

工程分析에 관한 細部適用 技法 報告

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ABSTRACT

The main idea of this report, which deals with the process analysis in outfitting fields, is to improve working methods and further to secure higher productivity by removing unreasonable work factors in the workshop with the economical point of view.

For this purpose, a series of techniques has been applied to some parts of chronically less productive outfitting works, expecting less man hour consumption and better working conditions to go with it.

That is to make full use of process chart flow diagram (man & machine chart gang process chart). The text gives brief introductions of the charts respectively and the appendix shows actual practice directly applicable for the guidance of utilizing these charts.

As the result of this, some of unreasonable work factors are removed from the total cycle and finally standard working method & time can be come out by reasonable working time and gradually improved working method.

1. Introduction

工程分析이란 作業分析, 動作分析, 時間分析(PTS/MTM)에 이르는 첫단계로써, 궁극적인 目標인 生産性向上과 作業標準 및 標準時間을 獲得하기 위하여 보다 巨視的인 作業單位區分 및 分析에 依한 工程의 不合理點, 浪費要素, 作業者와 機械의 Loss time除去와 process cycle time을 提供할 수 있는 科學的이고 組織的인 手段이다.

아울러 該當作業標準 및 標準時間을 設定하는데 裨승하여 細部的인 工程分析技法의 提供에 依한 關聯部署의 積極活用을 유도함으로써 보다 實用的이고 合理的인 作業標準과 標準時間이 設定될 수 있도록 보장하는데 있다.

工程分析에서 使用되는 技法은 process chart, flow diagram, man & machine chart, gang process chart를 利用하는 것이며 이것의 作成目的, 作成方法, 適用範圍, 착안점 및 分析方法은 뒷면에 체계적으로 나열되어 있고 부록에는 當造船所 1007, 1008번船의 艤裝製作과 設置部間에 關한 工程分析技法의 細部適用實例를

收錄하여 보다 쉽게 응용할 수 있도록 하였다.

마지막으로 工程分析課程을 거치지 않은 作業標準과 標準時間은 획일화의 效果는 있겠지만 合理性, 經濟性이 결여될 可能性이 있으며 본 報文을 통하여 紹介하는 工程分析技法이 作業標準과 標準時間設定에 미약하나마 參考가 되길 바란다.

2. Process chart

1) 作業目的

process chart input은 工程에 대한 보다 충분한 이해 및 이를 개선하기 위한 手段으로써, 統一된 方法에 依해 工程을 記錄하기 위하여 考案된 樣式중의 하나이다. 이것의 目的은 일련의 作業을 遂行하는 課程에서 개별적인 作業段階를 도표로 나타냄은 물론 원재료의 도입에서 완성부품 또는 완제품에 이르는 完成工程까지의 운반, 저장, 檢査, 機械作動과 같은 各段階를 徹底하게 추적함으로써 보다 확실한 工程 개선 方案을 提示하는데 있다.

2) 適用範圍

船殼工場, 艤裝工場, 大組立工場, outfitting center,

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예비야적장, 木工場 등에 效果的으로 適用된다.

3) 作成範圍

우선 資材 위주의 flow (material type)와 作業者 위주의 flow(man type)로 區分하여야 한다. 一般的으로 work shop에서는 material type을 適用하는 것이 바람직하고 man type은 생략하는 대신에 다음절에 있는 gang process chart를 效果的으로 利用하면 된다.

process chart에서 使用하는 symbol은 5개로써 아래와 같이 정의된다.

○ : Operation

- 部材 또는 원재가 加工될 目的으로 人力 및 裝備에 依해 정반 또는 機械위에 올려지는 상태.
- 加工될 部材가 정반 또는 機械에 고정되는 상태.
- 加工이 完了된 部材가 정반 또는 機械로 부터 분리되는 상태.
- 加工된 部材가 정반 또는 機械로 부터 차기부재의 加工을 위하여 내려지는 상태.

⇒ : Transportation

- 部材 또는 원재가 하나의 場所에서 다른 場所로 이동하는 상태.
- 部材 또는 원재가 다른 場所로 이동되기 위하여 어떤 場所에서 들어올려지는 상태와 다른 場所로 이동된 후 내려지는 상태는 operation으로 간주한다.

D : Delay

- 어떤 部材에 대하여 計劃된 차기 作業이 즉시 遂行되지 않는 상태.

□ : Inspection

- 圖面對照, 部材確認, 마킹, 수량확인, 品質確認의 경우

▽ : Storage

- 部材가 管理 상태하에서 保管되어 있고 入出庫時에 確認(승인)을 必要로 하는 상태

○ : Operation & Inspection

- 工程課程중에 두개의 activity가 同時に 發生하는 경우
지급부터는 記錄 및 전산화의 편의를 위하여 symbol 대신에 대문자 O.T.D.I.S로 表記 하겠다.

4) 착안점 및 分析方法

- 어떤 作業이 完全히 不必要한 것인지를 分析할 것
- 두개의 作業을 한개로 묶을 수 있는것인지를 分析할 것.
- 더욱 合理的인 部品の 경로(flow route)가 發見될 수 있는지를 分析할 것.
- 더욱 經濟的인 機械裝備가 使用되어야 하는지를

分析할 것

- 工程간 지연요소(delay)를 제거할 수 있는지를 分析할 것.
- 그외 其他 개선사항이 發見될 수 있는지를 分析할 것

3. Flow diagram

1) 作成目的

發生된 material flow를 평면도(일례 : Workshop Layout)상에 직접 표시 함으로써 보다 理解하기 쉬운 better picture를 提供하는데 있다. 그외의 目的은 process chart와 同一하다.

2) 適用範圍

yard內 各種 workshop 및 倉의 作業장에 效果的으로 適用되며 transportation flow를 추적하는데 적합하다. 그러나 대조립, 탑재, 의장설치 작업에는 적합하지 않다.

3) 作成方法

實際로 發生한 activity의 경로(flow route)를 직선과 화살표를 使用하여 workshop layout 또는 yard layout상에 表示하고 어떤 activity가 發生했는가를 表示하기 위해 앞절에서 언급한 process symbol을 직선과 함께 表示한다. 正確한 운반거리 및 운반빈도의 측정과 같은 특별한 경우를 제외하고는 作成할 必要가 없다.

4) 着眼點 및 分析方法

process chart에서 언급한 方法과 同一하다.

4. Man & Machine Chart

1) 作成目的

process chart 또는 flow diagram들이 工程중의 여러 作業 段階들을 잘 나타내고 있지만 man & machine chart에 의해 일련의 作業이나 工程을 單位工程으로 細分化하여 時間概念에 입각, 圖表를 作成할 必要가 있으며, 이것의 目的은 機械의 稼動狀態, 作業者와 機械의 일체감 여부, 불균형이 發生하는 作業, idle time 이 많이 發生하는 作業을 分析하여 作業者와 機械의 idle time을 除去함은 물론 單位 作業에 대한 total cycle time을 提供하는데 있다.

2) 適用範圍

船殼工場, 艤裝工場, outfitting center, 木工場, shot blast plant등에 設置되어 있는 各種 機械 裝備類에 効

果의으로 適用된다.

3) 作成方法

우선 대부분의 作業을 다음 3가지 단계로 區分해야 한다.

- 作業準備(get ready) : 加工될 部品를 機械 위에 놓기
- 機械작동(Do) : drilling, bending, cutting 등
- 作業完了(put away & clean up) : 加工完了部品の 除去 및 機械로부터의 scrap 除去

그 다음 man & machine chart의 상단에 operator, helper, machine을 記錄하고 chart의 세로변에 時間(분 또는 초)을 表示 해준다.

그리고 3가지로 分類된 作業段階에 입각하여 同一한 時間에 發生하는 作業者와 機械의 행위를 one cycle (作業準備→作業完了)이 끝날때까지 記錄해준다. 工程分析 段階에서는 time factor가 중요한 것이 아니므로 time check를 엄격하게 할 必要가 없으며 설정 동작 분석이나 標準時間 設定作業을 遂行하더라도 time check 방법은 많은 人員이 所要되고 正確性이 떨어져므로 作業者의 순수작업시간 측정에 關한 한, time check가 전혀 필요없는 PTS/MTM 技法을 紹介할 예정이다.

4) 着眼點 및 分析方法

一般的으로 機械가 작동중일 때는 作業者는 idle 상태에 있는 경우가 대부분이고 作業者가 作業중 일때는 機械가 idle 狀態에 있는 경우가 많으므로

- 1대의 機械에 配置된 作業人員을 줄일 수 있는지 分析 할 것.
- 1대의 作業員에 할당된 機械 台수를 증가 시킬수 있는지 分析할 것.
- 機械 또는 作業者를 Full time으로 가져갈 수 있는지 分析할 것
- total cycle time을 줄일수 있는지 分析할 것
- 作業効率을 높일수 있는 各種 보조공구, 운송장비가 最大한 利用될 수 있는지를 分析할 것

5. Gang process chart

1) 作成目的

作業者 集團의 作業活動을 分析하여 作業者들의 대기시간, 지연시간을 最小로 할 수 있는 集團으로 재구성하는데 있으며 作業者 위주의 man type process chart를 총괄한 chart이다.

2) 適用範圍

小組立, 中組立, 大組立作業, 塔載作業, 선형의장, 大韓造船學會誌 第19卷 第2號 1982年 6月

艙裝設置作業, 운반하역作業 등에 效果的으로 適用된다.

3) 作成方法

process chart에서 언급한 symbol을 그대로 使用하던데 作業者개개의 cycle이 아닌 전체group의 cycle을 나타내어야 한다.

또한 매 cycle 마다 發生하지 않는 作業要素는 除外하고 이것은 cycle 이 시작되기전에 예비작업으로 포함시키면 된다(예 : 자제입수).

그 다음 gang process chart의 가로변에 作業者 개체들을 記入하고 세로변에는 同時에 發生하는 作業者 개체들의 다양한 행위를 symbol(5가지)에 의해 group cycle이 끝날때까지 가능한 한 time unit를 同一하게 하여 記錄해 나간다.

1회의 group cycle이 끝나면 group 전체가 수행한 symbol 갯수를 完成한 作業數量(output)으로 나누어 완성된 작업량 1개당 symbol 수량을 하변에 表示해준다.

4) 着眼點 및 分析方法

우선 6何 原則에 의해 group process를 分析한 후 同一한 方法에 의해 作業者 개체의 process를 分析한다. 그다음 group process에 關聯된 운반 및 저장작업을 分析한 후 어떻게 하면 作業者 集團의 대기 時間을 줄일수 있는지를 檢討한다.

作業者 集團의 대기 시간을 줄이기 위한 한가지 방법은 우선 作業者 集團을 技能別 作業組로 분할하여 가장 대기 시간이 많은 技能別 作業組와 가장 대기 시간이 적은 技能別 作業組를 選定한 후 대기 시간이 많은 作業組의 人員을 감원하고 대기 시간이 적은 작업조의 人員을 充員하여 作業者 集團을 재구성 하는 것이다. 一般的으로 이런 方法은 작업자 집단을 우선 10~12명 이하로 구성하여 적용하는 편이 좋다.

6. Closing Remarks

부록에 紹介된 工程技法의 適用實例는 극히 一部分에 불과하며 艙裝製作 및 設置部間에서 노출된 개선작업점에 關해서

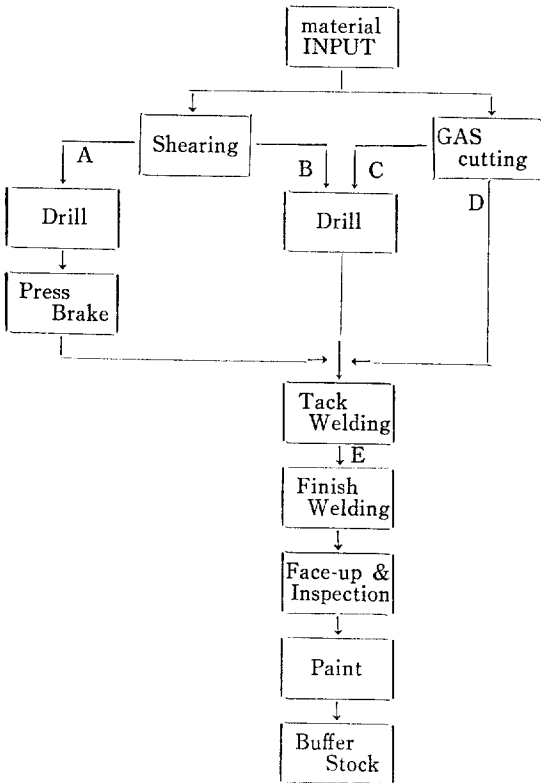
- designer는 生産部署의 時數를 줄여줄 수 있는 simple(economic) design을 위하여,
- planner는 作業者의 handwork대신 보유 機械裝備를 最大한 活用할 수 있는 workshop order를 위하여,
- engineer는 作業者의 idle time을 줄일수 있는 workshop control을 위하여, "How can it be improved"를 항상 염두에 두어야 할 것이다,

7. Appendix

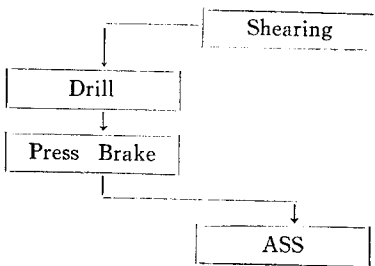
1) Process Chart

1-1. Pipe protector cover (ship no. 1007)

PRESENT TOTAL FLOW



1-1-(a). A-Flow



(a)-①. Item name

No. 1 Single part
(see enclosed drawing)

(a)-②. Process chart (present method)

Symbol	Description
O	lift
T	30m(travel)

O	lay down
D	delay
I	identify & mark
O	lift(load)
O	shearing
O	lay down(unload)
D	delay
O	lift
T	20m(travel)
O	lay down
D	delay
O	lift(load)
O	drill
O	unload
D	delay
O	lift
T	30m(travel)
O	lay down
D	delay
I	identify
O	load
O	press brake
O	unload
D	delay
O	lift
T	15m(travel)
O	lay down
D	delay

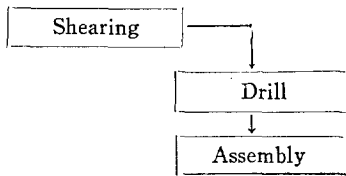
(a)-③. Review for improvement

• after shearing work, it's much better to transfer this single part to next operation(drill) immediately by using crane. (because it's too heavy to lift by hand).

(a)-④. Number of operations

symbol	present flow	improved flow
O	17 EA	16 EA
D	7 EA	6 EA
I	2 EA	2 EA
T	4 EA(95m)	4 EA(95m)
S	.	.

1-1-(b). B-Flow



(b)-①. Item name

No. 4 Single part

(b)-②. Process Chart(present method)

Symbol	Description
I	
O	
O	Shearing
O	
D	
O	
T	20m(travel)
O	
D	
O	
O	drill
O	
D	
O	
T	40m(travel)
O	
D	

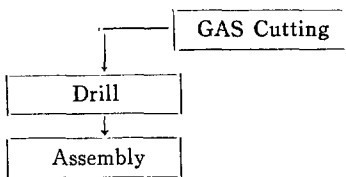
(b)-③. Review for improvement

None

(b)-④. Number of operations

Symbol	Present flow	improved flow
O	10 EA	same with the left hand
D	4 EA	//
I	1 EA	//
T	2 EA(60m)	//
S	.	.

1-1-(c). C-Flow



(c)-①. Item name

No. 2 Single part

(c)-②. Process chart(present method)

Symbol	Description
O	
T	35m(25m) travel
O	
D	
I	identify & mark
O	nesting (lift)
O	gas cutting(angle cutting)
O	
D	
O	
T	20m(travel)
O	
D	
O	
O	drill (punching hole)
O	
D	
O	
T	40m(travel)
O	
D	

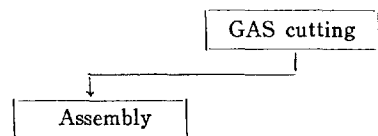
(c)-③. Review for improvement

- angle cutter(FUJI CUTTER) should be used for cutting angles instead of using gas cutting tool.
- replace drill machine by angle cutter for making holes on the angle.

(c)-④. Number of operations

Symbol	present flow	improved flow
O	12 EA	10 EA
D	5 EA	3 EA
I	1 EA	1 EA
T	3-EA(95m)	2 EA(65m)
S	.	.

1-1-(d). D-Flow



(d)-①. Item name

No. 3 Single part

(d)-②. Process Chart(present method)

Symbol	Description
I	identify & mark
O	nest(lift)
O	gas cutting(angle cutter)
O	heating(lay down)
IO	bending
D	

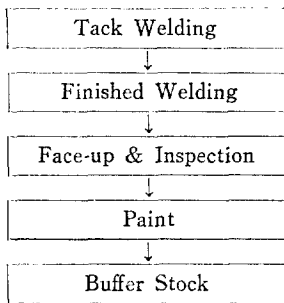
(d)-③. Review for improvement

- please change the shape of this single part to remove hand bending.
- replace gas cutting tool by angle cutter.

(d)-④. Number of operations

Symbol	present flow	improved flow
O	4 EA	3 EA
D	1 EA	1 EA
I	1 EA	1 EA
T	.	.
S	.	.

1-1-(e). E-Flow



(e)-①. Item name

Relevant single parts which have to be assembled.

(e)-②. Proces Chart(present method)

Symbol	Description
I	identify item
O	nest & fix
O	tack weld
D	
O	10m (travel)
D	
O	welding
D	
O	20m (travel)
D	
O	face-up
I	
ID	
O	
T	60m (travel)
O	
D	

I	
O	
T	10m (travel)
O	shot blast
O	paint
T	10m travel
O	
O	dry
I	mark the item No.
D	
O	
T	80m (travel)
O	
S	

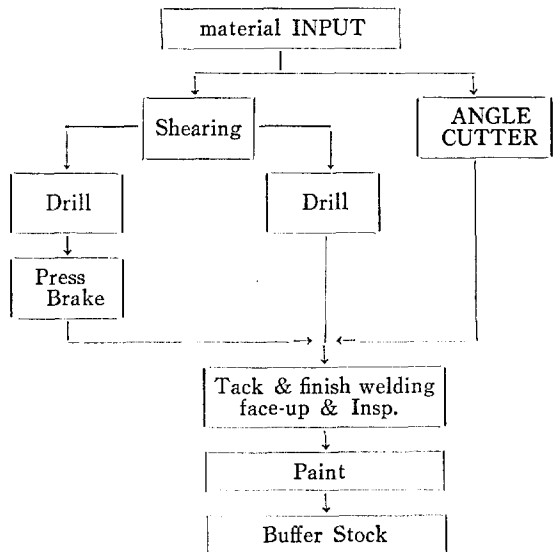
(e)-③. Review for improvement

- ask the same worker to take charge of tack welding, final welding and face-up work consecutively at the same workplace.

(e)-④. Number of operations

Symbol	present flow	improved flow
O	17 EA	13 EA
D	7 EA	1 EA
I	4 EA	4 EA
T	6 EA(190m)	4 EA(160m)
S	1 EA	1 EA

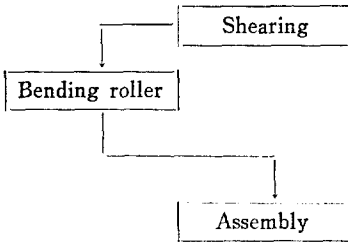
1-1-(f). Improved total flow



1-1-(g). Total Number of operations

Symbol	present flow	improved flow
O	60 EA	52 EA
D	24 EA	15 EA
I	9 EA	9 EA
T	15EA(440m)	12EA(380m)
S	1 EA	1 EA

1-2-(a). A-Flow



(a)-①. Item name

No. 1, No. 2 single part(see enclosed drawing)

(a)-②. Process Chart(present method)

Symbol	Description
O	lift
T	30m (travel)
O	lay down
D	delay
I	identify & mark
O	lift
O	shearing
O	lay down
D	delay
O	lift
T	5m
O	lay down
D	delay
I	identify(quantity) mark
O	lift
O	bending roller
O	lay down
D	delay
O	lift
T	15m(travel)
O	lay down
D	delay

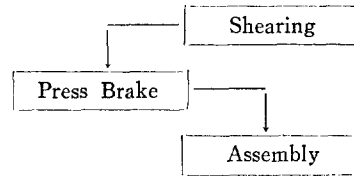
(a)-③. Review for improvement

None.

(a)-④. Number of operations

Symbol	present flow	improved flow
O	12 EA	same with left hand
D	5 EA	"
I	2 EA	"
T	3EA(50m)	"
S	.	.

1-2-(b). B-Flow



(b)-①. Item Name

No. 3, No. 9, No. 10
single part.

(b)-②. Process Chart(present method)

Symbol	Description
I	identify & mark
O	
O	shearing
O	
D	
O	
T	5m (travel)
O	
D	
I	identify
O	
O	press brake
O	
D	
O	
T	20m (travel)
O	
D	

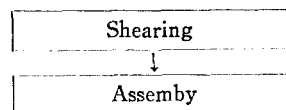
(b)-③. Review for improvement

None.

(b)-④. Number of operations

Symbol	present flow	improved flow
O	10 EA	same with left hand
D	4 EA	"
I	2 EA	"
T	2 EA(25m)	"
S	.	.

1-2-(c). C-Flow



(c)-①. **Item name**

No. 5, No. 6, No. 12
single part.

(c)-②. **process chart (present method)**

Symbol	Description
I	identify & mark
O	
O	shearing
O	
D	
O	
T	25m (travel)
O	
D	

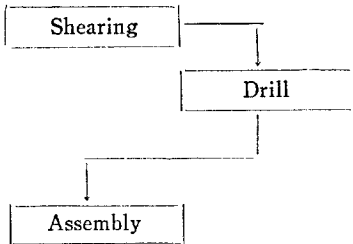
(c)-③. **Review for improvement**

None.

(c)-④. **Number of operations**

Symbol	present flow	improved flow
O	5 EA	same with left hand
D	2 EA	"
I	1 EA	"
T	1 EA (25m)	"
S	.	.

1-2-(d). **D-Flow**



(d)-①. **Item name**

No. 7 single part.

(d)-②. **Process Chart(present method)**

Symbol	Description
I	
O	
O	shearing
O	
D	
O	
T	20m (travel)
O	

D	
O	
O	Drill

O	
D	
O	
T	40m (travel)
O	
D	

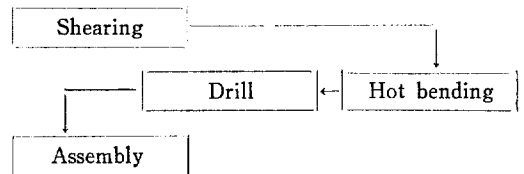
(d)-③. **Review for improvement**

None.

(d)-④. **Number of operations**

Symbol	present flow	improved flow
O	10 EA	same with left hand
D	4 EA	"
I	1 EA	"
T	2 EA (60m)	"
S	.	.

1-2-(e). **E-Flow**



(e)-①. **Item name**

No. 8 single part.

(e)-②. **Process chart(present method)**

Symbol	Description
I	
O	
O	shearing
O	
D	
O	
T	50m(15m) travel
O	
D	
I	
O	
O	heating
O	bending
D	
O	
T	50m (travel)

O
D
I
O
O drill
O
D
O
T 50m (travel)
O
D

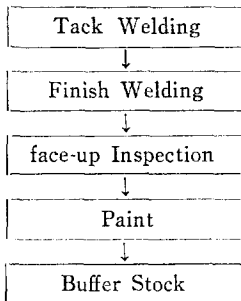
(e)-③. Review for improvement

- change the shape of this part to get rid of hand bending work.
- replace this part by purchased stock item.

(e)-④. Number of operations

Symbol	present flow	improved flow
O	15 EA	9 EA
D	6 EA	3 EA
I	3 EA	1 EA
T	3 EA(150m)	2 EA(65m)
S	.	.

1-2-(f). F-Flow



(f)-①. Item name

relevant single parts which have to be assembled.

(f)-②. Process Chart(present method)

Symbol	Description
I	identify items
O	nest & fix
O	tack weld
D	
O	
T	10m (travel)
O	
D	

O welding
D
O
T 20m (travel)
O
D
O face-up
I
D
O
T 60m (travel)
O
D
I
O
T 10m (travel)
O shot blast
O paint
T 10m (travel)
O
O dry
I mark the item No.
D
O
T 80m (travel)
O
S

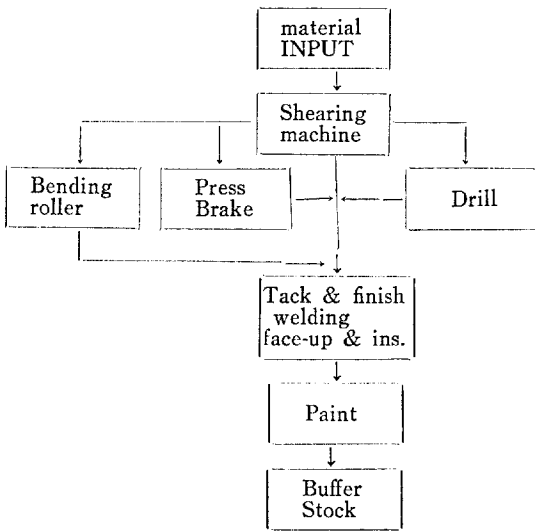
(f)-③. Review for improvement

- ask the same worker to take charge of tack welding, final welding, and face-up work consecutively at the same workplace.

(f)-④. Number of operations

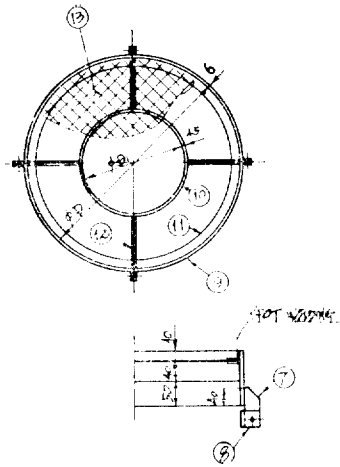
Symbol	present flow	improved flow
O	17 EA	13 EA
D	7 EA	1 EA
I	4 EA	4 EA
T	6 EA(190m)	4 EA(160m)
S	1 EA	1 EA

1-2-(g). Improved Total Flow



1-2-(h). Total number of operations

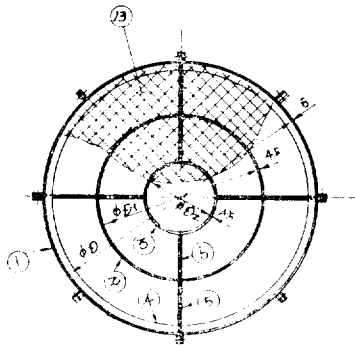
Symbol	present flow	improved flow
O	69 EA	59 EA
D	28 EA	19 EA
I	13 EA	11 EA
T	17 EA(500m)	14 EA(385m)
S	1 EA	1 EA



N.D	P	P	P	QT/Exp	PAINT AREA
200A	200	150	200	2.5m	0.5M ²
200A	200	100	200	3	0.4M ²

WELDING: 1.2

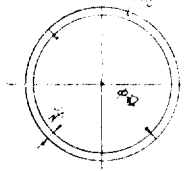
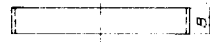
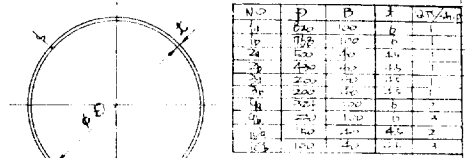
WORK NO	1007/8	WORK	E390 600 JAM FAB. OF FLA
DEPT NO	532	DESCRIPTION	FAB. OF FLAME ARRESTOR FOR EXH. GAS PIPE
TEL NO	415		
DATE			



N.D	P	P	P	QT/Exp	PAINT AREA
800A	820	500	200	1.5m	1M ²
760A	768	400	200	1	0.5M ²

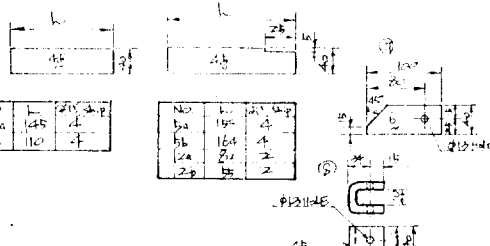
WELDING: 1.2

WORK NO	1007/8	WORK	E390 600 JAM FAB. OF FLA
DEPT NO	532	DESCRIPTION	FAB. OF FLAME ARRESTOR FOR EXH. GAS PIPE
TEL NO	415		
DATE			



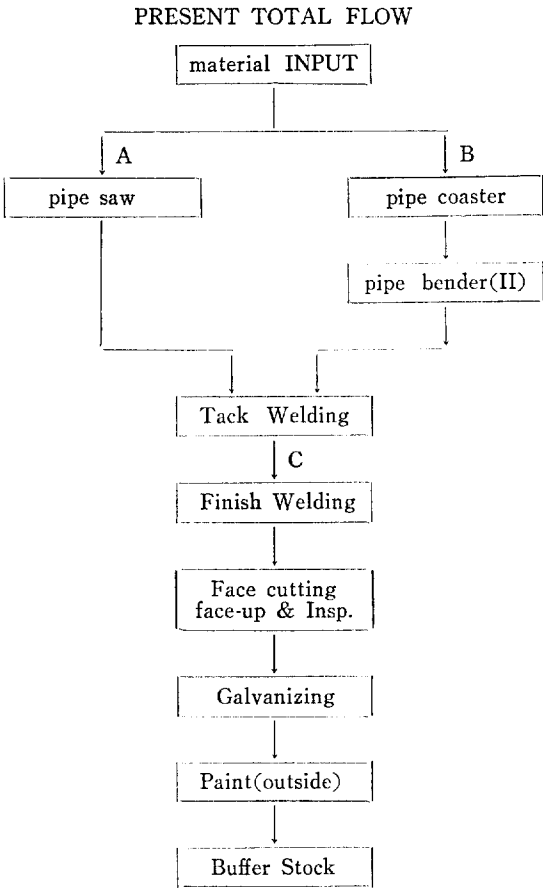
No	L	QT/Exp
11	145	4
12	110	4

N.D	P	P	P	QT/Exp
11	150	4	4	
12	160	4	4	
13	200	2	2	
14	200	2	2	

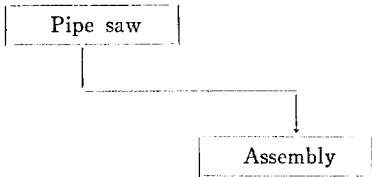


WORK NO	1007/8	WORK	E390 600 JAM FAB. OF FLA
DEPT NO	532	DESCRIPTION	S/P OF FLAME ARRESTOR
TEL NO			
DATE			

1-3. F.W. Service System



1-3-(a). A-Flow



(a)-①. Item name

No. 2 single part (see enclosed drawing).

(a)-②. Process Chart(present flow)

Symbol	Description
O	lift
T	25m (travel)
O	lay down
D	delay
I	identify item & mark
O	lift
O	pipe saw cutting

O	lay down
ID	delay
O	lift
T	25m (travel)
O	lay down
D	delay

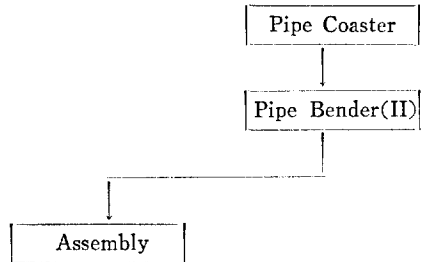
(a)-③. Review for improvement

- after pipe saw cutting, transfer these straight pipes(with batch) to assembly table at once in order to remove stock congestion and delay in this area.

(a)-④. Number of operations

Symbol	present flow	improved flow
O	7 EA	7 EA
D	3 EA	2 EA
I	1 EA	1 EA
T	2 EA(50m)	2 EA(50m)
S	.	.

1-3-(b). B-Flow



(b)-①. Item name

No. 1, No. 6 single part.

(b)-②. Process Chart(present flow)

Symbol	Description
O	
T	20m (travel)
O	
D	
I	identify & mark
O	
O	pipe coaster cutting
O	
ID	
O	
T	15m (travel)
O	
D	

I	identify & mark
O	
O	pipe bending
O	
D	
O	
T	15m (travel)
O	
D	

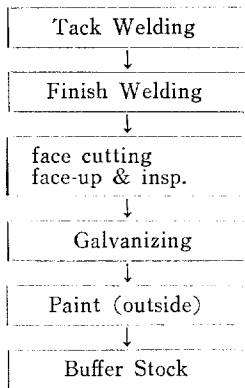
(b)-③. Review for improvement

- mark the bending point of pipe (single part) before this material is cut.
- after cutting, transfer these pipes (with batch) to next work station at once in order to remove stock congestion and delay in this area.

(b)-④. Number of operations

Symbol	present flow	improved flow
O	12 EA	12 EA
D	5 EA	4 EA
I	2 EA	1 EA
T	3 EA(50m)	3 EA(50m)
S	.	.

1-3-(c). C-Flow



(c)-①. Item name

relevant single part which have to be assembled.

(c)-②. Process Chart(present method)

Symbol	Description
I	identify & mark
O	
I	correct measurement
O	cutting margin by hand
O	grinding
O	tack weld

O	
D	
O	
T	15m (travel)
O	
D	
O	
O	welding
O	
D	
O	
T	25m (travel)
O	
ID	
O	face cutting & face-up
I	identify
O	loading on truck
O	galvanizing
O	laydown from truck
I	
D	
O	
T	10m (travel)
O	paint(out surface)
T	10m (travel)
O	dry
O	marking the item No.
I	
O	
T	50m (travel)
O	
S	

(c)-③. Review for improvement

- consider pipe elongation ratio and cut off assembly margin before bending. if not allowed, try to use proper aux. tool to have good cutting surface while hand cutting.
- ask the same worker to carry out tack welding, final welding work, one after the other at the same workplace.
- try not to make finished items stagnated in the face-up(inspection) area.

(c)-④. Number of operations

Symbol	present flow	improved flow
O	22 EA	16 EA
D	5 EA	2 EA
I	5 EA	4 EA
T	5 EA(110m)	4 EA(95m)
S	1 EA	1 EA

3) Man & machine chart

3-1. Pipe single part QAJ 1 (pipe bender II)

3-1-(a). Man & machine chart (present method)

Operation: Pipe bending	Work order No.: ship no. 1007
Part name: Pipe single part(SGP 65A 17.4kg)	Part no.: QAJ 1
Machine name: Pipe bender (II) 100φ	Machine no.: 12(BB)
Location: Outfitting fabri-shop	Date: 81. 2
Operator/helper name:	Chart by: J.H. Kim

min-utes	Operator	time	helper I	time	helper II	time	machine	time
0.5	Take a look at the drawing	0.5	take a look at the drawing	0.2	left the single part from shop floor	0.2	idle	1.2
	measure & mark the bending point		idle	1.3	load the single part on the machine	0.3		
					idle	0.3		
1.0	fixed the single part to the machine	0.2	idle	0.5	assisting for the operator	0.2	bending	0.3
	apply lub-oil to the single part	0.2			idle	0.5		
1.5	idle	0.8	release the single part from the machine	0.2	assisting for the helper I	0.2	idle	0.5
			lay down the single part on the shop floor	0.3	idle	0.3		
2.0								

SUMMARY (present method)

Minutes	Operator	Helper I	Helper II	Machine (pipe bender)
Idle time	0.8	1.3	1.1	1.7
Working time	1.2	0.7	0.9	0.3
Total Cycle time	2.0	2.0	2.0	2.0
Utilization in percent	$\frac{1.2}{2.0} = 60\%$	$\frac{0.7}{2.0} = 35\%$	$\frac{0.9}{2.0} = 45\%$	$\frac{0.3}{2.0} = 15\%$

Total man & machine hour per single part=8 minutes

Review for improvement

- Please remove "help I" to another machine (work station).
- Prepare special pallet(table-shaped) and place it beside the machine.
- Mark the bending point of pipe (single part) before this material is on the machine.

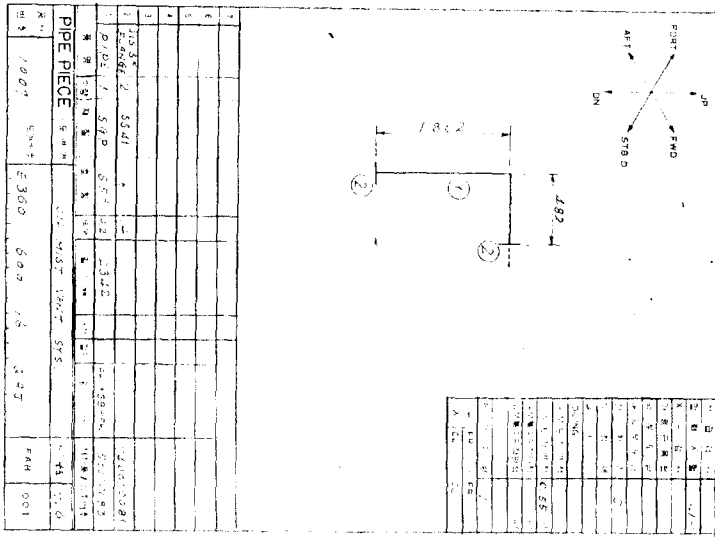
3-1-(b). Man & machine chart (improved method)

Operation: pipe bending			Work order no.: Ship no. 1007					
Part name: Pipe single part (SGP 65A 17.4kg)			Part No.: QAJ 1					
Machine name: Pipe bender(II) 100φ			machine no.: 12 (BB)					
Location: Outfitting fabri-shop			Date: 81.2					
operator/helper name:			Chart by: J.H. Kim					
min-utes	operator	time	helper I	time	helper II	time	machine (pipe bender)	time
0.5	take a look at the drawing	0.3			load the single part on the machine (from pallet table)	0.3	idle	0.7
	fix the single part to the machine	0.2			assisting for the operator	0.2		
	apply lub-oil to the single part	0.2			idle	0.5	bending	0.3
1.0	idle	0.3			release the single part from the machine	0.2		
	assisting for the help II	0.2			load the single part on the pallet table.	0.1		
1.3	idle	0.1						

SUMMARY (improved method)

	operator	helper I	helper II	machine
idle time	0.4		0.5	1.0
Working time	0.9		0.8	0.3
Total cycle time	1.3		1.3	1.3
Utilization in percent	$\frac{0.9}{1.3} = 69\%$		$\frac{0.8}{1.3} = 62\%$	$\frac{0.3}{1.3} = 23\%$

Total man & machine hour per single part=3.9 minutes.



4) Gang process chart

4-1. Main engine chock mounting

4-1-(a). Gang process chart (present working method)

Operation: ship no. 1007 main engine chock mounting			Date: 81. 2			
Item: Cast iron chock			No of workers: 6 men			
Location: ship no. 1007 engine room			Chart by: J.H. Kim			
chock fitter	grinder	chock fitter	grinder	chock fitter	grinder	Description
O	D	O	D	O	D	<ul style="list-style-type: none"> Unit gang is composed of 1 chock fitter and 1 grinder. <p>Chock fitter activity</p> <p>O; apply special paint between engine bed and down surface of engine foundation to see if the chock has correct surface. mounting, releasing, adjusting of chocks are included here.</p> <p>D; Waiting</p> <p>Grinder activity</p> <p>O; grinding work, usually this work takes double the manhours of fitting work.</p> <p>D; Waiting</p>
D	O	D	O	D	O	
D	O	D	O	D	O	
O	D	O	D	O	D	
D	O	D	O	D	O	
D	O	D	O	D	O	
O	D	O	D	O	D	
D	O	D	O	D	O	
D	O	D	O	D	O	
O	D	O	D	O	D	
D	O	D	O	D	O	
D	O	D	O	D	O	
O	D	O	D	O	D	
D	O	D	O	D	O	
D	O	D	O	D	O	
O	D	O	D	O	D	
D	O	D	O	D	O	
D	O	D	O	D	O	
O	D	O	D	O	D	
SUMMARY						
TOTAL ACTIVITIES: 6×19=114 EA						
TOTAL OUTPUT: 3 EA CAST IRON CHOCK MOUNTING.						
ACTIVITIES PER OUTPUT: 144÷3=38 EA						

4-1-(b). Gang process chart (improved method I)

Operation: ship no. 1007 main engine chock mounting						Date: 81. 2	
Item: Cast iron chock						No of workers: 6 men	
Location: ship no. 1007 engine room						chart by: J.H. Kim	
grinder	chock fitter	grinder	grinder	chock fitter	grinder	description	
D	O	D	D	O	D		
O	O	D	O	O	D		
O	D	O	O	D	O		
D	O	O	D	O	O		
O	O	D	O	O	D		
O	D	O	O	D	O		
D	O	O	D	O	O		
O	O	D	O	O	D		
O	D	O	O	D	O		
D	O	O	D	O	O		
O	O	D	O	O	D		
O	D	O	O	D	O		
D	O	O	D	O	O		
O	O	D	O	O	D		
O	D	O	O	D	O		
D	O	O	D	O	O		
D	O	D	D	O	D		
SUMMARY							
TOTAL ACTIVITIES: 6×20=120 EA							
TOTAL OUTPUT: 4EA CAST IRON							
CHOCK MOUNTING.							
ACTIVITIES PER OUTPUT: 120÷4=30 EA							

Gang process chart (improved method II)

Operation: ship no. 1007 main engine chock mounting						Date: 81. 2	
Item: Cast iron chock						No. of workers: 3 men	
Location: ship no. 1007 engine room. Chart by: J.H. Kim							
Chock Fitter	Chock Fitter	Chock Fitter	Description	Chock Fitter	Chock Fitter	Chock Fitter	Description
O1	O1	O1	• Unit gang is composed of only 1 chock fitter. He is to carry out fitting and grinding works one after the other.	O2	O2	O2	
O2	O2	O2		O2	O2	O2	
D	D	D		O1	O1	O1	
O2	O2	O2		O2	O2	O2	
O2	O2	O2		O2	O2	O2	
D	D	D	Chock fitter activity	D	D	D	
O1	O1	O1	O1; Fitting work (the same as previously mentioned)	O1	O1	O1	
O2	O2	O2		O2	O2	O2	
O2	O2	O2	O2; Grinding work.	O2	O2	O2	
D	D	D		D	D	D	
O1	O1	O1	D ; Relaxing	O1	O1	O1	
SUMMARY							
TOTAL ACTIVITIES: 3×25=75EA							
TOTAL OUTPUT: CAST IRON CHOCK							
MOUNTING (3EA)							
ACTIVITIES PER OUTPUT: 75÷3=25 EA							

4-2. F.W. piping installation

4-2-(a). Gang process chart (present method)

Operation: ship no. 1007 F.W piping installation				Date: 81. 2
Item: F.W pipe (copper pipe)				No. of workers: 4 men
Location: Ship no. 1007 officer deck				Chart by: J.H. Kim
Pipe cutter	Pipe flange welder	helper	Pipe fitter	description
O	D	D	D	Pipe cutting by hand
D	D	O	O	on board measurement & marking with helper's assistance
D	D	O	O	"
O	D	D	D	Pipe cutting (correct length)
D	O	O	D	Pipe flange tack welding with helper's assistance
D	O	D	D	Pipe flange welding
D	D	O	O	Pipe aligning & fitting with helper's assistance
D	D	D	O	Pipe flange coupling
				<ul style="list-style-type: none"> • Unit gang is composed of 1 pipe cutter, 1 welder, 1 fitter and 1 helper
				SUMMARY
				TOTAL ACTIVITIES: 4×8=32EA
				TOTAL OUTPUT: Pipe installation (1 piece)
				ACTIVITIES PER OUTPUT: 32 EA

4-2-(b). Gang process chart (improved method I)

Operation: ship no. 1007 F.W piping installation				Date: 81. 2
Item: F.W pipe (copper pipe)				No. of worker: 3 men
Location: ship no. 1007 officer deck				Chart by: J.H. Kim
pipe cutter	pipe flange welder	helper	pipe fitter	description
O	D		D	Pipe cutting by hand
D	O		O	On board measurement & marking with helper's assistance.
D	O		O	"
O	D		D	Pipe cutting (correct length)
D	O		O	Pipe flange tack welding with helper's assistance.
D	O		D	Pipe flange welding
O	D		O	Pipe alignment & fitting with helper's assistance.
D	D		O	Pipe flange coupling
				<ul style="list-style-type: none"> • Unit gang is composed of 1 pipe cutter, 1 welder and 1 fitter. • here, the pipe welder should be responsible for helper's work too.
				SUMMARY
				TOTAL ACTIVITIES: 3×8=24EA
				TOTAL OUTPUT: pipe installation(1 piece)
				ACTIVITIES PER OUTPUT: 24 EA

4-2-(c). Gang process chart (improved method II)

Opertation: ship no. 1007 F.W piping installation				Date: 81. 2
Item: F.W pipe (copper pipe)				No of workers: 2 men
Location: ship no. 1007 officer deck				chart by: J.H. Kim
pipe cutter	pipe flange welder	helper	pipe fitter	description
	O		D	Pipe cutting by hand (rough cutting)
	O		O	On board measurement & marking with helpers assistance.
	O		O	"
	D		O	Pipe cutting (correct length)
	O		O	Pipe flange tack welding with helper's assistance.
	O		D	Pipe flange welding
	O		O	Pipe aligning & fitting with helper's assistance.
	D		O	Pipe flange coupling
				<ul style="list-style-type: none"> •Unit gang is composed of 1 welder and 1 fitter. •here, the pipe welder should be responsible for helper's work too. •here, the pipe fitter should be responsible for pipe cutter's work too.
				SUMMARY
				TOTAL ACTIVITIES:2×8=16 EA
				TOTAL OUTPUT: Pipe installation(1 piece)
				ACTIVITIES PER OUTPUT: 16 EA

参 考 文 献

<p>[1] W. Grant Ircson and Eugene L. Grant, Handbook of Industrial Engineering and Management, 2nd ed. Prentice-Hall Inc., 1971.</p> <p>[2] Ralph M. Barnes, Motion and Time Study: Design and Measurement of Work, 6th ed. John Wiley & Sons Inc., 1968.</p>	<p>[3] Guy C. Close, Jr., Work Improvement, John Wiley & Sons Inc., 1960.</p> <p>[4] William G. Cochran, Sampling Techniques, 3rd ed., John Wiley & Sons, 1977.</p> <p>[5] 郭秀一, 姜錫昊, 生産管理, 重版, 博英社 1980</p> <p>[6] B&W, Production Planning and Control System (Chapter 10)</p>
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