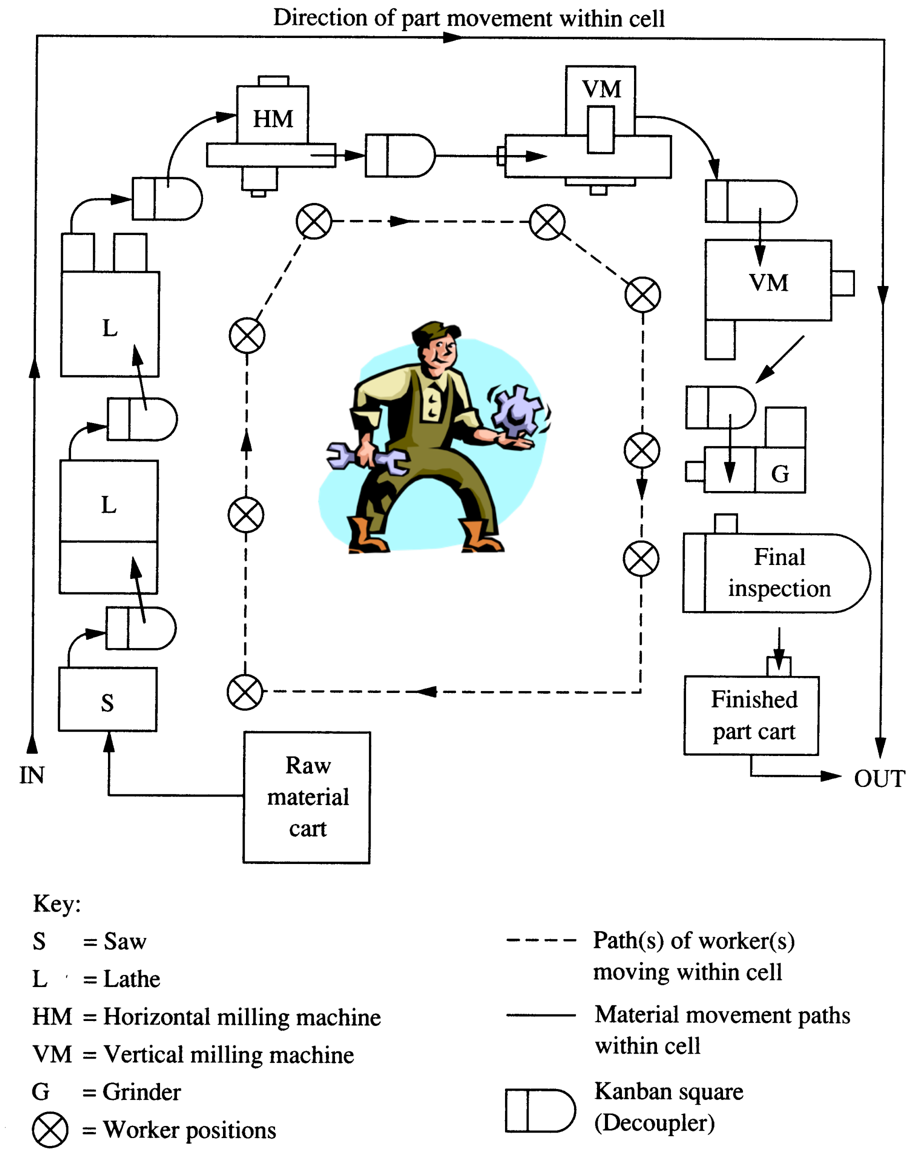
TPS Cell: Analysis and Redesign

1. Work flow (part separate from worker)
2. Standard work (highly specified)
3. Production rate flexibility

Ref: J T. Black Ch 4

Machining Cell

Operator moves part from machine to machine (including "decouplers") by making traverse around the cell.



Cell Features

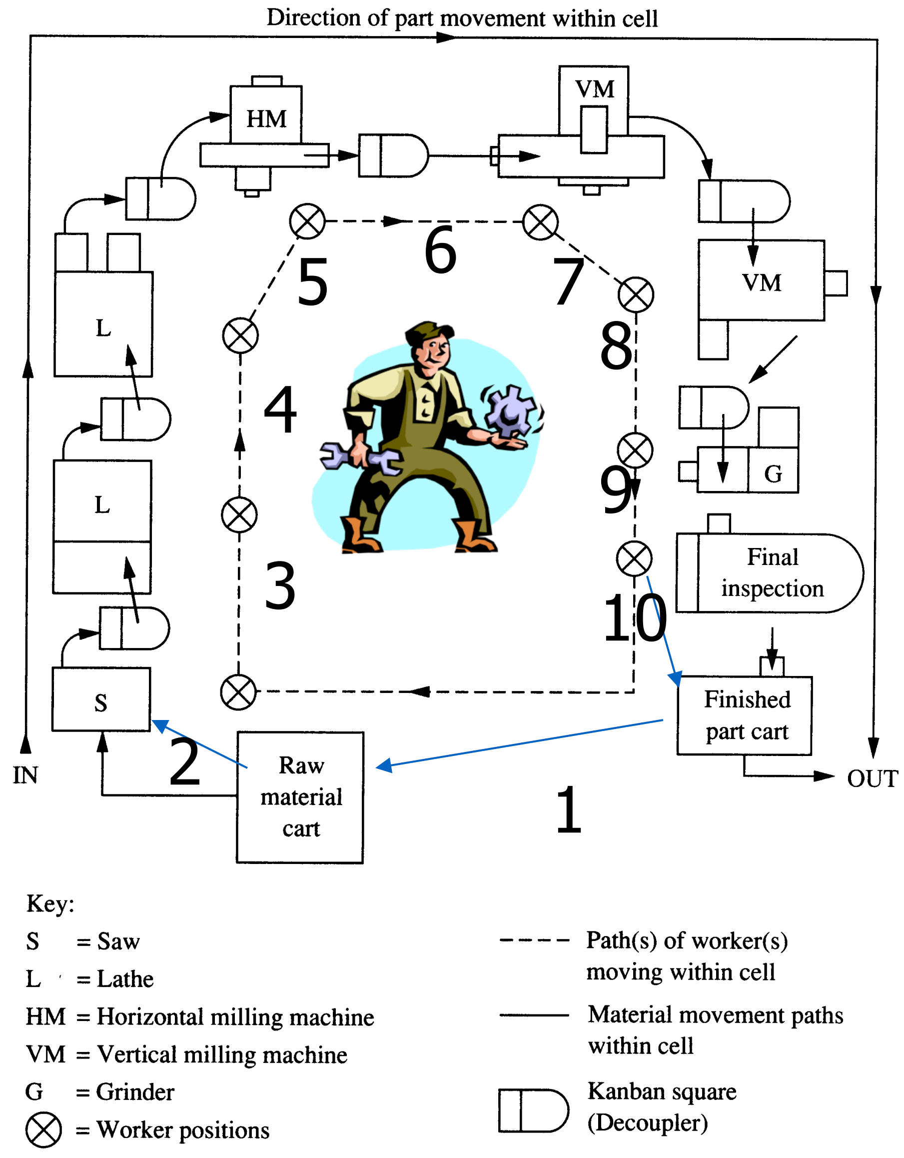
- “Synchronized”, sequential production
- Operator decoupled from individual machines
- Operator integrated into all tasks
- Goal: single piece Flow
- Best with single cycle automatics, but can be done manually too

See Brigg & Stratton Video

Walking segments - 10

Machining Cell

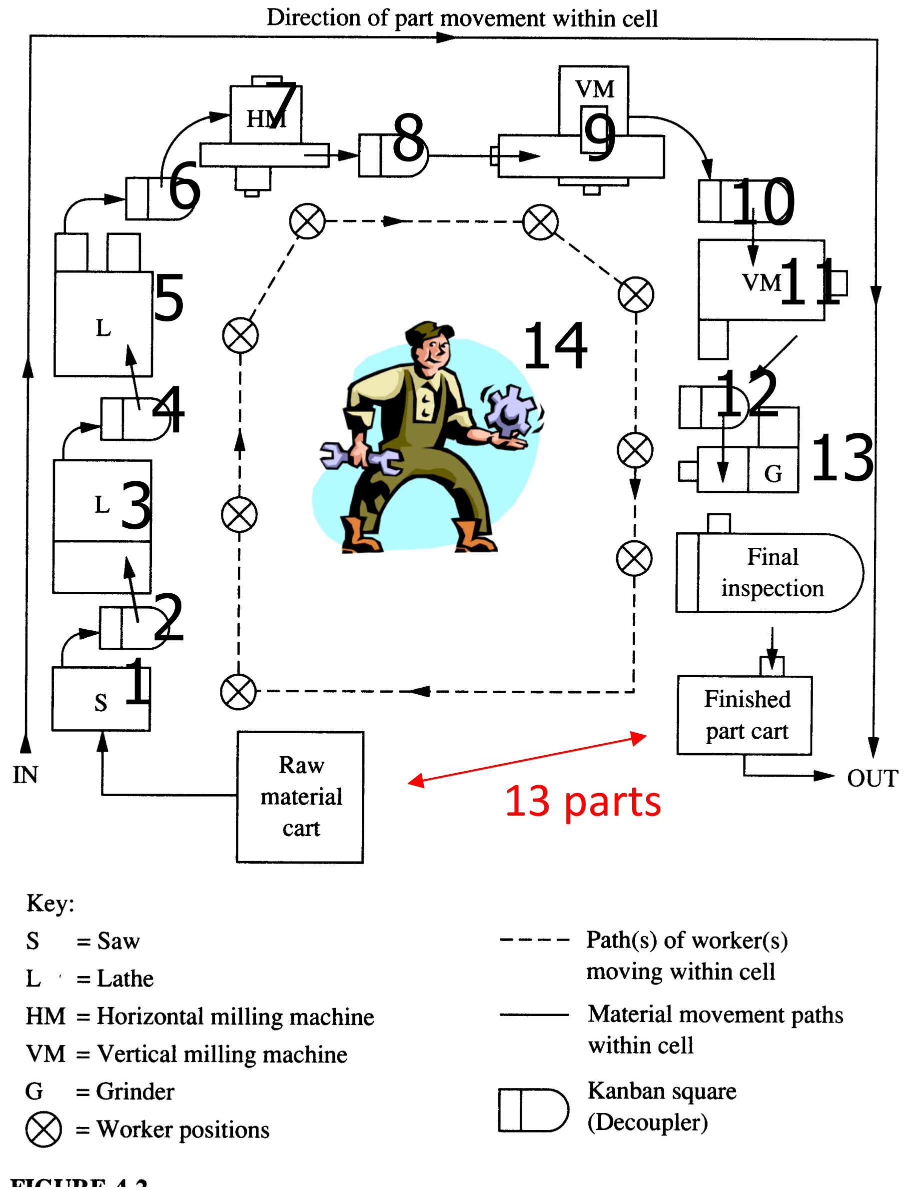
segment		Manual (Sec)	Walk to (Sec)	Machine (Sec)
1	Raw		3	
2	Saw	15	3	60
3	L1	10	3	70
4	L2	12	3	50
5	HM	12	3	120
6	VM1	20	3	70
7	VM2	20	3	60
8	G	15	3	60
9	F.I.	19	3	
10	Finish part		3	
	Totals	**M+W**	**= 153**	**490**



Parts in the cell ~ 14

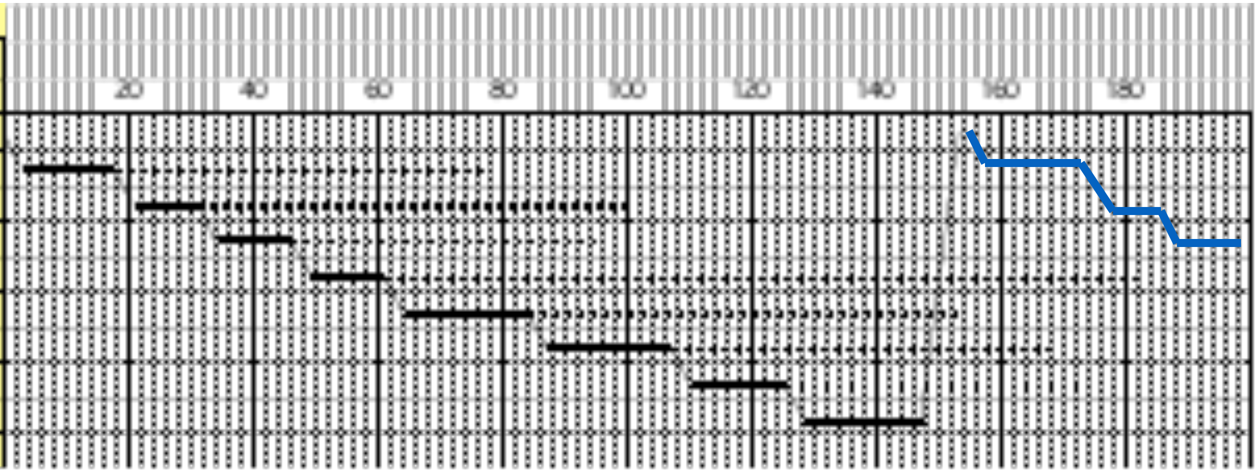
Machining Cell

	Manual (Sec)	Walk to (Sec)	Machine (Sec)
Raw		3	
Saw	15	3	60
L1	10	3	70
L2	12	3	50
HM	12	3	120
VM1	20	3	70
VM2	20	3	60
G	15	3	60
F.I.	19	3 + 3	
Totals	**M+W**	**= 153**	**490**



Standard Work for Cell

PA JT. Black Cell		Operators:		
PROCESS		TIME (secs)		
#	OPERATION	Man	Walk	Auto
1	Raw		3	
2	Saw	15	3	60
3	L1	10	3	70
4	L2	12	3	50
5	HM	12	3	120
6	VM1	20	3	70
7	VM2	20	3	60
8	G	15	3	50
9	F.I.	19	6	



Cell produces one part every 153 sec

Note: machine time Max (MTj) < cycle time CT

i.e. 120+12 < 153

TPS Cell

1. Production rate = λ

$$\lambda = \frac{1 part}{153 \text{ sec}} = 23.5 \text{ parts/hr}$$

2. WIP = L?

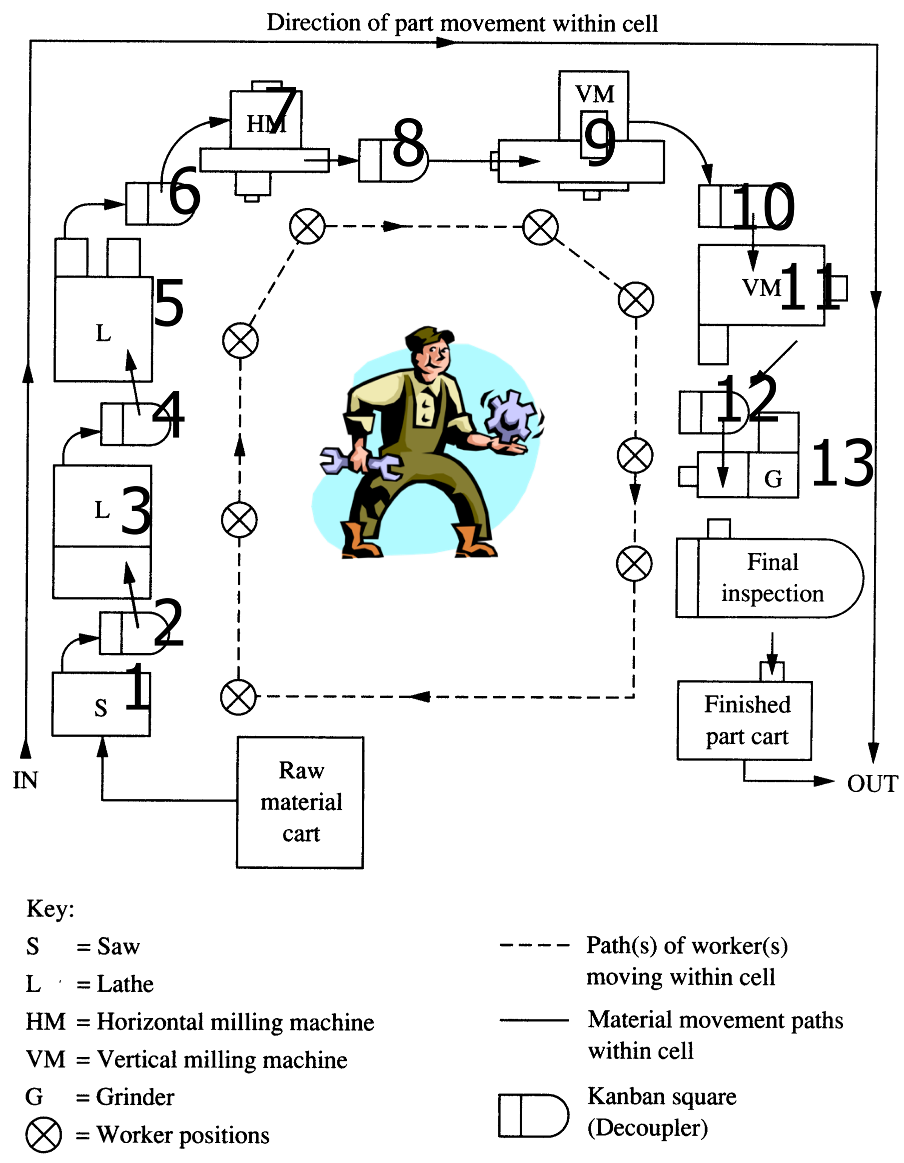
3. Time in the system = W?

Number of round trips; 13

Machining Cell

Saw	3+15	+ 153
#1 decoupler	1.5	+153
L1	1.5+ 10	+153
	…….	…….
Grind	1.5+ 15	+153
Manual and walk	19+3	out
	150	153X13 =1989

$$1989 + 150 = \underline{2139}$$



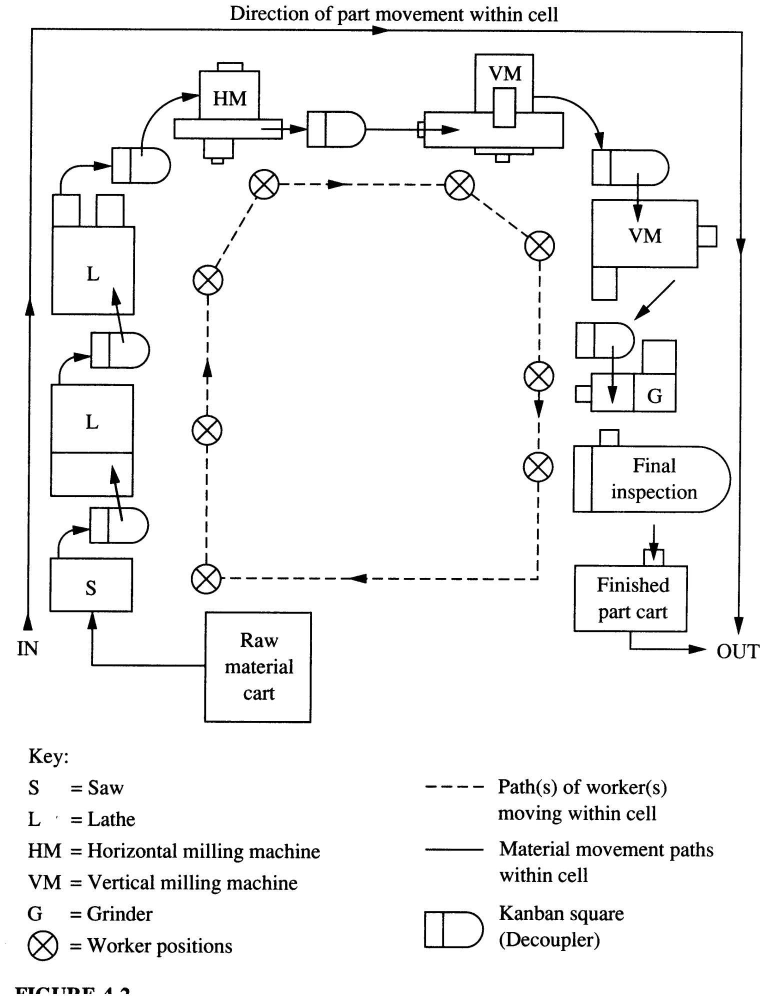
By Little's Law

L = (13 + 1) X (150/153) +

13 X (3/153) = 13.98 parts

rate, λ = 1/153 parts/second

W = 153 X 13.98 = <u>2139 sec</u>



TPS Cell

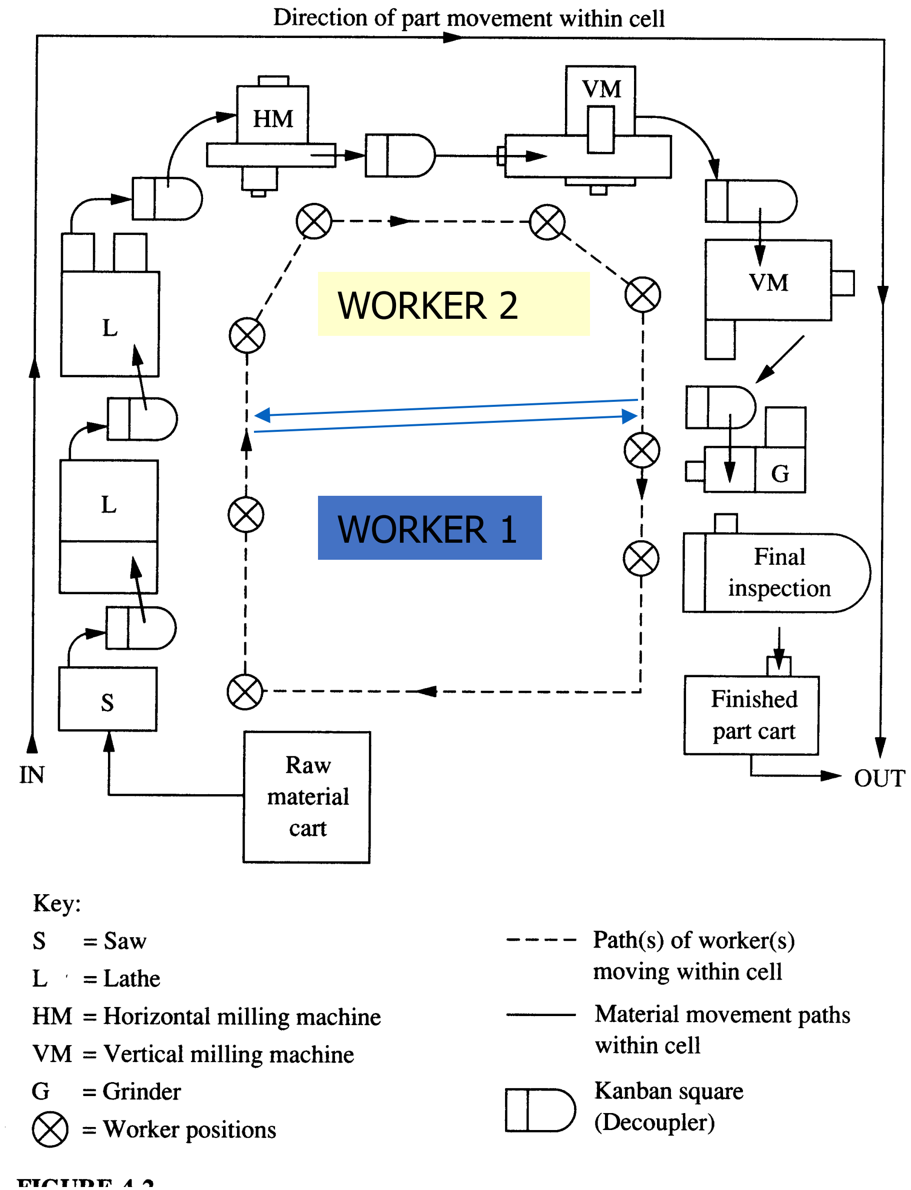
Increase production rate:

a) add additional worker to cell

b) modify machine bottlenecks

To increase production rate add 2nd worker

	Manual (Sec)	Walk to (Sec)	Machine (Sec)
Raw		3	
Saw	15	3	60
L1	10	3+3	70
L2	12	3	50
HM	12	3	120
VM1	20	3	70
VM2	20	3+3	60
G	15	3	60
F.I.	19	3 + 3	
Totals	**M+W**	**= 159**	**490**
Work 1		**80**	
Work 2		**79**	



What is the production rate for this new arrangement?

Check max(MTj) < CT

Worker 1; 80 = 80

Worker 2; 12+120 >79

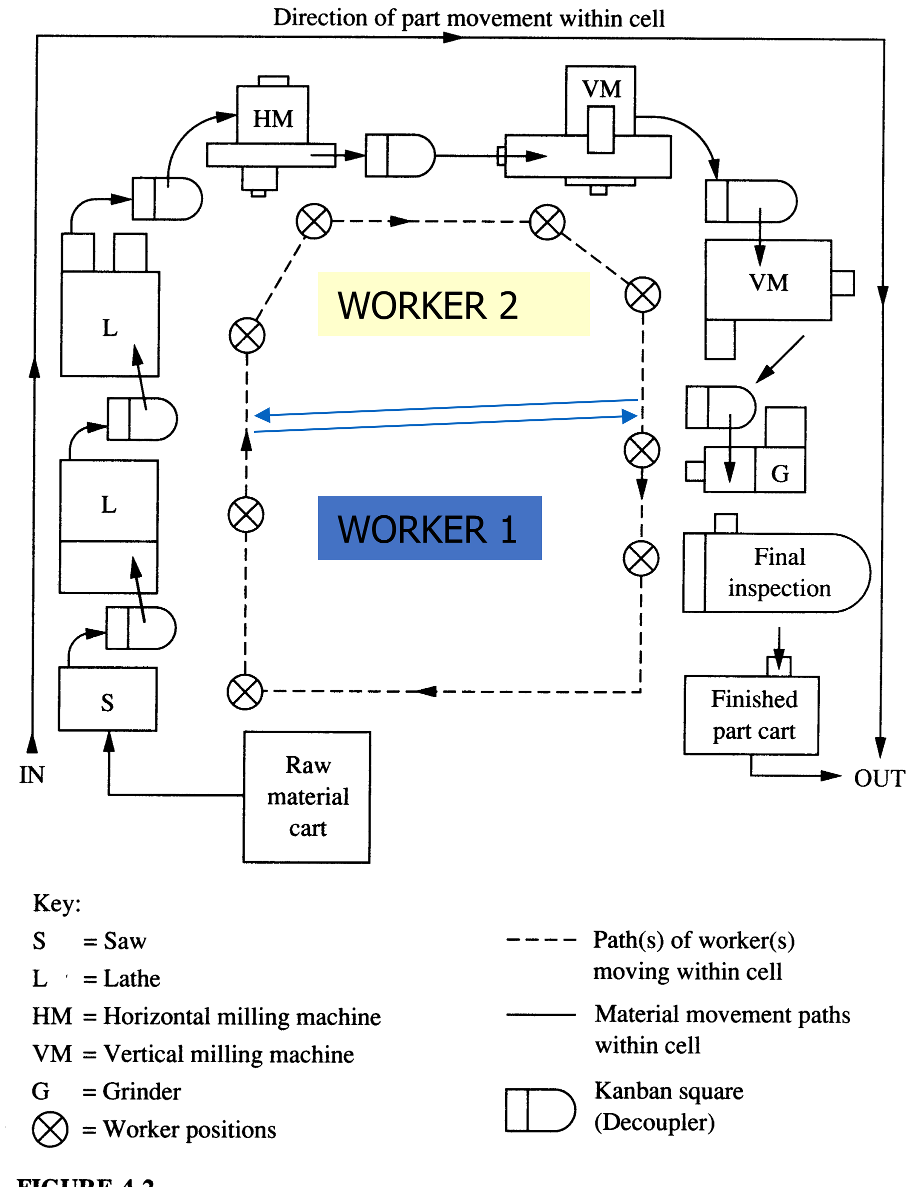
One part every 132 seconds

We are limited by the HM (horizontal mill)

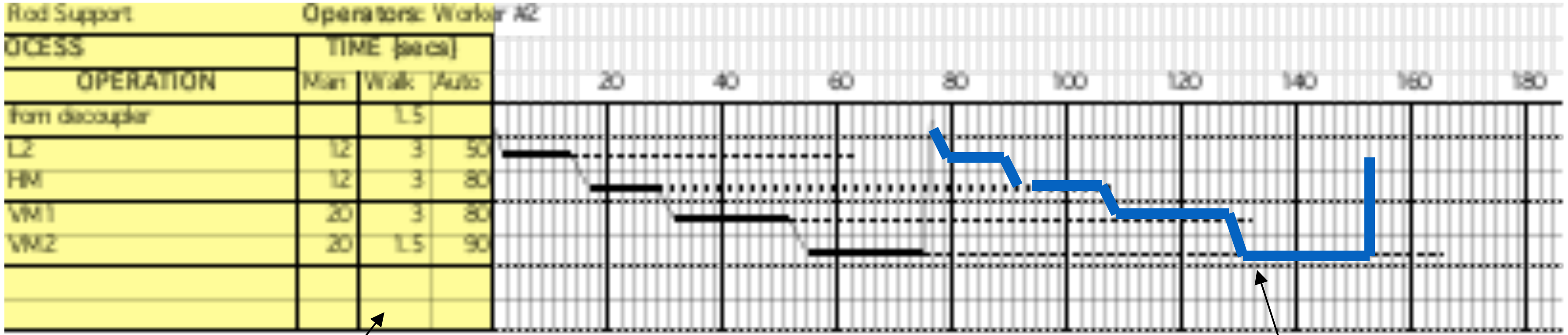
$$\lambda = \frac{1\,part}{132\ \mathrm{sec}} = 27.3\ \mathrm{parts/hr}$$

Can we shift work off of the HM to reduce the cycle time?

	Manual (Sec)	Walk to (Sec)	Machine (Sec)
Raw		3	
Saw	15	3	60
L1	10	3+3	70
L2	12	3	50
HM	12	3	120 → 80
VM1	20	3	70 → 80
VM2	20	3+3	60 → 90
G	15	3	60
F.I.	19	3 + 3	
Totals	**M+W**	**= 159**	**490**
Work 1		**80**	
Work 2		**79**	



Standard Work for Worker #2



Cycle # 1

Cycle # 2

+3

Operator waiting
On machine

What is the new production Rate?

Check max(MTj) < CT

Worker 1; 80 = 80

Worker 2; 110 > 79

Hence Worker #2 will be waiting on Vertical Mill #2

What is the new production Rate?

- The new production rate is;

  one part every 110 sec

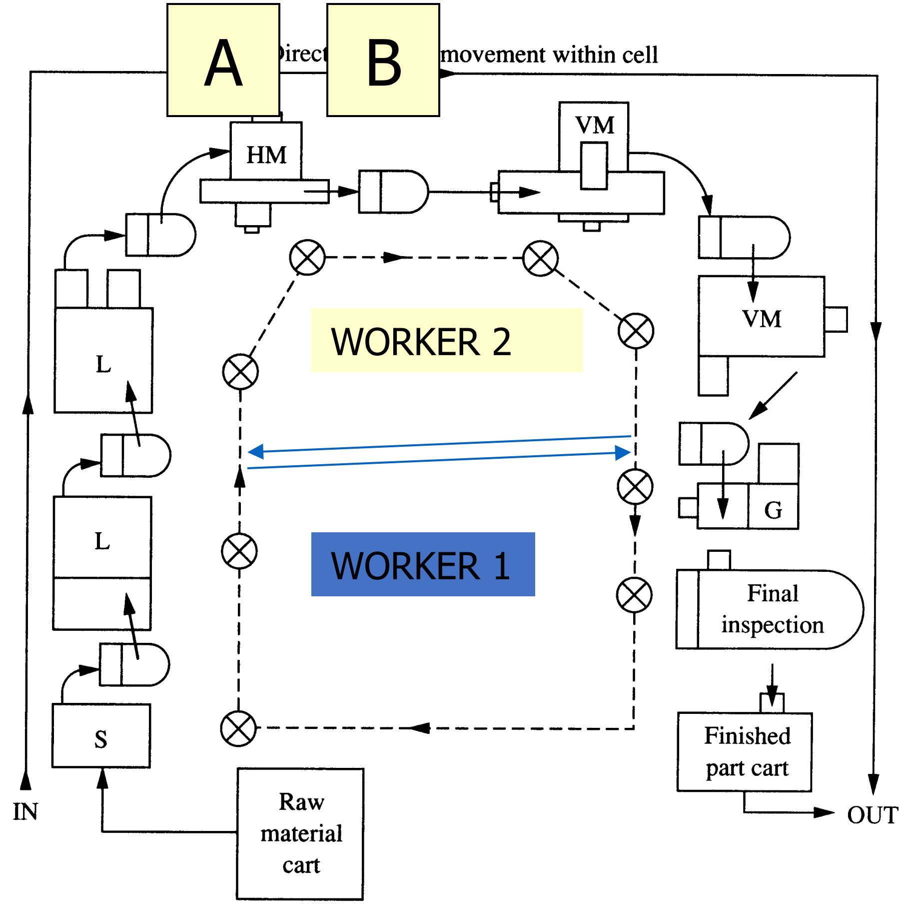
- Pro and Cons; Worker “idle”, can’t speed up by adding additional worker
- Design for flexibility make;

  Max(MTj) < CT/2

$$\lambda = \frac{1\,part}{110\ \text{sec}} = 32.7\ \text{parts/hr}$$

Alternative solution add 2 HM's

	Manual (Sec)	Walk to (Sec)	Machine (Sec)
Raw		3	
Saw	15	3	60
L1	10	3+3	70
L2	12	3	50
HM	12	3	120
VM1	20	3	70
VM2	20	3+3	60
G	15	3	60
F.I.	19	3 + 3	
Totals	**M+W**	**= 159**	**490**
Work 1		**80**	
Work 2		**79**	



$$\lambda = \frac{1\,part}{90\ \text{sec}} = 40\ \text{parts/hr}$$

Almost double!

TPS cell summary

1. Original cell - 23.5 parts/hr
2. Additional worker- 27.3 parts/hr
3. Shift work- 32.7 parts/hr
4. Add additional HM 40 parts/hr