ENGINEERED LABOR STANDARDS
IN THE
MANUFACTURE OF SHEETMETAL CASE GOOD ITEMS

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BATH IRON WORKS CORPORATION

Engineered Labor Standards
in the
Manufacture of Sheetmetal Case Good Items

FINAL REPORT
Task ES-8-12

Submitted to:
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MarAd Program Manager and Chairman
SNAME Panel SP-8 on Industrial Engineering
Bath Iron Works Corporation
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Conducted by:
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Date: August, 1984

This project is managed and cost-shared by Bath Iron Works Corporation for the National Shipbuilding Research Program. The program is a cooperative effort of the Maritime Administration's Office of Advanced Ship Development, the U.S. Navy, the U.S. shipbuilding industry, and selected academic institutions.

SHIP PRODUCIBILITY RESEARCH PROGRAM

SNAME PANEL SP-8 ON INDUSTRIAL ENGINEERING

TASK ES-8-12

FINAL REPORT

ENGINEERED LABOR STANDARDS IN THE MANUFACTURE OF SHEETMETAL CASE GOOD ITEMS

August, 1984

Bath Iron Works Corporation

M.W.

M. W. Cunningham III
Project Engineer

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Project Manager

I. Background

In June, 1983, Bath Iron Works (BIW) requested a “no cost” extension of its Phase III/FY-82 Shipyard Data application Program, Task ES-8-12, to allow the performance of a short term project titled, ’’Engineered Labor Standards in the Manufacture of Sheetmetal Case Good Items.” The effort would focus on evaluating MOST(1) developed labor standards for shop control/scheduling and determining machine/work center capacity. The proposed project would supplement work already done by National Steel and Shipbuilding Company (NASSCO) in the sheetmetal area as well as broaden the base of sheetmetal data available to the shipbuilding industry. On August 10, 1983, after a ballot by Panel SP-8 members, BIW received permission from the MarAd Program Office to proceed with the projec

II. Introduction

The BIW Sheetmetal Shop has approximately 200 employees working in two separate facilities. The main shop fabricates and assembles ventilation ductwork and custom flat work such as small foundations bins, racks, dressers. The main shop also fabricates parts for hig volume case good items; i.e. lockers, bunks, power and lighting panels. These case goods are then sent to another building, Hyde South Assembly, where they are formed, spot welded and finally assembled.

(1) MOST (Maynard Operation Sequence Technique) is a predetermined time system developed by the H. B. Maynard Co.

The main Sheetmetal Shop operates three full shifts, while the Hyde South operation works a full first shift with second and third shift support only as needed.

Scheduling of work is recognized as a problem, resulting overtime and an extensive multi-shift operation. Shop scheduling is currently done by job number (2) where each job number is slotted within a 10-week window. This “lO-week rule” often results in either too much or too little work at various shop operations, necessitating reassignment of workers and/or overtime.

III. Objectives

The primary objectives of the project were to apply engineered labor standards:

- o To determine machine efficiencies in order to balance machine loading.
- o As a base for shop floor control procedures to facilitate sho loading, manning, scheduling.
- o To evaluate make/buy comparisons for sheetmetal case good items.

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(2) Job numbers are assigned by the Planning Department and refer to material for a shipset or construction zone.

IV. Approach

A. Task 1 - “Establish engineered labor standards as needed for high volume sheetmetal case good items such as bunks, lockers, and power and lighting panels, This would supplement data developed under Phase III by NASSC0.”

To avoid duplicating data that had already been developed, the MOST data base developed by NASSCO was reviewed. Although the work NASSC0 did covered ventilation ductwork, there were a few sub-operations that were applicable to case good items. These sub-operations; however, were not directly transferable because they covered segments of work that were not compatible with the segments BIW was using, For example, the sub–operation for assembling elbow included riveting the joint, Riveting operations were also needed for case good items, but because riveting was included in NASSC0’s assembly operation, it could not be transferred directly to BIW’s application. Instead, the actual riveting portion was broken out and loaded into the data base as a stand-alone sub-operation which could be used anywhere a riveting operation was needed.

In order to build standards for the manufacture of lockers, supplemental data for shearing, forming, spot welding, punching, an assembly were developed. In all, 48 sub-operations and titlesheets were created and are listed in Appendix A.

This data, together with what NASSC0 developed, should cover th majority of work found in any sheetmetal shop.

B. <u>Task II</u> – “Document the validity and reliability of engineered labor standards for these high volume case good items by comparing these labor standards to existing operations analyses and to historical labor hours."

Are labor standards developed with the "MOST" system reliable as a predictive tool?

The answer to that question is yes!

Two types of lockers built in the sheetmetal shop were used as a test. Level time standards were developed (see Appendix B for samples of the forms used for this task) for each locker at each machine/work center and then totaled to give the overall time for one locker of each type. The machine/work centers covered include the forming area, spot weld area, riveting and assembly areas. The standards were then compared to actual returned labor hours for those products for each of the machine/work centers.

Since the standards did not contain a performance allowance, there was a difference between the standard time and the actuals. This difference was consistent between all work centers, thereby demonstrating the reliability of the standards,

To be accurate, the standards must reflect “real world” conditions. A performance factor must be added to compensate for day to day inefficiencies of the workplace. The factor used was determined by a random time work sampling. A total of 732 observations were made over a period of six working days. The work sampling work sheet (see (Appendix C) identified two major categories of time; productive and non-productive. Productive time included fabrication, assembly, machine usage and material handling activities. Non-productive time included personal time, missing from job site, breakdowns, illness, interference, and an “other” category to include anything else that might reduce productivity. When the standards, with the performance factor, were compared to actual times, there was no significant difference; i.e. less than 6%,

The standards which were developed for this evaluation were shown to be reliable and an accurate measure of work content.

C. Task III - “Apply the labor standards as a tool to aid in developing make/buy decisions. By applying labor and overhead rates to the engineered standards, a determination can be made whether it is more cost effective to make in–house or purchase from an outside source.”

Make vs. buy analyses are often not done for such reasons as: too time-consuming, impossible to make an accurate comparison, or not enough base data available to build a reliable analysis. Engineered standards provide a flexible data base that is easily adapted to new products. The data that was developed was used to calculate the standard time to fabricate a cabinet enclosure. That information was then used to validate a manhour estimate for a new product. With the engineered standards, any new product (cabinet enclosure, vanity, locker, etc.) can be analyzed to determine whether it would be more cost effective to make in-house or to buy from a vendor.

D. Task IV – “Determine machine capacities and efficiencies by applying engineered labor standards to each machine. This will enable the shop planners to balance the workload among the machines and thus provide smoother schedules. By accurately determining the efficiency of each machine, such as a press brake, we can compare the shop capacity to the projected workload to determine if more machines are needed or if overtime must be planned for."

Data developed during this project was used to determine the capacities of the various work centers in the Sheetmetal Shop. The individual work center capacities were then combined to indicate total shop capacity, That exercise indicated that under a heavy workload, we would need additional capacity at the CNC Turret Punch Press work center.

E. Task V - “Use engineered labor standards to establish shop control procedures to be used for shop scheduling and manning, Good, realistic scheduling requires accurate and consistent labor hour estimates for the projected workload. Engineered labor standards fill this requirement. Being able to predict how many manhours will be required to perform the work will enable the shop managers to efficiently man the facility.”

Prior to developing a scheduling system or shop controls for BIW’s Sheetmetal Shop, a survey was done of the work accomplished by Peterson Builders, Inc. (PBI) in their pipe shop and by NASSC0 in their sheetmetal shop. Both PBI and NASSCO claimed significant manhours could be saved by using engineered standards and implementing shop controls and scheduling systems. To avoid as many problem areas as possible, it was decided to examine more closely the system and procedures NASSC0 was developing. At NASSC0’s invitation, Mr. Ron Belanger (Assistant Foreman of the Sheetmetal Shop) and Mr. Maurice Cunningham III visited NASSCO to get a better understanding of their scheduling system and how it could be used at BIW. The following is an excerpt from the trip report for the visit. The full report appears in Appendix D.

> “We met with Mr. Irwin Struss (General Superintendent for Sheetmetal and Electrical), Mr. Cal Files (Assistant Superintendent for Sheetmetal), Mr. Harry Strake (Supervisor of Planning for Sheetmetal and Electrical), Mr. (Alan McQuaide (Assistant General Foreman, Electrical), and Mr. Bill Oakes (Senior Industrial Engineer) to discuss their system, how it was developed, how it was being implemented, and what the benefits of such a scheduling system might be."
>
> “From our discussions with these gentlemen, it was clear that they are all solidly supportive of scheduling systems based on engineered labor standards, Although they have no hard numbers at this time, they feel that simply by using engineered labor standards, the productivity of their shop will improve by at least 30%. Level loading the shop and smoother scheduling will reduce idle time, maximize machine utilization, and reduce overtime."

The accuracy and reliability of the standards, coupled with the benefits of better shop control, have led to a pilot implementation of a scheduling program in BIW’s Sheetmetal Shop.

V. Summary of Results & Conclusions

The following results were achieved from BIW’s efforts in the Sheetmetal Shop case good area.

° Data was developed for forming, spot welding, and assembling case good items. Also, data was input to the data base which covers shearing and CNC Turret Punch Press operations. This data, along with data developed for ventilation duct work at NASSCO, should facilitate the development of engineered labor standards for a wide variety of sheetmetal products.

° Engineered labor standards were compared to actual hours for two types of lockers to verify that engineered standards are reliable predictive tools.

° By using the data developed for case good items, labor standards were established for a potentially new product (cabinet enclosure), confirming the flexibility of the data as well as its usefulness for simulations.

o The engineered data was also used in developing machine and work center capacities to more easily determine if the shop has adequate capacity to efifciently handle anticipated workloads.

- A work sampling analysis identified the potential for 20–30% labor savings in the sheetmetal case goods area, Based on conversations with personnel at NRSSCO, these savings can be achieved through the use of shop controls based on engineered labor standards,

Furthermore, it can be concluded from the PBI pilot project, information supplied by NASSC0, and this BIW project, that:

- Engineered labor standards facilitate methods improvement analyses, Simulations can be performed and the impact o-F method changes quantified without actually testing the ideas on the shop floor,
- Engineered labor standards provide solid backup data to justify capital acquisitions of equipment or facilities,
- The use of engineered labor standards provides a consistent means of developing schedules which will not be affected by the loss of key personnel.
- The ability to accurately predict the manhours required for a given workload and schedule that work properly will reduce peaks and valleys which potentially would, in turn, reduce the need for overtime or periodic layoffs,

VI. Follow-On Activity

As a result of the recently completed project, BIW will continue its effort in the Sheetmetal Shop to implement a shop control/scheduling system.

The information formulated under this program will be used as the base for the pilot implementation project, targeted for completion at the end of 1984,

The first step will be to determine work center parameters, such as "bends," for press brakes. Each parameter will be selected for its ease of application; for instance, each product has a bend instruction booklet, so determining the number of bends is a simple task, The second step will be to assign a time value to each work center parameter. A shop planner could then take a product, count the number of bends and determine the manhours required for that product at the press brake work center,

The labor required for products at each work center will be established and formatted in a manner to simplify application. The manhours can then be used for shop scheduling and level loading of key work centers.

SHEETMETAL DATA

APPENDIX A

1391. CHANGE DIE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
PART OF THE SET UP OPERATION

1392. ALIGN (BOTTOM) DIE ON BRAKE WITH HAND AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
ALIGN BOTTOM DIE WITH TOP DIE

1393. MOVE (ALIGNMENT) FLAT BAR ON BRAKE WITH HAND AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
ONLY COVERS HANDLING THE TWO ALIGNMENT BARS

1394. SET-UP BACKGAUGE ON BRAKE WITH HAND AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
SET-UP BACKGAUGE PRIOR TO MAKING ANY BENDS

1395. MOVE PRESS BRAKE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
SIMPLY RUN THE BRAKE DOWN TO SEE THAT THE DIES LINE UP

1396. SET-UP CONTROL BOX ON BRAKE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
INPUT THE BEND DIMENSIONS

1397. BEND (SCRAP) PLATE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
TESTING MACHINE SETTINGS.

1398. POSITION SHIM IN BRAKE WITH HAND AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
SHIMS GO UNDER THE BOTTOM DIE.

1399. BEND PLATE ON BRAKE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
ESTIMATE THAT EACH FLATE WILL HAVE TWO BENDS BEFORE ASIDING THE PLATE,

1400. MOVE PLATE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
PARTS ARE PLACED IN THE OUT-BASKETS TO AWAIT SHIPMENT TO THE NEXT WORK STATION,

1401. BEND FLATE ON BRAKE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
ESTIMATE THAT EACH PLATE WILL HAVE TWO BENDS BEFORE ASIDING THE PLATE+

1402. TITLESHEET

BENDING BRAKE SHEET METAL SHOP

1403. ALIGH (BOTTOM) DIE ON BRAKE WITH HAND AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
ALIGN BOTTOM DIE WITH TOP DIE

1404. MOVE (ALIGNMEMT) FLAT BAR 0N BRAKE WITH HAND AT (BENDING AREA) SHEET METAL SHOP SHEET METAL

ONLY COVERS HANDLING THE TWO ALIGNMENT BARS

1405. SET-UP BACKGAUGE ON BRAKE WITH HAND AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
SET-UP BACKGAUGE PRIOR TO MAKING ANY BENDS

1406. SET-UP CONTROL BOX ON BRAKE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
INPUT THE BEND DIMENSIONS TO THE BACK GAUGE CONTROL BOX+

1407. POSITION SHIM IN BRAKE WITH HAND AT (BENDING AREA) SHEET-METAL SHOP SHEET METAL
SHIMS GO UNDER THE BOTTOM DIE+

1408. BEND PLATE ON BRAKE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
ESTIMATE THAT EACH PLATE lIiDILL HAVE TWO BENDS BEFORE ASIDING THE PLATE+

1409. SET-UP (AND TEAR DOWNM) GAUGE (FRONT) (ON BRAKE AT (BENDING AREA) SHEET METAL SHOP SHEET METAL
FRONT GAUGE USED TO INSURE PROPER SIZING OF FINISHED PRODUCT.

1426. SET-UP SWITCH FOR SPOT-WELIIER AT (SPOT-WELDING-AREA) SHEET METAL SHOP SHEET METAL
TURN POWER ON

1427. CHANGE FILTER (WATER) ON SPOT-WELDER AT (SPOT-WELD-AREA) SHEET METAL SHOP SHEET METAL
FILTERS ARE IN CANISTERS BEHIND THE SPOT-WELDER

1428. CHANGE TIP (POINTS) ON SPOT-WELDER AT (SPOT-kiELI!ING-AREA) SHEET METAL SHOP SHEET METAL
CHANGE FROM STRAIGHT TO OFFSET OR VICE VERSA

1429. CLEAN TIP (POINTS) ON SPOT-WELDER AT (SPOT-WELDING-AREA) SHEET METAL SHOP SHEET METAL
NEED TO CLEAN THE POINTS TO INSURE GOOD WELDS

1430. ASSEMBLE SHAPEDS PLATE (S) FOR SPOT-WELDER AT (SPOT-WELDING-AREA) SHEET METAL SHOP SHEET METAL
BUILDING SUB-ASSEMBLIES

1431. WELD (SPOT-WELD) SHAPED PLATE (S) ON SPOT-WELDER AT (SPOT-WELD-AREA) SHEET METAL SHOP SHEET METAL
MACHINE IS ALL READY TO GO AND THE PARTS ARE AT THE MACHINE+

1432. REMOVE ASSEMBLY (SUB) AT (SPOT-WELDING-AREA) SHEET METAL SHOP SHEET METAL
RETURN THE SUB-ASSEMBLY TO THE WORK-BENCH AFTER THE SPOT WELES HAVE BEEN MADE.

1433. MOVE ASSEMBLY (SUB) AT (SPOT-IJELLIIMG-AREA) SHEET METAL SHOP SHEET METAL
HAND CARRY THE SUB-ASSEMBLIES FROM THE WORK-BENCH TO THE OUT-BASKET

1434. TITLESHEET

SPOT-WELDING SHEET METAL SHOP

1453. RIVET (SHEETMETAL) ASSEMBLY FOR (FINAL ASSEMBLY) WITH RIVET GUN AT
(RIVET AND ASSEMBLY AREA) SHEET METAL SHOP SHEET METAL
OF THE TWO PARTS TO BE ASSEMBLED, ONE IS FREPUNCHED,

1454. MOVE SHAPED PLATE (PARTS) FOR (RIVETING) WITH RIVET GUN AT (RIVET AND
ASSEMBLY AREA) SHEET METAL SHOP SHEET METAL
MOVE BY HAND

1455. ASSEMBLE (FINISHED) ASSEMBLY AT (RIVET AND ASSEMBLY AREA) SHEET METAL
SHOP SHEET METAL
MOST OF THESE PARTS SIMPLY POP INTO PLACE+

1456. DRILL (HOLE) IN (THIN MATERIAL,<1/8") WITH DRILL AT (RIVET AND ASSEMBLY
AREA) SHEET METAL SHOP SHEET-METAL
USUALLY TWO HOLES ARE DRILLED AT THE SAME TIME

1457. MARK (HOLE LOCATION) ON (SHEETMETAL PARTS) WITH MARKER AT (RIVET AND
ASSEMELY AREA) SHEET METAL SHOP SHEET METAL
USE EITHER GREASE PEN OR MARKER TO MARK HOLES,

1458. TITLESHEET

RIVETING AND ASSEMBLY SHEET METAL SHOP

1459. MOVE (FINISHED) ASSEMBLY AT SHEET METAL SHOP SHEET METAL
HAND CARRY ASSEMBLY

1460. ASSEMBLE SHAPED PLATE (S) FOR SPOT-WELDER AT (SPOT-WELDING-AREA) SHEET
METAL SHOP SHEET METAL
BUILDING SUB-ASSEMBLIES

1461. REMOVE ASSEMBLY (SUB) AT (SPOT-WELDING-AREA) SHEET METAL SHOP SHEET
METAL
RETURN THE SUB-ASSEMBLY TO THE WORK-BENCH AFTER THE SPOT WELDS HAVE
BEEN MADE,

1462 MOVE (SUB) ASSEMELY AT SHEET METAL SHOP SHEET METAL
MOVE PARTS FROM BENCH TO MACHINE

1463. INSPECT (SUB) ASSEMBLY AT SHEET METAL SHOP SHEET METAL
LOOK PART OVER

1464. INSPECT (SUB) ASSEMBLY AT SHEET METAL SHOP SHEET METAL
WORK THE PART TO MAKE SURE IT FITS PROPERLY,

1466. ASSEMBLE DOOR ON LOCKER AT SHEET METAL SHOP SHEET METAL
ASSEMBLE LATCH ROD AND HANDLE MECHANISM

1467. INSTALL DRAWER IN LOCKER AT SHEET METAL SHOP SHEET METAL

```
      TAP CORNERS SQUARE

1468. COMBINED  SUB-OP

      ASSEMBLE DOOR FOR LOCKER AT SHEET METAL SHOP SHEET METAL
       ASSEMBLE THE ROD AND HANDLE

1469. FLAME CUT PLATE ON TURRET PUNCH PRESS WITH PLASMA AT SHEET METAL SHOP
      SHEET METAL
      TURRET PUNCH PRESS IS NUMERICALLY CONTROLLED

1470. PUNCH PLATE ON TURRET PUNCH PRESS AT SHEET METAL SHOP SHEET METAL
      TURRET PUNCH PRESS IS NUMERICALLY CONTROLLED

1471. MOVE PLATE ON CART AT SHEET METAL SHOP SHEET METAL
      MOVE SHEETS FROM NEARBY STORAGE TO THE MACHINES FOR PROCESSING,

1472. SHEAR PATE ON SHEAR AT SHEET METAL-SHOP SHEET METAL
      GATE SHEAR; TIME PER STROKE,

1473. TITLESHEET

      CUTTING, PUNCHING, SHEARING           SHEET METAL SHOP


ENTRIES FOUND: 48

Enter <H, LN, R, SE, or EX> ?
```

TIME STANDARDS DOCUMENTS

APPENDIX B

COUNTING SHEET

A document for recording the necessary frequencies for each work element at a given work center. The top half of the form is the header information which identifies the part, product and work center. The bottom half lists the work elements and provides space for making the count.

PRESS BRAKE COUNTING SHEET

DETAIL/UNIT/PART		REV. LTR/DATE	
PROCESS/OPER CODE	FORMING	STANDARD CODE	PROD
PART NAME			
SHIP CLASS	FFG-7	HULL	384
COST CLASS/JOB #	PIECE	TRADE	SHEET METAL
GROUP (UNIT/ZONE)	2100	WORK AREA	X
SUB-GROUP	X	WORK ZONE	2
SUB-SUB-GROUP		WORK CENTER	PRESS BRAKE
CREW/MACHINE	1	ASSET/MACHINE	X
ITEM	X	SUB-ITEM	
GEN. DRAWING	322-8040	WORK ORDER	B-2 LOCKER
DET. DRAWING		SHEET	
WORK PACKAGE	322-8041	APPLICATOR	MWC
OPER. DESCRIPTION	FORMING OPERATIONS FOR A SHIPSET of B-LOCKERS FACTORED DOWN TO PROVIDE THE TIME FOR A SINGLE		
DATE	27 SEPT 83	ISSUE #	1
PIECES PER JOB			

#	WORK ELEMENT DESCRIPTION	BASE FREQ.	OPERATION	FREQ. PER PART	PIECES PER JOB/SHIP	TOTAL FREQ. /
1	SET-UP FRONT GAUGE	1	PER EACH FRONT GAUGE		/	/
2	CHANGE DIE	2	PER BEND TYPE		/	/
3	MOVE ALIGNMENT BARS	1	PER BEND TYPE		/	/
4	SET-UP BACK GAUGE	1	PER BEND TYPE		/	/
5	CYCLE PRESS BRAKE	1	PER BEND TYPE		/	/
6	SET CONTROL BOX	1	PER BEND TYPE		/	/
7	ALIGN BOTTOM DIE	1	PER BEND TYPE		/	/
8	BEND SCRAP PLATE	3	PER BEND TYPE		/	/
9	POSITION SHIM	2	PER TWO LINEAR FEET		/	/
10	BEND PLATE	1	PER TWO BENDS		/	/
11	MOVE PILE OF PLATES	1	PER PILE OR BATCH		/	/

>

STANDARD CALCULATION SHEET

This is the heart of the H. B. Maynard "Time Standard Calculation" Program. Frequencies gathered on the "Counting Sheet" are applied to the appropriate method steps. The program then calculates the level time, applies the performance factor, and gives the standard time per piece or per batch.

BATH IRON WORKS

STANDARD CALCULATION SHEET

(Time Standards Calculation Program)

Detail/Unit/Part	STANDARD	Rev. Ltr/Date	1
Process/Oper Code	SPOT WELDING	Standard Code	PROD
Part Name	X		
Ship Class	FFG-7	Hull	384
Cost Class/Job #	SUB-ASSEMBLY	Trade(s)	SHEET METAL
Group (Unit/Zone)	2100	Work Area	X
Sub-Group	X	Work Zone	2
Sub-Sub-Group	X	Work Center	SPOT WELDER
Crew/Machine	1	Asset/Machine	X
Item	X	Sub-Item	X
Gen. Drawing	322-8040	Work Order	B-1 LOCKER
Det. Drawing	X	Sheet #	X
Work Package	322-8041	Applicator	MWC
Oper. Desc.	SPOT WELD OPERATIONS FOR A SHIPSET OF B-1 LOCKERS FACTORED DOWN TO SINGLE PIECE.		
Date	9-Feb-84	Issue #	1

Step	Method Instruction		Freq
1	SET-UP SWITCH FOR SPOT-WELDER * TWO WATER VALVES FOR THE COOLING * SYSTEM. * TWO LARGE SWITCHES FOR POWER. * FREQ. = ONCE PER SHIFT.	(1426)	0

```
 2  ASSEMBLE  SHAPED PLATE (S) FOR SPOT-WELDER       ( 1460)          0
     * CLAMP PARTS TOGETHER USING 'VISE-GRIP'
     * CLAMPS.
     * FREQ. = ONCE PER TWO PIECES.
 3  MOVE  (SUB) ASSEMBLY                             ( 1462)          0
     * USE THIS SUB-OP FOR ANY MOVEMENT OF
     * THE SUB-ASSEMBLY AT THE SPOT WELD AREA
     * THAT ONLY ENVOLVES A FEW STEPS.
     * FREQ. = ONCE PER MOVE.
 4  SPOT WELD                                        ( MACH)          0
     * FREQ. = ONCE PER SPOT WELD.
 5  REMOVE  ASSEMBLY (SUB)                           ( 1461)          0
     * TAKE THE CLAMPS OFF AND ASIDE THEM.
     * PLACE THE SUB-ASSEMBLY ON OR NEAR THE
     * WORK-BENCH.
     * FREQ. = ONCE PER WELD CYCLE.
 6  INSPECT  (SUB) ASSEMBLY                          ( 1463)          0
     * VISUALLY CHECK THE ASSEMBLY
     * FREQ. = ONCE PER INSPECTION.
 7  MOVE  ASSEMBLY (SUB)                             ( 1433)          0
     * ONLY AVERAGE ABOUT TWO SUB-ASSEMBLIES
     * PER TRIP.
     * FREQ. = ONCE PER TWO SUB-ASSEMBLIES.
 8  CHANGE  FILTER (WATER) ON SPOT-WELDER            ( 1427)          0
     * ALL FOUR FILTERS ARE CHANGED AT THE SAME
     * TIME.  THEY ARE CONTAINED IN TWO
     * CANISTERS.
     * FREQ. = ONCE PER 12 MAN HOURS.
 9  CHANGE  TIP (POINTS) ON SPOT-WELDER              ( 1428)          0
     * POINTS ARE TAPPED INTO PLACE.
     * FREQ. = ONCE PER JOB TYPE.
10  CLEAN  TIP (POINTS) ON SPOT-WELDER               ( 1429)          0
     * FILE, CHAMPHER AND SAND-PAPER BOTH
     * POINTS TO MAINTAIN GOOD WELDS
     * FREQ. = ONCE PER 15 SPOT WELDS.


       TOTAL HRS - MANUAL                                   0.00000
       TOTAL HRS - PROCESS                                  0.00000
       STANDARD HOURS PER PIECE                             0.00000
       PIECES PER HOUR @ 100%                               0.0


                                                INTERNAL EXTERNAL  LOC
STEP                             SA        FREQ    HRS      HRS     #
-------------------------------------------------------------------------
 1                              0.00       0.00           0.00000  1426
 2                              0.00       0.00           0.00000  1460
 3                              0.00       0.00           0.00000  1462
 4  MACHINE OPERATION           0.00       0.00           0.00000
 5                              0.00       0.00           0.00000  1461
 6                              0.00       0.00           0.00000  1463
```

```
  7                               0.00       0.00            0.00000  1433
  8                               0.00       0.00            0.00000  1427
  9                               0.00       0.00            0.00000  1428
 10                               0.00       0.00            0.00000  1429

                                                    ----------------
   MANUAL TIME(HRS)                                  0.00000  0.00000

   ACTUAL PROCESS TIME(HRS)                          0.00000  0.00000

   FACTORED PROCESS TIME(HRS)                        0.00000

   TOTAL INTERNAL TIME(HRS)                          0.00000

TITLE SHEET USED IN SETTING STANDARD:  1434


                          BATH IRON WORKS

                     STANDARD CALCULATION SHEET

                (Time Standards Calculation Program)



                        STANDARD CALCULATION

Type of                Elemental    Percent       Allowance   Standard
  Work                   Time       Allowance        Time        Time
-------------------   ----------    ---------     ---------   ---------

EXTERNAL MANUAL         0.00000      80             0.00000     0.00000

ASSIGNED INTERNAL      (0.00000)    (80  )         (0.00000)  (0.00000)

PROCESS TIME            0.00000      80             0.00000     0.00000

STANDARD(HRS/CYCLE)     0.00000                    0.00000     0.00000

PIECES PER CYCLE           1

STANDARD HOURS                                                 0.00000

         (PIECES PER HOUR @ 100%)                               0.0

*Command <H,LA,LI,LT,LR, or EX> ?
```

WORK SAMPLING FORM

APPENDIX C

sample 2

Date : 10 April8
By: MWC
1

Area : Hyde – Sheetmetal Shop

Observation Number	Work STATION	Random Time	Fabricating	Material Handling	Machine Use		Break down	Personal Time	Idle	Interference	Missing	Other	Comments
1		A 8:05											
2	A		✓										
3	A		✓										
4	A		✓										
5	B						✓						Fluxcore machine
6	B		✓										grinding parts
7	C				✓								
8	D				✓								
9	E				✓								
10	E				✓								
11	F		✓										
12	F		✓										
13	G									✓			talking with outside machinist
14	G				✓								
15	H										✓		
16	M			M									
17													
18													
19													
20													
21													
22													
23													
24													
25													
			6	1	5		1	0	0	1	1	0	Sub Total
													Total

TRIP REPORT

SCHEDULING WITH ENGINEERED STANDARDS
AT NASSCO

APPENDIX D

F-295 B

BATH IRON WORKS CORPORATION

MEMORANDUM

FROM- R. J. Belanger/M. W. Cunningham III DATE April 4, 1984

TO- Distribution

SUBJECT- Trip Report; Scheduling with Engineered Standards at NASSCO

Introduction

In an effort to improve productivity and resource utilization in our Sheetmetal Shop, Mr. Ron Belanger (D-17) and I have been looking at ways of better scheduling the work through the shop. One approach which seems to have great promise uses engineered labor standards to set realistic times for producing the various products that are fabricated at the Sheetmetal Shop. National Steel and Shipbuilding Company (NASSCO), of San Diego, CA, as an offshoot of a MarAd funded project, has embarked on a program to use engineered labor standards in their sheetmetal shop to schedule work, level load the shop and to determine machine capacities.

On March 20, 1984, Mr. Belanger and I visited NASSCO to get a better understanding of their scheduling system and how it could be used here at BIW. We met with Mr. Irwin StrFSuss (General Superintendent for Sheetmetal and Electrical), Mr. Cal Files (Assistant Superintendent for Sheetmetal), Mr. Harry Strake (Supervisor of Planning for Sheetmetal and Electrical), Mr. Alan McQuaide (Assistant General Foreman, Electrical), and Mr. Bill Oakes (Senior Industrial Engineer) to discuss their system, how it was developed, how it was being implemented, and what the benefits of such a scheduling system might be. We were also given a tour of their sheetmetal shop, their shipyard, and a fascinating tour of the cable laying ship ZEUS that NASSCO has built for the Military Sealift Command (MSC).

Benefits

From our discussions with these gentlemen, it was clear that they are all solidly supportive of scheduling systems based on engineered labor standards. Although they have no hard numbers at this time, they feel that simply by using engineered labor standards, the productivity of their shop will improve by at least 30%. Level loading the shop and smoother scheduling will reduce idle time, maximize machine utilization, and reduce overtime.

The System

Mr. Oakes has been and is continuing to work closely with Mr. Strake to develop and implement a scheduling system using engineered labor standards. They have broken the fabrication of ventilation systems down to the fabrication of fourteen basic shapes. For each shape they developed engineered labor standards using the Maynard Operation Sequence Technique (MOST) , which would cover all the work going into the fabrication of one of these shapes from raw stock to finished piece. The shapes and standard times were then organized on a single sheet of paper to be used by the planners as a worksheet. The planner analyzes a ventilation sketch (a sketch is a run of ventilation from flange to flange and may contain one or more shapes) (see Exhibit 1), and uses the Worksheet (see Exhibit 2) to develop the standard time for that sketch. The standard time is written onto the sketch and becomes part of the working documents used by the mechanic in fabricating the duct assembly. This gives the mechanic a clear goal to shoot for. No longer is he working against a budget of hundreds or thousands of manhours, but rather a goal of only a few hours. When the job is completed, the actual hours are added to the sketch and can be compared to the standard to see how the mechanic is performing. Now the supervisor has an accurate, unbiased measuring tool to measure how well he and his crew are doing. Also , the mechanic is motivated to report problems and delays that are beyond his control and were probably ignored or accepted as standard operating procedure in the past.

Standards at the sketch level allow the shop "planners to schedule the work through the shop much more smoothly than they had been able to when using the large block of manhours associated with budgets. In the past, the workload in the shop was characterized by high peaks and low valleys which were extremely counterproductive. They feel that using standards allows them to define machine capacities, overall shop capacity, pinpoint bottlenecks and level load the shop.

Mr. Oakes indicates that they are still in the implementation phase and have not yet verified that they are getting the productivity improvement they have predicted. In talking with Mr. Struss, Mr. Files, and Mr. Strake, the early indicators are that the system is working as expected. Mr. Oakes does intend to monitor the returned hours and make comparisons with Past-actuals. He also indicates that they are in the process of-computerizing their system. Blanks for their ductwork are produced. on an N/C punch press, and as the planners develop the various sketches and tapes, the computer will be programmed to automatically assign the standard hours. Also , at this point, the actual scheduling and level loading calculations must be done manually, but they plan to develop a computer program to do this for them.

Background Information

Mr. Oakes is a Senior Industrial Engineer with many years of experience, particularly in sheetmetal fabrication. He was trained in the MOST system of engineered labor standard development during the fall of 1979 as part of the Methods/Labor Standards Development Program funded by the Maritime Administration under its Ship Producibility Research Program, Panel SP-8. After several years developing data for fitting and welding in the structural area at NASSCO, Mr. Oakes was moved back into their sheetmetal shop, where he has worked for the past year and a half. He has been the NASSCO Data Coordinator for the SP-8 Program mentioned above (which BIW participated in). Mr. Oakes' present duties include methods improvements, labor standards development/maintenance, facilities improvement and-equipment procurement/justification.

Sheetmetal Shop Tour

Mr. Oakes and Mr. Files escorted Mr. Belanger and I through their sheetmetal shop. They almost exclusively fabricate ventilation ductwork, with about 300 people and a shop somewhat smaller than ours. They seem to have plenty of room to work, with much clear space around the workbenches. Everyone seemed busy. Their methods seemed quite similar to ours, with no remarkable jigging or fixturing devices in evidence. It is evident that they have borrowed some of our ideas in that they. have purchased a seam welder (identical to ours) and a Whitney Panel Master (a less capable machine than our Wiedematic CNC Turret Punch Press) since their visits to our facility during the fall of 1982.

Their in-process storage seems better organized than ours, but also their volume is lower. Material is hand-carried, moved on wheeled carts, or moved by forklift. Raw material is stored outside the shop in racks and is stocked on a min./max. basis. Raw material comes from the vendor to a warehouse and from there the racks are stocked. They once had an ordering system similar to ours and replaced it with the min./max. system. Since they do much of their own design work, they have been able to reduce the variations in material sizes to only a handful, three thicknesses of sheet aluminum for example. This alone has greatly reduced their inventory and storage problems.

yard Tour

NASSCO'S yard appeared to be fairly neat and clean, even though there was considerable material piled on pallets and in racks all over the yard. Everywhere we went people seemed to be busy. There seemed to be almost no one wandering about the yard, either. Another remarkable feature was the lack of buildings. Because of the consistently good weather in the San Diego area, much of their work is done outside under the blue sky. They treat rain the way we treat snow and estimate about five shutdown days per year.

NASSCO employs over 5,000 people and operates on essentially a two-shift basis, working primarily Naval contracts. Their current workload includes a cable laying ship (ZEUS) they have built for a Navy hospital ship for overhaul, and three roll on/roll offs they are stretching. One of the Ro/Ro's was in the graving dock where it had been sliced in two; the bow floated ahead, and was waiting for a new midsection to be added.

One piece of equipment that may be of particular interest to us at BIW is a Tee bar welding machine. The machine is used for welding built-up bars and webs and could have an application her in welding the Tee bars we will be fabricating for CG-51. We migh also consider dropping our stripping operation and fabricating our Tee bars. The machine has a motorized conveyor, holding devic twin welding heads, and a Post weld heating system to reduce we distortion." No tacking is-needed and the weld quality was very good. Mr. Oakes will send us the manufacturer's name and any ot pertinent data.

ZEUS Tour

In the afternoon we were allowed to tour the cable laying ship ZEUS . This ship will be used by the Navy to lay and retrieve underwater cables. It has the capability of working cable from eith the bow or the stern and has diesel electric propulsion. Quality of workmanship was excellent and rivaled any of ours.

WESTEC

The 1984 Western Metal and Tool Exposition and Conference (WESTEC) was held in Los Angeles, CA March 19-22. Since we were planning to be at NASSCO on March 20, we decided to stay in San Diego an extra day and travel to Los Angeles with a contingent from NASSCO. The exposition offered displays and demonstrations from over 1,000 companies. With only one day to tour the show, we decided to skip many of the machining exhibits in order to concentrate on finding and seeing the sheetmetal and laser equipment. We had hoped to see: 1) flexible manufacturing cells, 2) material handling devices, 3) laser cutting equipment, but found none of the first two and only one laser.

I found the exhibition extremely interesting and feel that it broadened my perspective on what the “state of the art” is in sheetmetal fabrication. We were able to see, in action, a slightly smaller version of our Wiedeman CNC turret punch press, which would be an excellent complement to our machine. Having this second machine would allow us to reduce the burden on our existing machine and extend its working life as well as increase our overall capacity in that area. Also, we saw the new Atlantic press brakes and shears similar to the ones we have purchased for our Portland facility. All in all, the day was well spent.

Conclusions/Recommendations

1. Having reasonable, realistic goals for our production workers is essential for maximizing productivity. Our current budgets of hundreds and thousands of manhours are so large that the individual loses sight of how his effort really contributes to the meeting or exceeding of those budgets. Engineered labor standards can provide the tool to measure individual performance and will enable us to schedule work more effective level load the shop and determine machine capacities. Although even NASSCO has not verified the benefits of such a system, I believe they exist and that a 20 to 30 percent improvement in productivity is achievable. We should develop and implement such a system in our sheetmetal shop.

2. Our present CNC turret punch press is being worked almost around the clock, seven days a week. We should take a hard look at our present and future workload for that machine and consider purchasing another, such as the one we saw at WESTEC, to relieve the strain on our present machine and improve scheduling.

3. The Tee bar welder at NASSCO may indeed have an application here at BIW in the fabrication of Tee bars for CG-51. We should further investigate the capabilities and limitations of that machine.

4. Exhibitions such as WESTEC provide an opportunity for us to maintain a high level of awareness as to the “state of the art” in fabrication and production equipment and techniques. Such exhibitions should be attended periodically by appropriate BIW personnel to ensure that we are at the forefront of modern technology.

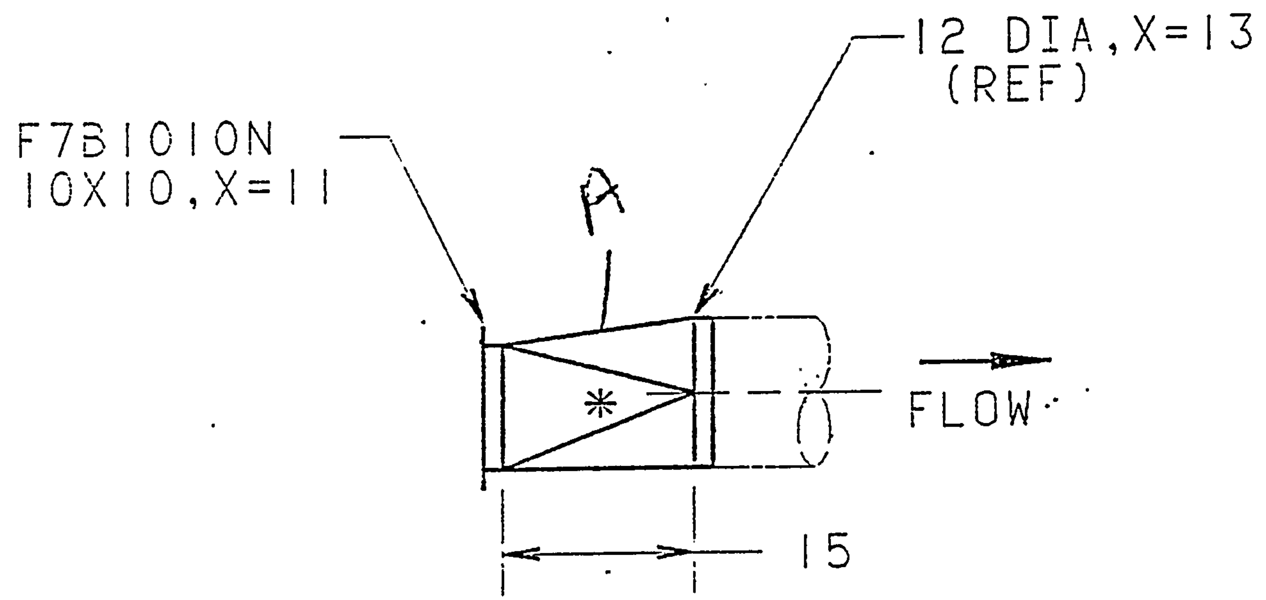
R. J. Belanger

M. W. Cunningham III

Distribution:

R. A. Young, Jr.	D-01
R. J. Bellonzi	D-56
R. L. Vermette	D-17
R. J. Belanger	D-17
D. R. Blais	D-56
J. E. DeMartini	D-56

EXHIBIT 1



A	52112

MATL	MA
S. HRS	4.1
A. HRS	
SH ?	

OPER SAW	PROG E. BYRD	VENT DET	DWG 43[redacted]-501-002 REV -	V6-204
C[illegible]	DATE [illegible]		ZONE 20-B SHT 5	V2-9200

SHEETMETAL STANDARD | SKETCH DATA

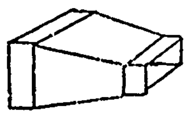
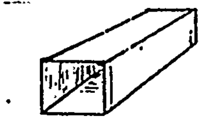
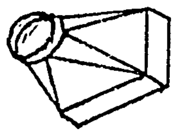
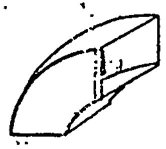
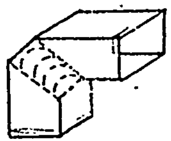
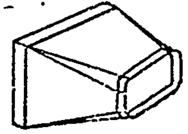
DATE 3/20/89

EDITION OF AUG 18 1983

V2- 92001

DWG

TRANSFORMER, RECTANGULAR			
AREAS	ALL LENGTHS		OFFSET
ALL	.40		.50
ALL, WELDED	.50		.50
STRAIGHT DUCT			
AREAS	ALL LENGTHS		
ALL, PITTS	.35		
ALL WELDED	.70		
SEAM WELD	.22		
TRANSITION	□-O #3	□-O OFFSET #6	□-O FO #11
USE LARGEST AREA			
≤ 100□ IN.	.75	.85	1.0
> 100□ IN.	1.20	1.54	1.34
HAND WELD	.93	.93	.93
ELBOW, RECT.	30° 45° 60° 90°		
AREAS			
≤ 100 □ IN.	.61		
> 100 □ IN.	.98		
HAND WELD	3.30		
ELBOW, VANE TURN			
AREAS			
≤ 100 □ IN.	2.07		
> 100 □ IN.	2.26		
TRANSITION	FO TO RADIUS	□ TO RADIUS	RND. TO RND.
AREAS			
≤ 100 □ IN.	1.16	.91	.93
> 100 □ IN.	1.35	1.43	1.48
HAND WELD	1.64	1.0	1.12
OFFSET	STANDARD		OGEE
AREAS	SHORT	LONG	OGEE
≤ 100 □ IN.	.68	1.32	.73
> 100 □ IN.	1.16	1.38	1.0
HAND WELD	1.36	1.68	1.30
ROUND DUCT			
AREAS	TO 20"LG.	TO 40"LG.	> 40"LG.
ALL DIA.	.36	.48	.60
BELLMOUTH, RECT			
AREAS			
ALL AREAS	1.34		
RIVETED JOINT (EACH)			
≤ 100 □ IN.	.18		
> 100 □ IN.	.41		
FLANGE, TEMPORARY FASTEN			
ALL SIZES	.05		
BRACKET, SUPPORT			
ALL SIZES	.12		
ACCESS COVERS, FAB. & INSTALL			
≤ 100 □ IN.	.63		
> 100 □ IN.	1.07		
END CAP			
ALL SIZES	.16		
CORED ELBOW (5 PIECE)			
≤ 6" DIA	1.20		
≥ 6" DIA	2.00		

Shape #	FITTING	FREQ	TOTAL
1			
2			
3 6 11			.85 .93
7			
8			
9 10			
12 13			
4			
14			
5