROC. CODE		165. PROC. CODE		166. PROC. CODE		167. PROC. CODE	
164		165		166		167	
168. PROC. CODE		169. PROC. CODE		170. PROC. CODE		171. PROC. CODE	
168		169		170		171	
172. PROC. CODE		173. PROC. CODE		174. PROC. CODE		175. PROC. CODE	
172		173		174		175	
176. PROC. CODE		177. PROC. CODE		178. PROC. CODE		179. PROC. CODE	
176		177		178		179	
180. PROC. CODE		181. PROC. CODE		182. PROC. CODE		183. PROC. CODE	
180		181		182		183	
184. PROC. CODE		185. PROC. CODE		186. PROC. CODE		187. PROC. CODE	
184		185		186		187	
188. PROC. CODE		189. PROC. CODE		190. PROC. CODE		191. PROC. CODE	
188		189		190		191	
192. PROC. CODE		193. PROC. CODE		194. PROC. CODE		195. PROC. CODE	
192		193		194		195	
196. PROC. CODE		197. PROC. CODE		198. PROC. CODE		199. PROC. CODE	
196		197		198		199	
200. PROC. CODE		201. PROC. CODE		202. PROC. CODE		203. PROC. CODE	
200		201		202		203	
204. PROC. CODE		205. PROC. CODE		206. PROC. CODE		207. PROC. CODE	
204		205		206		207	
208. PROC. CODE		209. PROC. CODE		210. PROC. CODE		211. PROC. CODE	
208		209		210		211	
212. PROC. CODE		213. PROC. CODE		214. PROC. CODE		215. PROC. CODE	
212		213		214		215	
216. PROC. CODE		217. PROC. CODE		218. PROC. CODE		219. PROC. CODE	
216		217		218		219	
220. PROC. CODE		221. PROC. CODE		222. PROC. CODE		223. PROC. CODE	
220		221		222		223	
224. PROC. CODE		225. PROC. CODE		226. PROC. CODE		227. PROC. CODE	
224		225		226		227	
228. PROC. CODE		229. PROC. CODE		230. PROC. CODE		231. PROC. CODE	
228		229		230		231	
232. PROC. CODE		233. PROC. CODE		234. PROC. CODE		235. PROC. CODE	
232		233		234		235	
236. PROC. CODE		237. PROC. CODE		238. PROC. CODE		239. PROC. CODE	
236		237		238		239	
240. PROC. CODE		241. PROC. CODE		242. PROC. CODE		243. PROC. CODE	
240		241		242		243	
244. PROC. CODE		245. PROC. CODE		246. PROC. CODE		247. PROC. CODE	
244		245		246		247	
248. PROC. CODE		249. PROC. CODE		250. PROC. CODE		251. PROC. CODE	
248		249		250		251	
252. PROC. CODE		253. PROC. CODE		254. PROC. CODE		255. PROC. CODE	
252		253		254		255	
256. PROC. CODE		257. PROC. CODE		258. PROC. CODE		259. PROC. CODE	
256		257		258		259	
260. PROC. CODE		261. PROC. CODE		262. PROC. CODE		263. PROC. CODE	
260		261		262		263	
264. PROC. CODE		265. PROC. CODE		266. PROC. CODE		267. PROC. CODE	
264		265		266		267	
268. PROC. CODE		269. PROC. CODE		270. PROC. CODE		271. PROC. CODE	
268		269		270		271	
272. PROC. CODE		273. PROC. CODE		274. PROC. CODE		275. PROC. CODE	
272		273		274		275	
276. PROC. CODE		277. PROC. CODE		278. PROC. CODE		279. PROC. CODE	
276		277		278		279	
280. PROC. CODE		281. PROC. CODE		282. PROC. CODE		283. PROC. CODE	
280		281		282		283	
284. PROC. CODE		285. PROC. CODE		286. PROC. CODE		287. PROC. CODE	
284		285		286		287	
288. PROC. CODE		289. PROC. CODE		290. PROC. CODE		291. PROC. CODE	
288		289		290		291	
292. PROC. CODE		293. PROC. CODE		294. PROC. CODE		295. PROC. CODE	
292		293		294		295	
296. PROC. CODE		297. PROC. CODE		298. PROC. CODE		299. PROC. CODE	
296		297		298		299	
300. PROC. CODE		301. PROC. CODE		302. PROC. CODE		303. PROC. CODE	
300		301		302		303	
304. PROC. CODE		305. PROC. CODE		306. PROC. CODE		307. PROC. CODE	
304		305		306		307	
308. PROC. CODE		309. PROC. CODE		310. PROC. CODE		311. PROC. CODE	
308		309		310		311	
312. PROC. CODE		313. PROC. CODE		314. PROC. CODE		315. PROC. CODE	
312		313		314		315	
316. PROC. CODE		317. PROC. CODE		318. PROC. CODE		319. PROC. CODE	
316		317		318		319	
320. PROC. CODE		321. PROC. CODE		322. PROC. CODE		323. PROC. CODE	
320		321		322		323	
324. PROC. CODE		325. PROC. CODE		326. PROC. CODE		327. PROC. CODE	
324		325		326		327	
328. PROC. CODE		329. PROC. CODE		330. PROC. CODE		331. PROC. CODE	
328		329		330		331	
332. PROC. CODE		333. PROC. CODE		334. PROC. CODE		335. PROC. CODE	
332		333		334		335	
336. PROC. CODE		337. PROC. CODE		338. PROC. CODE		339. PROC. CODE	
336		337		338		339	
340. PROC. CODE		341. PROC. CODE		342. PROC. CODE		343. PROC. CODE	
340		341		342		343	
344. PROC. CODE		345. PROC. CODE		346. PROC. CODE		347. PROC. CODE	
344		345		346		347	
348. PROC. CODE		349. PROC. CODE		350. PROC. CODE		351. PROC. CODE	
348		349		350		351	
352. PROC. CODE		353. PROC. CODE		354. PROC. CODE		355. PROC. CODE	
352		353		354		355	
356. PROC. CODE		357. PROC. CODE		358. PROC. CODE		359. PROC. CODE	
356		357		358		359	
360. PROC. CODE		361. PROC. CODE		362. PROC. CODE		363. PROC. CODE	
360		361		362		363	
364. PROC. CODE		365. PROC. CODE		366. PROC. CODE		367. PROC. CODE	
364		365		366		367	
368. PROC. CODE		369. PROC. CODE		370. PROC. CODE		371. PROC. CODE	
368		369		370		371	
372. PROC. CODE		373. PROC. CODE		374. PROC. CODE		375. PROC. CODE	
372		373		374		375	
376. PROC. CODE		377. PROC. CODE		378. PROC. CODE		379. PROC. CODE	
376		377		378		379	
380. PROC. CODE		381. PROC. CODE		382. PROC. CODE		383. PROC. CODE	
380		381		382		383	
384. PROC. CODE		385. PROC. CODE		386. PROC. CODE		387. PROC. CODE	
384		385		386		387	
388. PROC. CODE		389. PROC. CODE		390. PROC. CODE		391. PROC. CODE	
388		389		390		391	
392. PROC. CODE		393. PROC. CODE					

In addition to the discrepancy reports described under QV, discrepancies are reported from other sources. When a quality-related discrepancy is reported by the production workers themselves (one that occurred even though they followed prescribed rework procedures), the procedures are reviewed and, if necessary, revised. When a quality-related discrepancy is reported by an engine test cell, it is traced back to the rework processes and a determination is made as to what corrective actions are required. When a quality-related discrepancy is found in the fleet and reported to the NARF by a Navy message, the related rework operations may come to a halt until it is determined why the discrepancy occurred and what remedial action needs to be taken. All the analyses are done by the QE&A group.

Controlling Documents

Every organization has a set of controls in the form of directives, reports, and/or computer programs. The PPD shops use four control documents in relation to the workflow: UADP cards, labor reports, critical short charts, and hi-burner tables. These documents are described below:

1. As indicated previously, UADP cards accompany all components, units, and parts that are in the rework process. These cards (shown in Figure 6), which identify the engine, shop routing, the processes to be performed by the respective shops, and the standard time allotted to complete each process, tell the artisan what needs to be done and the PC person where the unit should go next.
2. The labor report (Figure 8), a computer printout that is issued daily for each shop and covers the previous day's work, identifies the work units, the artisans who worked on them, the time the artisan required to complete the processes, and the corresponding standard times allotted to complete the processes.
3. The critical shortage charts (Figure 9) list parts and units to be given high priority. These charts, which are issued weekly, list the parts and components needed to meet the next week's assembly schedule but that have not arrived in the assembly pool as scheduled.
4. The hi-burner report (Figure 10) lists the parts and components urgently needed by the Naval Air Logistics Supply System to support fleet operations.

Flow Process Charts

Industrial engineers often use flow process charts in tasks involving job design, process flow, work simplification, plant layout, etc. Figure 11 provides an example of a completed flow process chart. In this effort, a set of flow charts was constructed for each of the eight PPD shops selected for study to identify and describe representative processes employed in those shops. A set of charts represents a shop's entire operation; and an individual chart, a specific component of that operation. The charts were used (1) to estimate the relative lengths of the processes (i.e., number of steps), (2) to estimate the number of transactions per process, and (3) to determine how shop workloads were distributed.

TOP 51610 & 51630		51620 FINISHED PARTS TOOL - CRITICAL SHORTAGE		DATE	
TIME	9/1	WOOD	SCHEDULE: X	LA X	753
SEQUENCE		X	LA	X	STA
TYPE		319	877	878	279
DATE		-5	-10	2F	8F
COLON		8/17	8/20	8/21	8/24
		A	B	C	D
1	COMP. ROTOR		✓	✓	✓
2	676 ROTOR				✓
3	P/T ROTOR				✓
4	ROZ # 1 SEG:				✓
5	ROZ # 2				✓
6	ROZ # 3				✓
7	CASE # 1				✓
8	CASE # 2				✓
9	COMB. LINER				✓
10	COMB. CASES				✓
11	STATOR CASES				✓
12	COMP. R/FRAME				✓
13	EXHAUST CASE	✓	✓		✓
14	SEAL WSG. REAR				✓
15	SEAL AIR				✓
16	RING SEAL				✓
17	HSG. BRG. FWD.				✓
18	FRM FK CASE	✓			✓
19					
20					
21					
22					
23					
24					

Figure 9. Critical shortage chart.

FUNCTION: "HI - BURNER"		SUBJ: 4-81 PRODUCTION SCHED.	EFFECTIVE DATE: JULY 1981	PAGE 2 OF 3											
TO: DISTRIBUTION		FROM: 571-61	SIGNED: H.F. BAXTER	DATE: 13 JUNE 81											
SHOP	FGC.	NOMENCLATURE	SHOP TOT. TAT. REQ.	CUMULATIVE SHOP PRODUCTION SCHEDULE											
				7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19
6411	LL6A	J79 SCAV. PUMP	18 15	1	3	4	5	6	8	9	10	11	12	14	15
"	QWRA	T58 FLOW DVDR.	12 32	3	5	8	11	13	16	19	21	24	27	29	32
"	RNJA	T58 LUBE PUMP	14 40	4	7	10	14	17	20	24	27	30	33	37	40
"	XMHA	T58 PIT ACC. DRV.	14 15	1	3	4	5	6	8	9	10	11	13	14	15
"	XPSA	T58 FLOW DVDR.	12 10	1	2	3	3	4	5	6	7	7	8	9	10
6414	SENA	J79 E.G.T. SWITCH	14 30	3	5	8	10	13	15	18	20	23	25	28	30
"	STVA	J79 NOZZ. CONT.	20 30	3	5	8	10	13	15	18	20	23	25	28	30
"	B9BA	J79 NOZZ. CONT.	13 7	1	1	2	2	3	3	4	4	5	6	6	7
"	DK65	T58 IGN. UNIT.	20 18	2	3	5	6	8	9	10	12	13	15	16	18
"	EPPA	H46 ROTOR DMPR.	18 50	4	8	13	17	21	25	29	33	37	41	45	50
6415	K431	J79 FUEL NOZZLE	15 45	4	8	11	15	19	23	26	30	34	37	41	45
6416	ALYA	J79 FUEL CONTROL	37 22	2	4	6	8	9	11	13	15	17	18	20	22
"	E9BA	J79 FUEL CONTROL	28 2	0	0	0	0	0	1	1	1	2	2	2	2
"	E9SA	T58 FUEL PUMP	17 50	4	8	12	17	21	25	29	33	37	41	45	50
"	JM3A	T58 PURIFIER	13 35	3	6	9	12	15	18	20	23	26	29	32	35
"	NO9A	T64 FUEL CONT.	52 20	2	4	5	7	9	10	12	14	15	17	19	20
"	QAYA	T58 FUEL CONT.	33 40	3	7	10	13	16	20	23	26	30	33	36	40
"	VE8A	T58 FUEL CONT.	31 15	1	3	4	5	6	8	9	10	11	13	14	15
6421	EUCO	J79 TURB. NOZZLE	18 250	21	43	63	83	104	125	146	167	188	208	229	250
SCHEDULE OR STATUS SHEET (UNIVERSAL)				1110-NAVJAG/AC-4851/5 (REV. 5-81)											

Figure 10. Hi-burner report.

FLOW PROCESS CHART										NUMBER		PAGE NO.		NO. OF TABLES																					
PROCESS										1		2		3																					
Gae Generator (T-64)										SUMMARY																									
<input type="checkbox"/> MAN OR <input checked="" type="checkbox"/> MATERIAL CHART BEGINS Loading section CHART ENDS Shop PC pickup area CHARTED BY T. P. Enderswick DATE 7/ /81 ORGANIZATION 96315 Shop										ACTIONS		PRESENT		PROPOSED		DIFFERENCE																			
										NO. TIME		NO. TIME		NO. TIME																					
										OPERATIONS																									
										TRANSPORTATIONS																									
										INSPECTIONS																									
										DELAYS																									
										STORAGES																									
										DISTANCE TRAVELLED (Feet)																									
DETAILS OF <input checked="" type="checkbox"/> PRESENT <input type="checkbox"/> PROPOSED METHOD										OPERATION		TRANSPORTATION		INSPECTION		DELAY		STORAGE		DISTANCE IN FEET		QUANTITY		TIME		ANALYSIS		NOTES		ANALYSIS					
										1		2		3		4		5		6		7		8		9		10							
1 Generator loaded in ehop										●	●	□	◇	▽					70																
2 Record in log book										●	●	□	◇	▽					20																
3 Unit transported to work bench										○	●	□	◇	▽					36																
4 Examination of paper work for work required										○	●	□	◇	▽					-																
5 Disassemble generator										●	●	□	◇	▽					-																
6 0-3 parts (examine & inspect)										○	●	□	◇	▽					-																
7 Designate work to be done on paper and cards										●	●	□	◇	▽					-																
8 Tag and route parte										●	●	□	◇	▽					-																
9 Transact unit										●	●	□	◇	▽					180																
10 Remaining nuts, bolts and paper work in basket										●	●	□	◇	▽					-																
11 Basket in mechanic's storage										○	●	□	◇	▽					28																
12 Parts all or partly arrive from PC pool										○	●	□	◇	▽					-																
13 Transport from storage to bench										○	●	□	◇	▽					28																
14 Check paper and parts for work done										○	●	□	◇	▽					-																
15 Partial assembly when only limited parts are in										●	●	□	◇	▽					-																
16 Complete assembly when all parts available										●	●	□	◇	▽					-																
17 Transact unit										●	●	□	◇	▽					140																
18 Prepare for balance shop mount bal. bearings										●	●	□	◇	▽					-																
19 Transport to balance shop area										○	●	□	◇	▽					52																
20 Balance generator										●	●	□	◇	▽					-																
21 Transact unit										○	●	□	◇	▽					180																

Figure 11. Flow process chart.

Table 1 shows the workload percentage required by representative units for these shops. This table shows that (1) the PPD reworks and overhauls a fairly representative cross section of the engines and their components, (2) the steps within the processes include the entire range of rework activities (e.g., disassembling, inspecting, reworking parts, assembling, balancing, and testing), and (3) the identified processes cover between 65 to 100 percent of each shop's workload. Thus, it appears that all the shops are suitable for participating in the PEP. All processes listed in the flow charts each require one artisan to complete and transact. The one exception to this is in shop 96314, where the disassembly process of the basic engine requires two mechanics. After that step, however, the two mechanics individually disassemble the engine subassemblies (components) and transact the completed work.

Table 1
Workload Percentage Required by Representative
Units by Selected PPD Shops

Representative Units for Rework/Overhaul	Reference Engine	Percentage of Workload	Number of Steps	Number of Transactions
T-64 Small Engine Rework and Tests Shop (96314)				
1. Gas generator	T-64	5	26	4
2. Torque sensor rework	T-64	5	22	5
3. Power rotor turbine	T-64	8	18	5
4. Engine drive shaft	T-64	8	21	3
5. 413 compressor	T-64	8	52	2
6. Balance processes	T-64	8	8	1
7. Engine subassembly; disassemble	T-64	37	7-19 ^a (Avg 13)	2-6 ^a (Avg 4)
8. Engine subassembly; assemble	T-64	7	5	1
9. Engine assemble	T-64	7	5	1
10. Engine test	T-64	7	6	1
^a Depends on number of subassemblies to be disassembled				
Gearboxes/Electrical Shop (96411)				
1. Bungee (rod-flap RFL) recondition	---	15	22	4
2. Repair ignition exciter box	T-64	15	26	4
3. Electrical harness	---	10	10	2
4. Gearbox; transfer gearbox	J-79	60	24	2
Oil/Fuel Pumps, Filters, Actuators, and Accessories Shop (96412)				
1. Lub. pump	T-58	20	25	5
2. Hydraulic pump	---	10	15	3
3. Fuel pump	J-79	25	26	5
4. After burner fuel control	---	20	24	4
5. Other	---	25	--	-
Fuel Controls Shop (96413)				
1. Main fuel control (disassemble, exam., and route)	J-79	10	19	2
2. Main fuel control (disassemble, exam., and route)	T-58	10	20	2
3. Fuel control (assembly and test)	Both	75	17	3
4. Other	---	5	--	--
Fuel Accessories and Valves Shop (96414)				
1. Fuel nozzles	T-64	30	26	2
2. Pilot valves	---	50	20	5
3. Flow dividers	---	15	20	5
4. Others	---	5	--	-
Nozzle and Weld Shop (96421)				
1. Combustion liner reconditioning	T-58	5	11	4
2. First-stage nozzle reconditioning	J-79	35	24	9
3. Second-stage nozzle reconditioning	J-79	35	25	7
4. Other rework processes	---	25	--	-
Metal and Weld Shop (96422)				
1. Transition duct	J-79	40	12	2
2. Combustion liners	J-79	30	6	2
3. Combustion liner (disassembly and repair)	J-79	30	10	3
Machine Shop (Small) (96424)				
1. Transfer gearbox	J-79	30	16	4
2. Engine front frame	T-64	35	13	1
3. Other rework processes	---	35	--	-

Mini-survey Results

Results of the mini survey, which are presented in Table 2, shows that, on the average, foremen felt the six criteria rated were being met over 80 percent of the time.

Table 2
Degree to Which PPD Shops Meet Criteria

Shops	Criteria						Average (%)
	Work Measured Objectively (%)	Work Could be Measured Objectively (%)	Valid Standards in Place (%)	Performance Tied to Individual (%)	Work Re-curring in Nature (%)	Work Pace Tied to Individual (%)	
96314	90	83	69	94	100	96	88.7
96411	60	80	80	25	90	70	67.5
96412	75	30	75	50	85	75	73.3
96413	100	75	75	100	100	100	91.7
96414	50	75	75	90	95	95	80.0
96421	90	90	75	100	100	90	90.8
96422	90	90	95	85	85	80	87.5
96424	90	90	85	85	90	80	86.7
Average	80.6	82.9	78.6	78.6	93.1	85.8	83.3

Recommended Experimental and Control Shops

The shops recommended for inclusion in the experimental and control groups are listed in Table 3. As shown, the two groups are remarkably similar in terms of the four criteria used for selection. The first set of shops was selected as the experimental group over the second set because it contains shops from a wide cross-section of the PPD.

Table 3
Recommended Experimental and Control Groups

Shop Number	Criteria			
	Percentage of criteria met	Percentage of workload covered by PFCs	Number of people in the shop	Ratio of steps per transactions
Experimental Group				
96314	89	100	20	6.5
96411	68	100	14	6.9
96421	90	75	35	3.0
96424	87	75	16	5.8
Average	83.5	85.0	21.3	5.6
Control Group				
96412	73	75	13	5.3
96413	91	75	32	8.0
96414	80	95	18	5.5
96422	88	100	29	4.0
Average	83.0	86.3	23.0	5.7

Impediments to Productivity.

Some of the impediments listed below can be eliminated or reduced by PPD management, and others cannot. Most of them can affect one or more of the PPD shops at any given time; a few affect a shop's productivity constantly. The P&E group can provide more information on impediments 1-3; and the QA group, on impediment 4.

1. Withdrawal of rework funds. When NARF customers withdraw rework funds to support emergency operations elsewhere, a stop order is issued and reworking is halted on the set of engines affected, wherever this work may be in the PPD.

2. Engine arrival delays. Although schedules on the number and types of engines to be handled are developed annually and updated quarterly, operational circumstances (e.g., an emergency deployment) can delay engine arrivals, resulting in a temporary low level of available work.

3. Accelerated schedules. Because of insufficient backlog, overtime generated through the successful shops due to accelerated fleet replacement needs is followed by a period of very low workloads.

4. Engine failure messages. When the fleet experiences repeated engine failures that appear to have similar causes, NARF is advised to discontinue rework on the particular type and series of engines until a cause determination is made.

5. Rework done by other divisions. When engine parts are routed for reworking to other NARF divisions (e.g., to the Metal Manufacturing Processing Division for replating work) that have their own schedules, inordinate delays may occur, impeding the PPD work flow.

6. Production control personnel shortages. While the Production Control (PC) staff is generally viewed as productive, these are not enough people to move parts and material between and within shops and perform other PC functions. Consequently, the practice is to have shop personnel provide support (i.e., in moving materials and making up hardware kits (nuts, bolts, & washers). This practice is well known within the PPD but it is not reflected in the labor reports.

7. Delays in parts availability. Although assembly and rework processes require an orderly arrival of parts, many delays occur because (a) parts are not available or are misrouted, and (b) shops may accumulate parts to be reworked, to save set-up time, without realizing that those parts are needed by rework or assembly workers in other shops.

8. Work specialization. Work specialization, especially prevalent among some of the older artisans, proves disruptive when specialists are ill or on leave. To discourage this practice and prevent future occurrences, supervisors are rotating workers among the various operations within the shop.

9. Personnel procedures. Supervisors and managers, at all levels, must spend a disproportionate amount of time meeting the collective requirements of personnel directives, instructions, and union agreements.

10. Required absence of the foreman. Shop productivity has suffered because shop foremen are required to spend increasing amounts of time away from the shop attending

to personnel programs and other matters, leaving his alternate in charge. The alternate cannot be expected to do as effective a job as the foreman.

11. Foreman rotation. Shop foremen need technical, administrative, and managerial skills if they are to maintain and/or improve productivity. The NARF practice of rotating foremen among shops is unproductive, in that it often results in a first-line supervisor with less shop knowledge than the workers and, to some extent, places the foreman at the mercy of his workers. A foreman should be rotated only for "cause."

12. Equipment breakdowns. While breakdowns are to be expected with any equipment, older equipment breakdowns are more frequent. The equipment in some of the shops is long overdue for replacement.

13. Equipment out of alignment. Unaligned equipment that is not detected leads to unnecessarily long processing time (e.g., balancing) as well as to poor quality. Alignment problems can be due to (a) aging equipments, which do not hold their alignments as well as newer equipments, (b) the possibility that the equipment was not properly aligned in the first place, and (c) "drifting" resulting from normal use.

14. Time standards on work cards. All foremen interviewed felt that time standards should be removed from work cards because workers completing a rework process before the time specified often view the remaining time as "free time." Since the time required to rework a part depends upon its condition or state of disrepair, the time standard represents more of an average than a set time.

CONCLUSION

The results of this study indicate that the PPD is a sound candidate for the development of a PEP. The PPD organization will work with the research team to eliminate any impediments or control their affects, thereby creating the proper environment to develop the program.

DISTRIBUTION LIST

Chief of Naval Operations (OP-115) (2), (OP-135C4), (OP-140F2), (OP-987H)
Chief of Naval Material (NMAT 0722)
Chief of Naval Research (Code 270), (Code 440) (3), (Code 442), (Code 442PT)
Chief of Naval Education and Training (00A), (N-21)
Chief of Naval Technical Training (016)
Commandant of the Marine Corps (MPI-20)
Commander Naval Military Personnel Command (NMPC-013C)
Commander Navy Recruiting Command (Code 20)
Commanding Officer, Naval Aerospace Medical Institute (Library Code 12) (2)
Commanding Officer Naval Technical Training Center, Corry Station (Code 101B)
Commanding Officer, Naval Training Equipment Center (Technical Library) (5), (Code N-1)
Commanding Officer, Office of Naval Research Branch Office, Chicago (Coordinator for Psychological Sciences)
Commander, Army Research Institute for the Behavioral and Social Sciences, Alexandria (PERI-ASL), (PERI-ZT), (PERI-SZ)
Commander, Air Force Human Resources Laboratory, Brooks Air Force Base (Manpower and Personnel Division), (Scientific and Technical Information Office)
Commander, Air Force Human Resources Laboratory, Williams Air Force Base (AFHRL/OT), (CNET Liaison Office (AFHRL/OTLN))
Commander, Air Force Human Resources Laboratory, Wright-Patterson Air Force Base (AFHRL/LR)
Commanding Officer, U.S. Coast Guard Research and Development Center, Avery Point
Institute for Defense Analyses, Science and Technology Division
Defense Technical Information Center (DDA) (12)

DATE
FILME