Starm case

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Tips for drafting the *timeline*

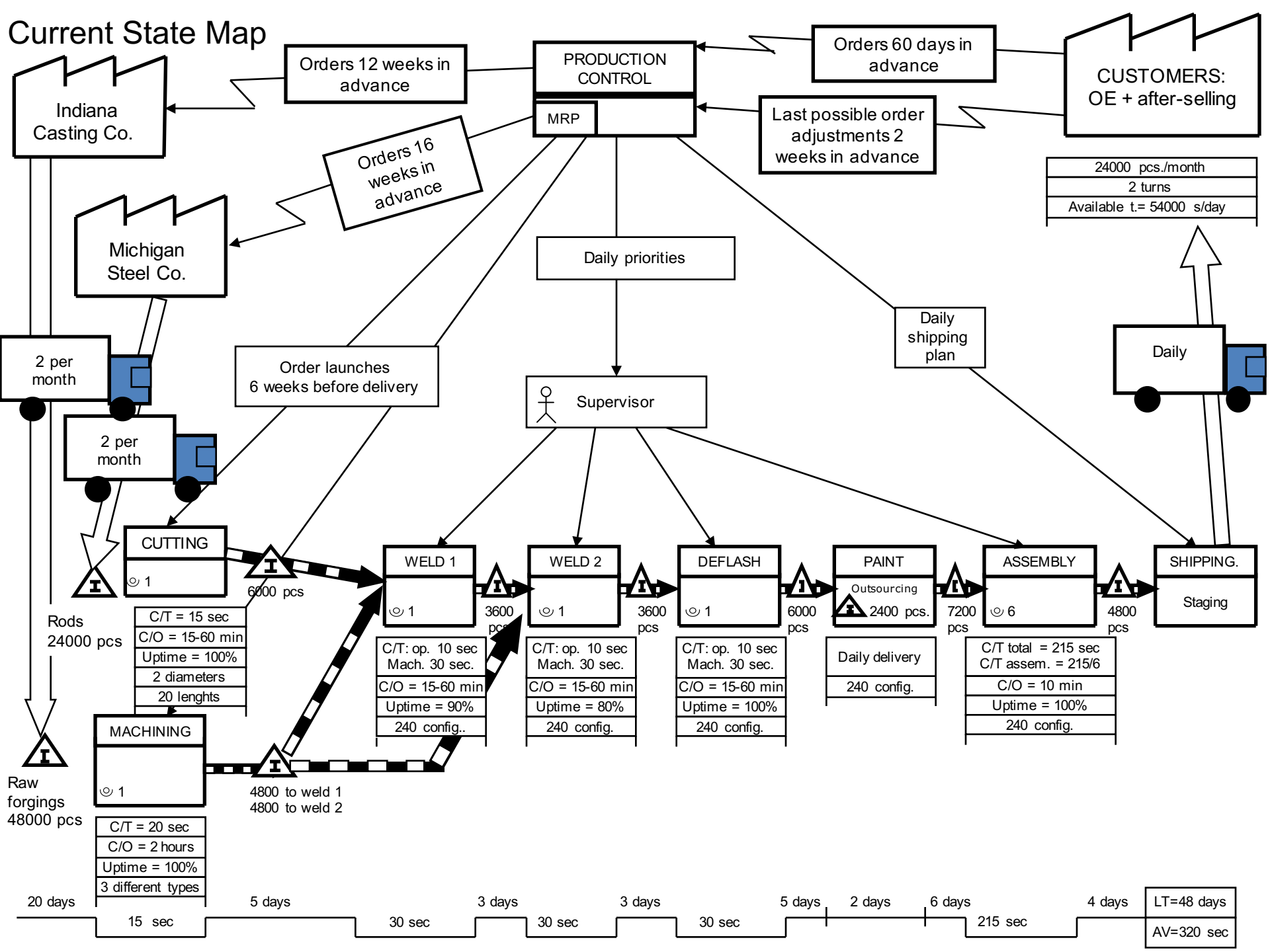
In case of processes in parallel, identify the critical path and use that time in the preparation of *timeline*.

In Starm S.p.A. the critical path is represented on the stage of cutting and buffer rods cut. Consequently you must use times of 15 seconds Value Added and times of 5 days Not Value Added.

When a finished product is composed of two or more components of the same type, like total C/T it is necessary to consider the time to produce all the required components from the finished product.

In Starm SpA, in the stage of mechanical machining it is necessary to consider time as value-added 40 seconds.
To consider the critical paths:
Cutting: 24.000[pcs]/1.200 [pcs/day] + 15[s]/(15[h/day]*0,5*3.600[s/h])
+6.000[pcs]/1.200[pcs/day] ≈ 25 days
Mechanical machining: 48.000[pcs]/2.400 [pcs/day] + 40[s]/(15[h/day]*3.600[s/h])
+9.600[pcs]/2.400[pcs/day] ≈ 24 days

The critical path to consider is passing from the stage of cutting.


Current State Map
Indiana Casting Co.
Orders 12 weeks in advance
PRODUCTION CONTROL
MRP
Orders 60 days in advance
CUSTOMERS: OE + after-selling
Last possible order adjustments 2 weeks in advance
Orders 16 weeks in advance
Michigan Steel Co.
24000 pcs./month
2 turns
Available t.= 54000 s/day
Daily priorities
Daily shipping plan
Daily
2 per month
2 per month
Order launches 6 weeks before delivery
Supervisor
CUTTING
1
6000 pcs
Rods 24000 pcs
C/T = 15 sec
C/O = 15-60 min
Uptime = 100%
2 diameters
20 lenghts
MACHINING
1
Raw forgings 48000 pcs
C/T = 20 sec
C/O = 2 hours
Uptime = 100%
3 different types
4800 to weld 1
4800 to weld 2
WELD 1
1
3600 pcs
C/T: op. 10 sec
Mach. 30 sec.
C/O = 15-60 min
Uptime = 90%
240 config..
WELD 2
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3600 pcs
C/T: op. 10 sec
Mach. 30 sec.
C/O = 15-60 min
Uptime = 80%
240 config.
DEFLASH
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6000 pcs
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C/O = 15-60 min
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PAINT
Outsourcing
2400 pcs.
7200 pcs
Daily delivery
240 config.
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C/T total = 215 sec
C/T assem. = 215/6
C/O = 10 min
Uptime = 100%
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20 days
15 sec
5 days
30 sec
3 days
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3 days
30 sec
5 days
2 days
6 days
215 sec
4 days
LT=48 days
AV=320 sec

Structure

1. Definition of improvements plan.

2. Quantitative calculation of the improvements (interventions sizing).

Design of Future State Map

The Future State Map is built answering 8 key questions:

1. What is the takt time of the product family that has been considered?
2. The company has to build the product for a finished products supermarket or directly to be shipped to the customer?
3. Where can the company introduce continuous flow?
4. Where is required to use a supermarket-pull system?
5. What point in the production chain (the pacemaker process) the company must be programmed?
6. How should the company level the production mix to pacemaker process?
7. What should be the increase of work to release in process pacemaker?
8. What improvements to the processes will be necessary to obtain the flow of the value stream described by Future State?

1. Takt time

1. What is the takt time of the product family?

Time available: T. opening system – scheduled stops

- scheduled stops:
  - YES scheduled maintenance, lunch (if stipulated in the contract), coffee breaks (stipulated in the contract), ...
  - NO set-up time, downtime, ...

Customer request

$$\text{Takt time} = \frac{\text{Time available}}{\text{Customer request}}$$

Takt time of the product family that has been considered

Time available:

- 8 hours per turn
- 2 turns per day
- 2 breaks of 15 minutes for each turn

Time available = (8 – 2 * 15) h/turn * 2 shifts/day = 15 h/day

Customer request:

- 24.000 steering arms per month
- 20 working days per month

Customer request = 24.000 pcs/month / 20 days/month = 1200 pcs/day

Takt Time = (15 h/day *3600 sec/h) / 1200 pcs/day = 45 sec/pcs

2. Produce for FGW or for shipping?

2. Produce for supermarkets or for shipping?

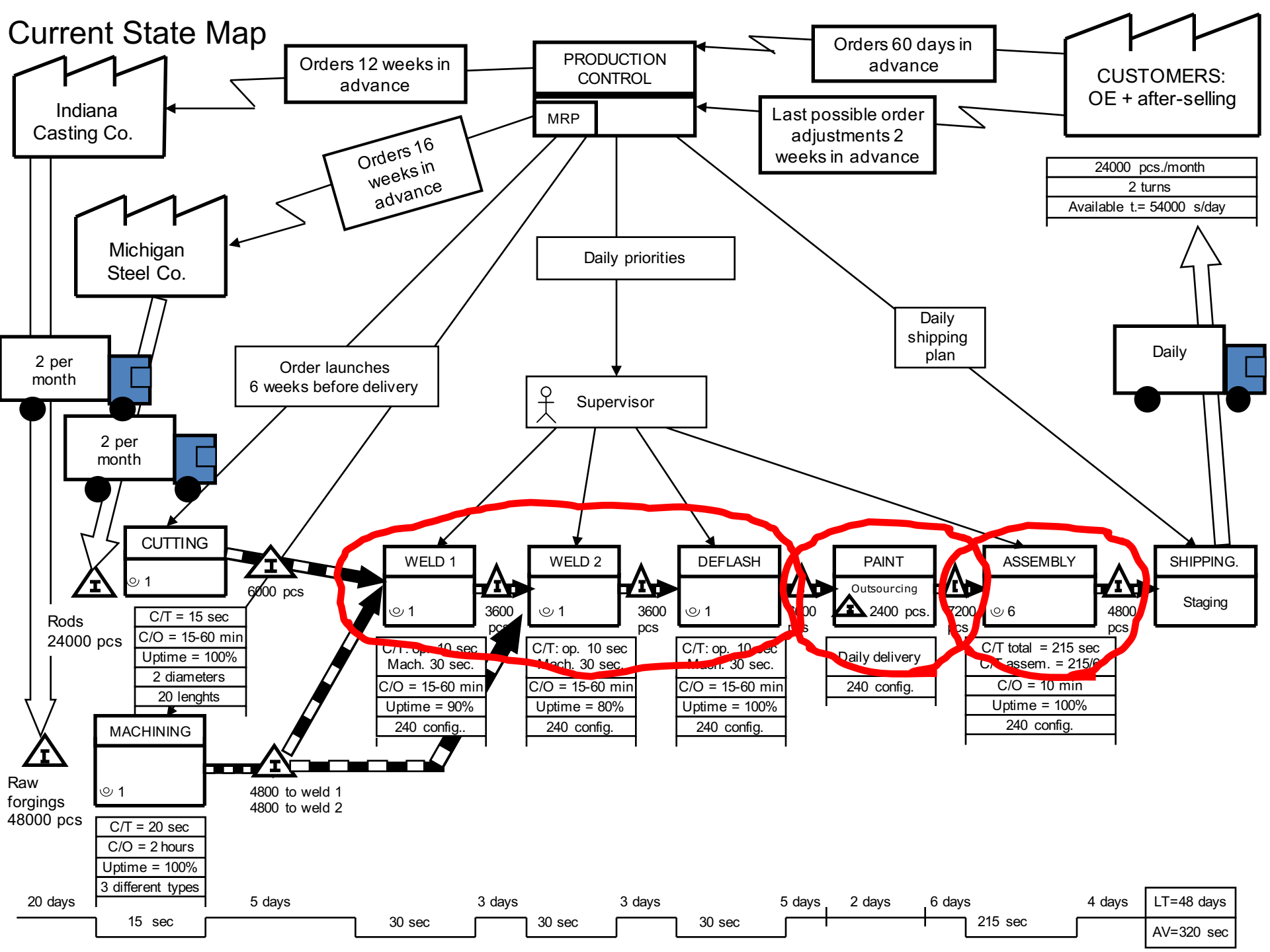
How to organize production?

Some drivers for your choice:

- time of delivery to the customer
- product features (good value, level obsolescence, product standardization level)
- demand predictability
- demand stability
- …….

Make to order - SHIPPING

3. The continuous flow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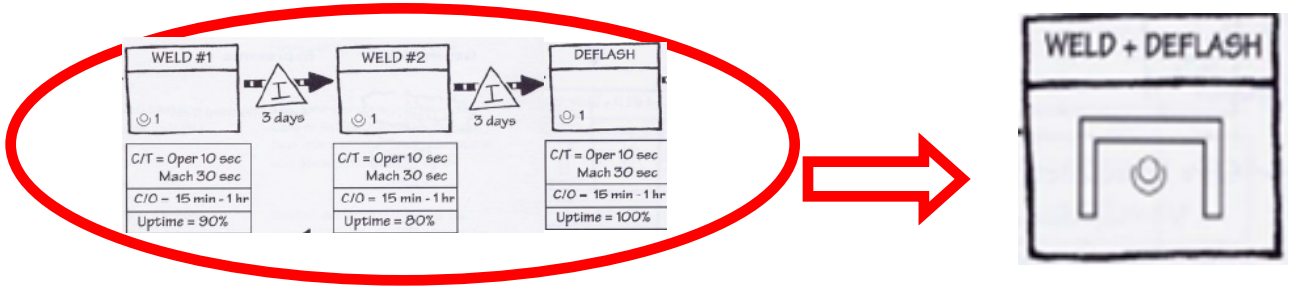
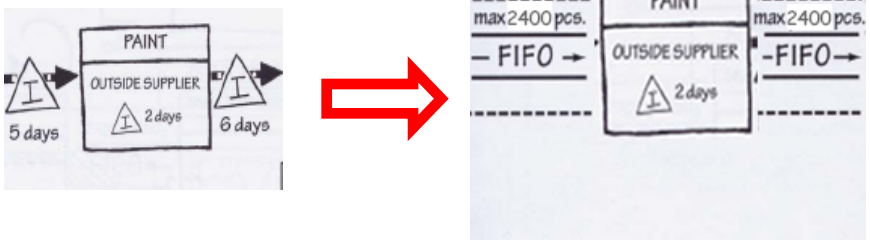
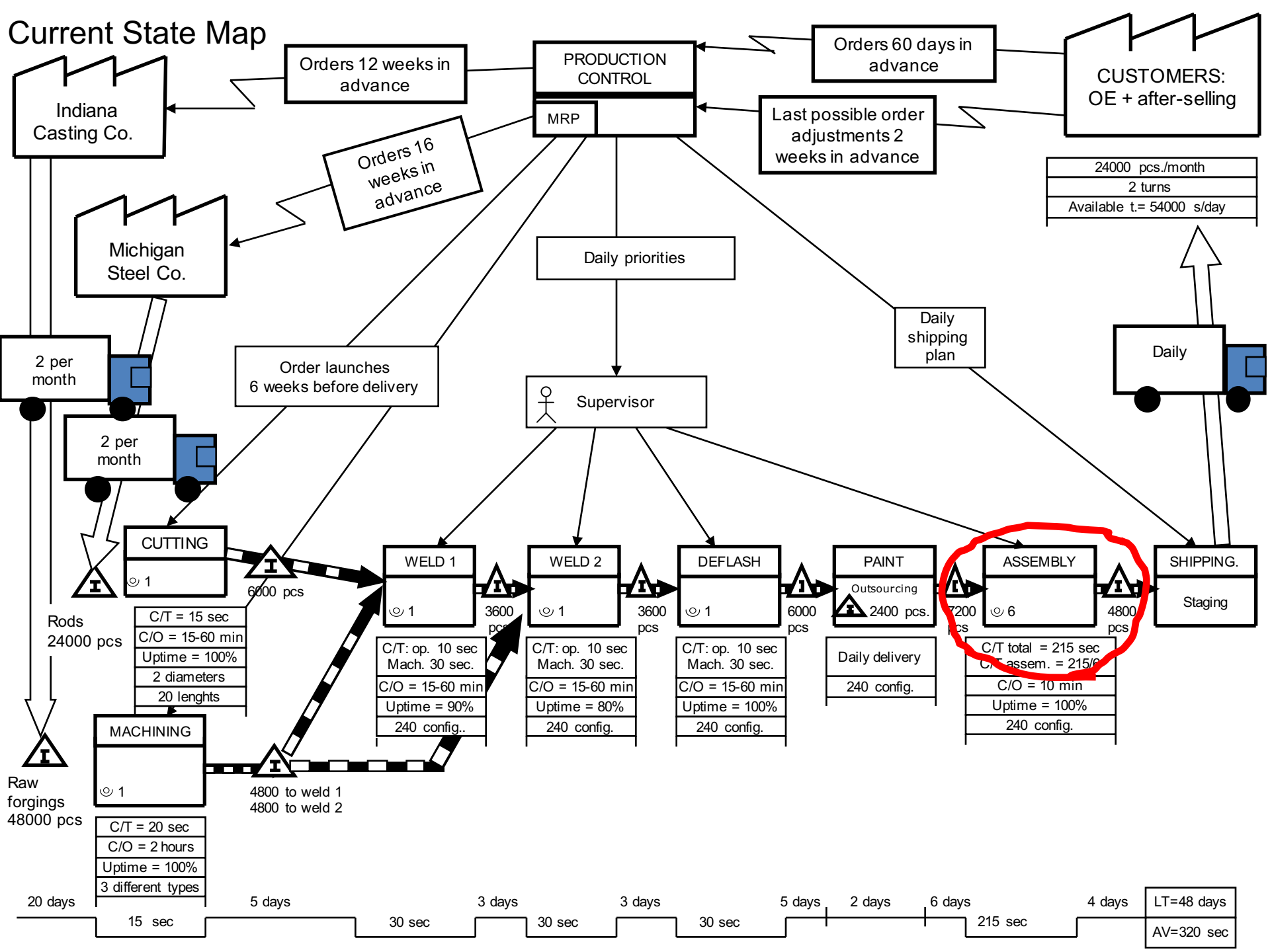
3. Where you can introduce continuous flow?

To support the decision of where to implement a continuous flow, think about DECAF:

- DEdicated
- Capable
- Available
- Flexible



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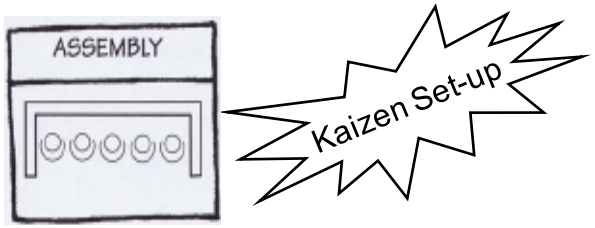
The flow to the stage of final assembly

To put continuous flow the final assembly it is necessary to put in line the operators.

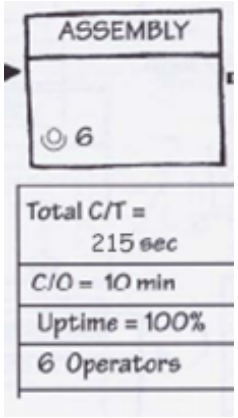
Benefits: The line configuration has many benefits, including greater efficiency (it is easier to manage) and a lower supply required (not always need material to supply 6 islands).

Disadvantages: The line configuration, however, requires a larger amount of set-up. In particular, each operator on the line should run 24 production changes every day.

With the current set-up time the final assembly can not be organize as a line. It is needed to act on the set-up time!



The flow to the stage of final assembly



At this stage each fitter assembles completely a finished product.

C/T for each operator is 215 sec.
Average order: 50 pcs.

With an average order of 50 pcs, they are required 1200/50 = **24 set-up**.

6 operators work completely finished products. For this reason, each operator must carry daily 24/6 = **4 set-up/operator**.

The total time (set-up + processing) required daily for each operator is then amounted to:
4 set-up/operator* 10 + 1200/6 * 215/60 = 40 + 717= 757 min = 12,62 h

The flow to the stage of final assembly

In the stage of final assembly, C/T is 215 seconds for the finished product. The Takt time is 45 seconds/finished product.

You may calculate the minimum number of operators required.

Content of work / Takt time = minimum number of workers

215 sec/pcs / 45 sec/pcs = 4,77 operators → **5 operators**

In the current situation, with 6 operators working in 6 islands assembly, you can not work with 5 operators working in 5 islands.

In this situation, each worker should do 24/5 = 4.8 set-up on average. The total time required would be:

4,8 * 10 + 215*(1200/5)/60 = 48 min + 860 = 908 min = 15,13 h > Ta

The flow to the stage of final assembly

In the current situation, even putting continuous flow final assembly will be able to work with 5 operators.

Put in line operators means allocate to each operator a package of activities with a cycle time of less than but close to takt time.

The possibility of putting continuous flow the final assembly and the possibility to save an operator is in any case subject to the possibility to reduce the time to set-up.

We assume that activities are composed of 'packages' uniforms activities and then load each operator as follows:

215/5 = 43 sec

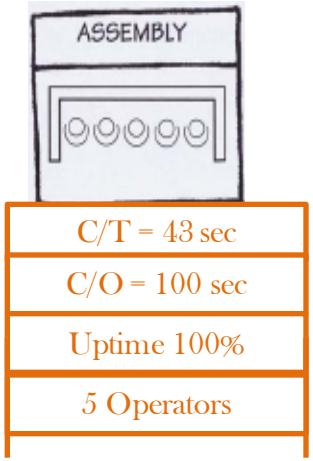
All five workers will perform 43 seconds of work on an individual piece.

The flow to the stage of final assembly

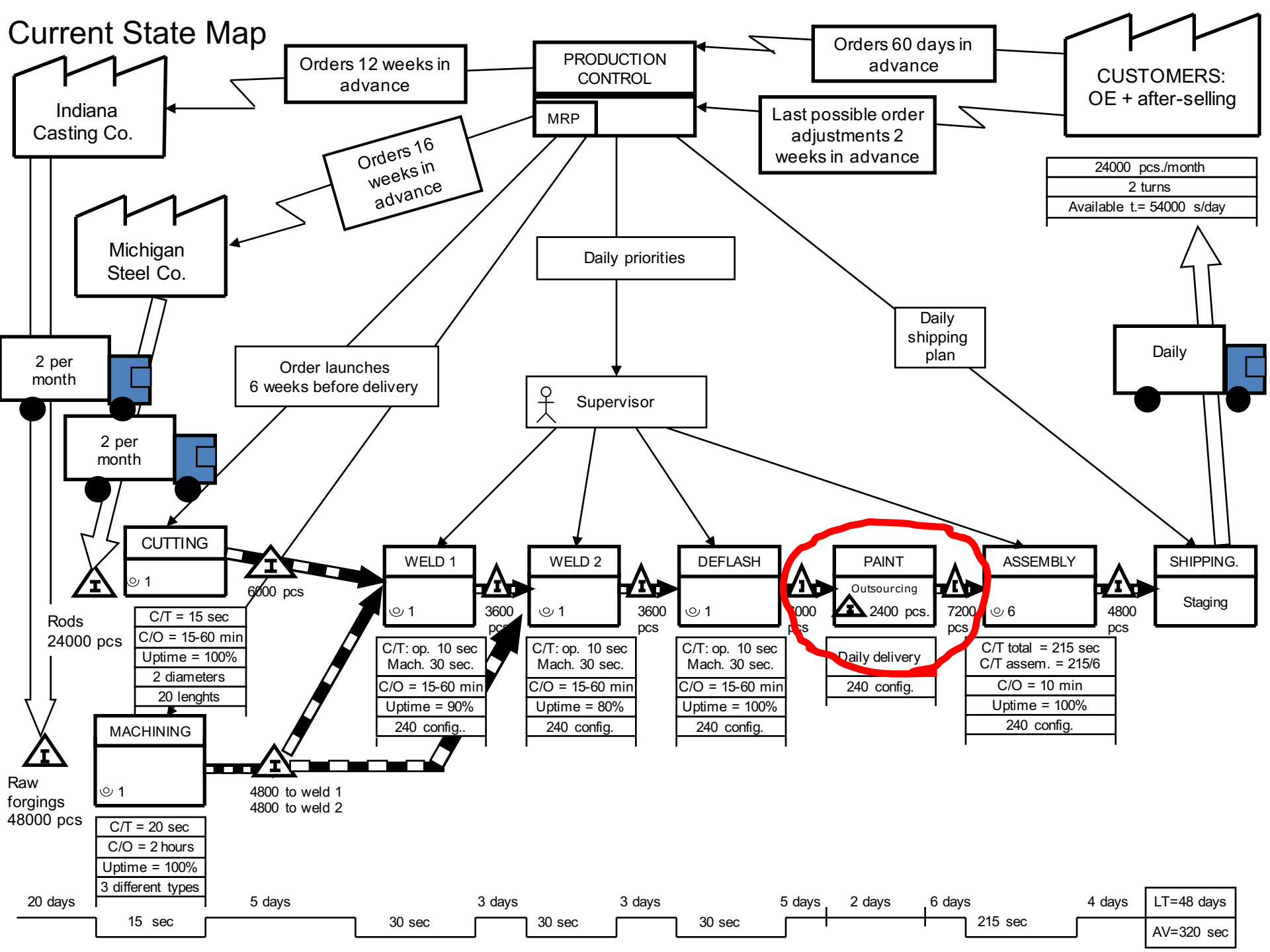
In the situation described, what it is the minimum target of reducing the time to set-up for each station assembly?

t. production + t. set-up ≤ t. available

43/1 * 1200 + 24 * C/O unitary ≤ 15 h * 3600 sec/h
52800 + 24 * C/O unitary ≤ 54000 sec
C/O unitary ≤ 100 sec → 1,67 min (total time ENTIRE LINE will stop for retooling)



In the case that it is possible to reduce the time to set-up for each station less than 1,67 min, then it will be possible to save one operator (6 to 5), which may go to conduct different tasks.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The flow to the stage of coating

Supplier takes arms unpainted once a day and return them painted once a day.
In order to absorb the variability in the rates of withdrawal and deposit of the products in the two stages, and prevent blocking events of the stages, Starm must decouple the processes using FIFO queues.

FIFO queues allow a constant supply to the stage downstream of the coating and the ability to stage upstream of the painting not hang uselessly.

The use of FIFO queues allows to avoid overproduction in cases of problems in the production process and allows a constant movement of the material!

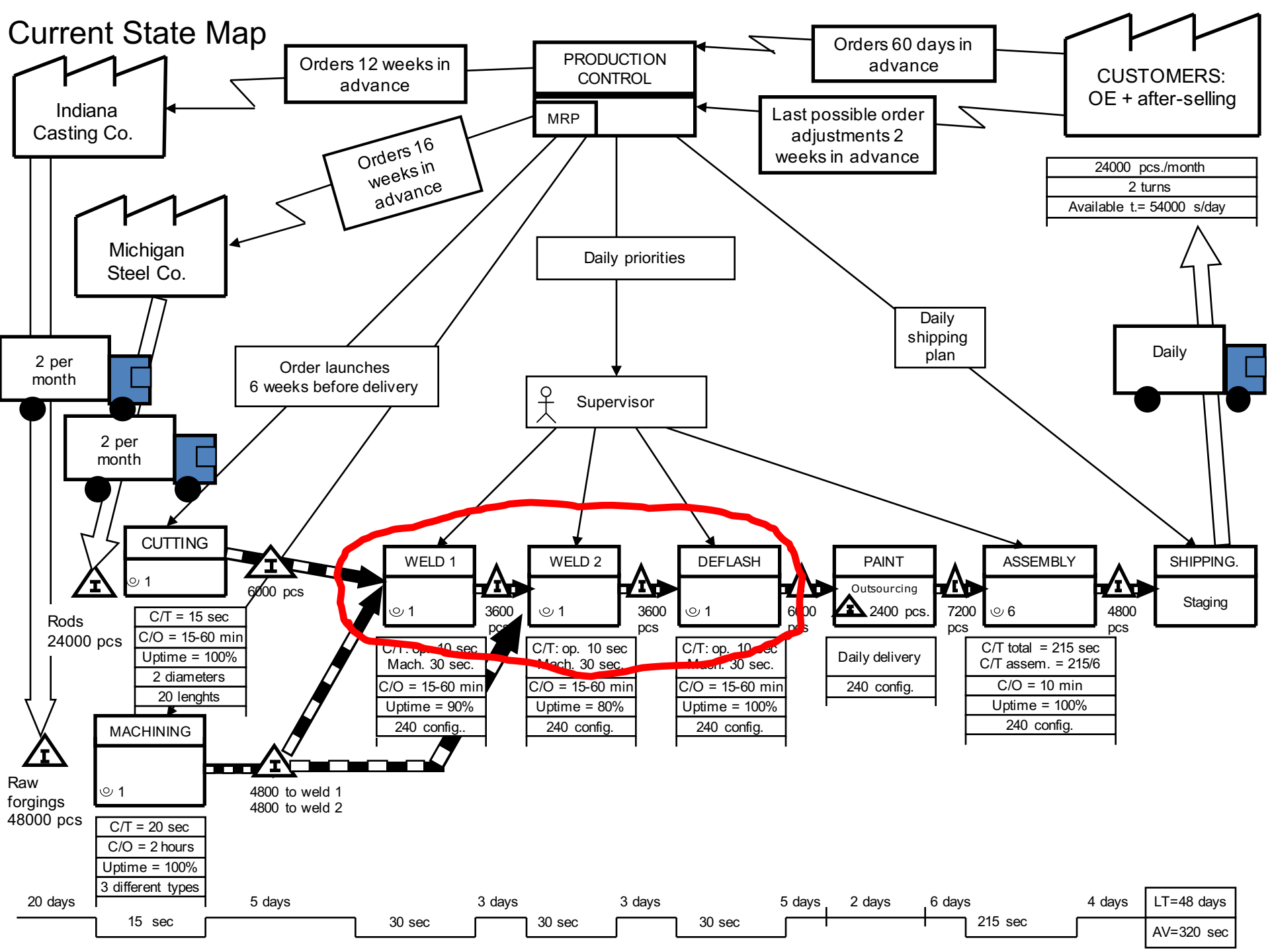
Sizing of the FIFO queues for coating

In order to prevent events of *starving* and *blocking* of the stages, Starm must decouple the processes using FIFO queues dimensioned at least on a production day.

Caution when sizing:

1. The supplier may have some variability in time delivery of the goods.
2. Production volumes may fluctuate daily. It may sometimes not be producing 1,200 products a day.

Starm should slightly over-dimensioned FIFO queues, for example of about 2 days of production in order not to lose production and output.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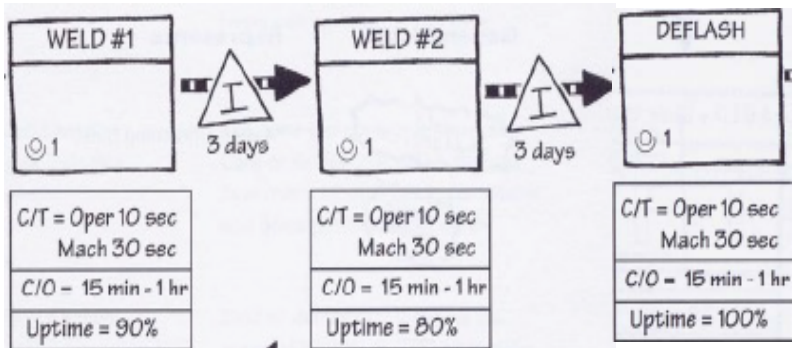
The flow Weld (soldering) 1 → Deflash (deburring)



Takt Time: 45 sec/pcs
C/T: 30 sec/pcs

Freeing the operator from the single machine:

You can organize a cell in U and manage it to a single operator that moves between machines.

C/T Oper.: 10 sec/pcs for machine → 30 sec/pcs for 3 machines < TT

C/T machine: 30 sec/pcs < TT

The flow Weld 1 → Deflash

TO MAKE FLOW (DECAF)

1. **DEdicate:** Yes, all three stages
2. **Capable:** C/T for all three < TT (30<45)
3. **Available?**
   - Connect stages also means linking the availability!
   - You need to check if the availability of the stages is a restriction to the possibility of making flow: (C/T) / A < TT?
   - 30 / (0,9*0,8) < 45 → the machine availability is not a problem.
4. **Flexible?**
   - You can work with an allotment of 50 average products? We work for shipping and must be able to be flexible enough to meet the customer's request. The client requires 24 different versions (1200/50) of product per day on 240 available in the catalog. In this cell it is held set-up only for the length and the diameter then the range which 'sees' the cell is 40 (and not 240), or in the cell there is set-up for welding different types of fittings.
   - So of the 24 variants requested, probably only a part depend on the diameter and length.

The flow Weld 1 → Deflash

So of the 24 variants requested, probably only a part depend on the diameter and length.

Example:

Product requested by client1: D1 L1 RG RP (diameter 1, 1 length, great fitting, fitting small)

Product requested by Client2: D1 L1 RG RM (diameter 1, length1, great fitting, coupling medium)

They are two different products, but in the cell is not expected to set-up to switch between them. So to make sure that the cell is flexible does not mean that you should take 24 set-ups a day.

For sizing we consider however the WORST CASE, in which 24 set - up a day in the cell are required.

The flow Weld 1 → Deflash

In the current situation, without changing any parameters, it is possible to carry out 24 set-up every day (situation corresponding to work with batches of average size 50 products)?

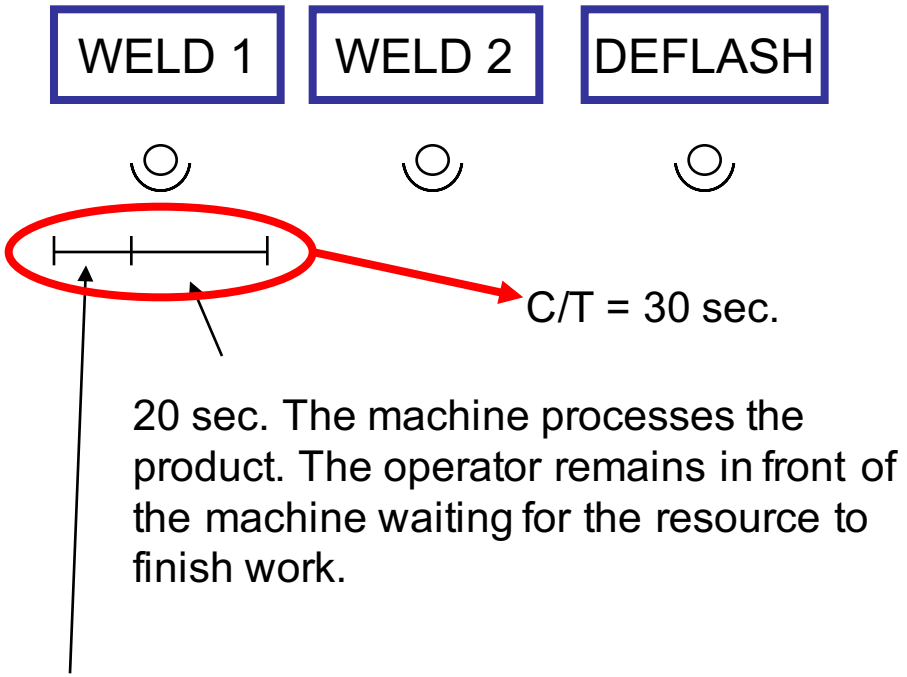
Available time every day to do set-up:

t. available – t. production =
15 h/day – [30/0.72 * 1200]/3600 h/day = 1.11 h/day

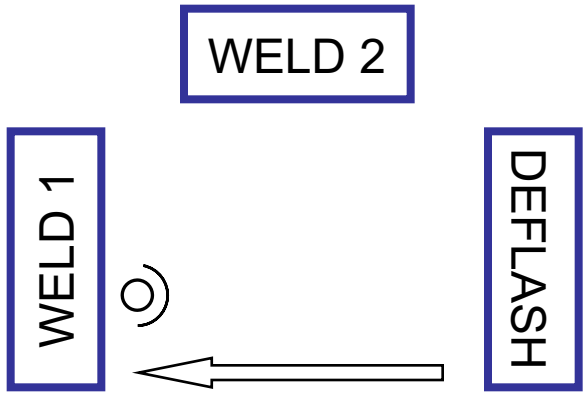
In 1.11 hours it is not possible to carry 24 set-up!

The flow Weld 1 → Deflash

Current situation



Proposed configuration



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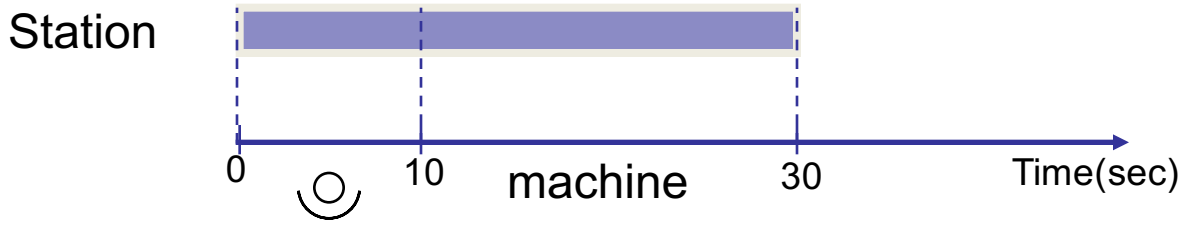
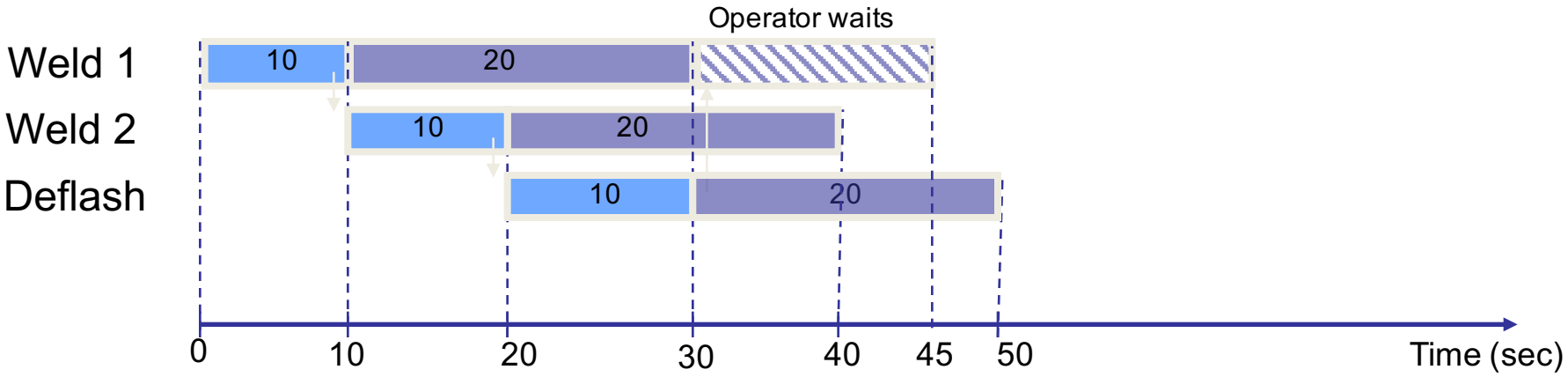
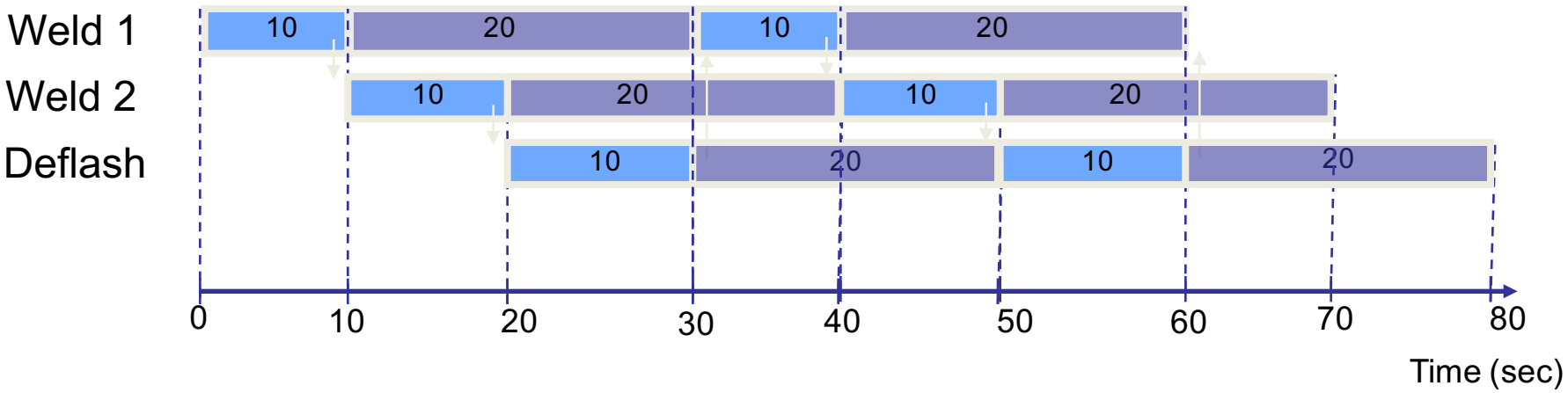




Proposed configuration

Also, the time required to set-up not allow the production to Takt Time: the cell must produce faster in order to accumulate the production for the time in which it was stopped for the change type.



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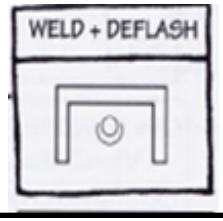


C/T 30 sec
C/O: KAIZEN SET-UP
Uptime: 72%
T. processing 90 sec

- You can save 2 resources (labor), but
- it is necessary to reduce activities not-value added (set-up)

The flow Weld 1 → Deflash

Reduction of set-up time

T. C/O + C/T * daily demand ≤ 15 h
T. C/O ≤ 15 h – 30/0,72 * 1200 / 3600 = 1,11 h/day

With the objective to work with batches of 50 products and considering a daily demand than 1200 products, the number of set-up required daily would be equal to 1200/50 = 24 set-up. (WORST CASE, see slide 12).

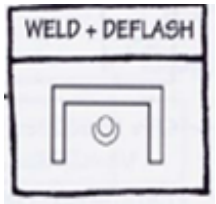
With this objective, the average time for the set-up on each machine should be equal to: 1,11 h * 60 min/h / 24 s-up = 2,78 min.

This means that each machine can be stopped to carry one turn production at most 2,78 minutes.

Having one single operator, this is the maximum time that he has available to retool the whole line. If you can do the set-up for the whole cell in less than 2,78 minutes, then just one operator is needed.
If you can not reach this level, or you require the use of multiple operators, or you must do a number of set-up lower, or you have to increase the availability of the cell.

The flow Weld 1 → Deflash

In the event that it were possible to retool the cell in less than 2,78 minutes, you can get:



C/T 30 sec
C/O 2,78 min
Uptime: 72%
T. processing: 90 sec

- A saving of 6 days in lead time
- A savings of 2 operators that can be assigned to other value-added activities

Cost of:

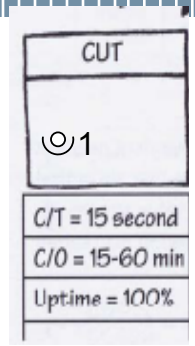
- Reduce activities non-value added

2. Where to insert a supermarket pull system?

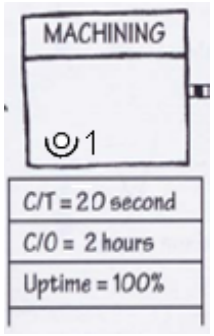
4. Where insert a supermarket pull system?

- Large production lots
- Low machine availability
- Shared resource
- …..

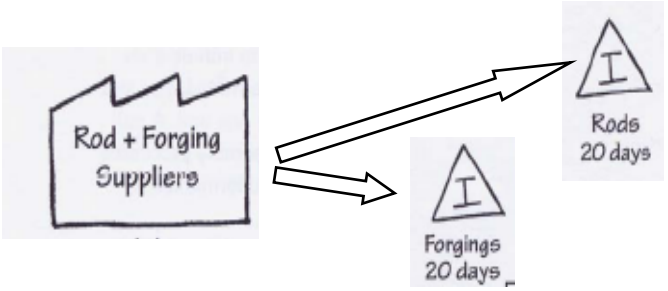
4. Where insert a supermarket pull system?



Cutting is shared between several families production.

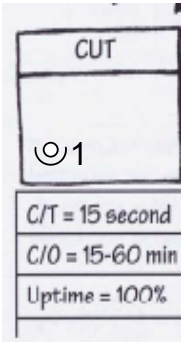


Machining required large productive lots. Different setup reason.



Raw materials inventories requiring large lots from suppliers, stock auctions shared.

Stage Cutting



The stage of cutting is shared between different families product.

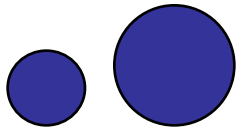
All production flows starting from the stage of cutting, must be free to take what they want when they want, even when the stage cut is working on another product family.

The stage of cutting can not therefore be put to flow with the downstream stages.

- At the stage of cutting, for the family of the steering arms, there are 20 different lengths and two different diameters.
- The machine for cutting works on the family of steering arms for 50% of its total available time.
- The total time of set-up required for re-assort the whole production range is equal to:
  2 diameters * 60 min + 2 * 20 lengths * 15 min = 12 h

Each of the 20 lengths of the bar can in fact be of two dimensions of different diameters.

Stage Cutting

20 different lengths  2 different diameters 

In the current situation, the EPE (Every Part Every) on the stage of cutting is:

C/O + (C/T)/A * # pdt required in the time of EPE ≤ time available in the range of EPE

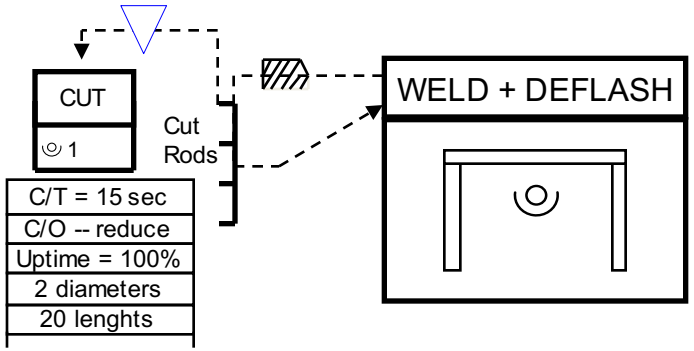
12h + 15/1 s/pcs * 1200 pcs/day / 3600 s/h * X day ≤ 0,5 * 15 h/day + * X day

X ≥ 5 days → EPE = 5 days

Stage Cutting

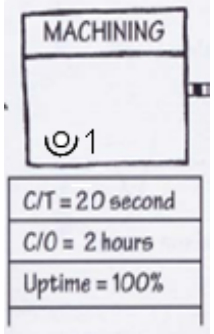
The reduction of EPE allows increased flexibility of the machine, allowing a reduction of stock downstream necessary because of the ability to restock the range much faster.

The reduction of EPE is pursued by the goal of reducing the time to set-up.



A gradual improvement in the time to set-up allows a constant increase in flexibility and a reduction in stocks stored downstream.

Stage Machining



2 hours spent for each set-up, the stage of machining requires very large productive lots. This production stage works three different forged fittings.

With current technical parameters, the stadium has to do lots.

EPE current:

(C/T/A) * daily demand * EPE + C/O * number variants ≤ T. available * EPE

20/1 * 2 * 1200 * EPE + 120 * 60 * 3 ≤ 15 * 3600 * EPE
48000 * EPE + 21600 ≤ 54000 * EPE
EPE ≥ 3,6 days

In the current situation, Machining require batches of about 4 days, that is necessary to aggregate average demand of 4 days of production for each product code.

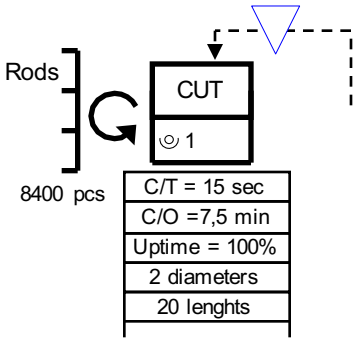
Stage Machining

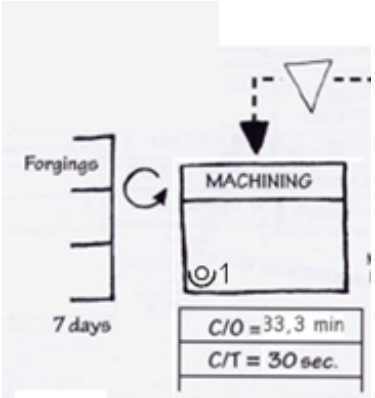
What said for cutting stage, it can be said also for machining stage.
Reducing the time of set-up will increase the flexibility and reduce stock levels.

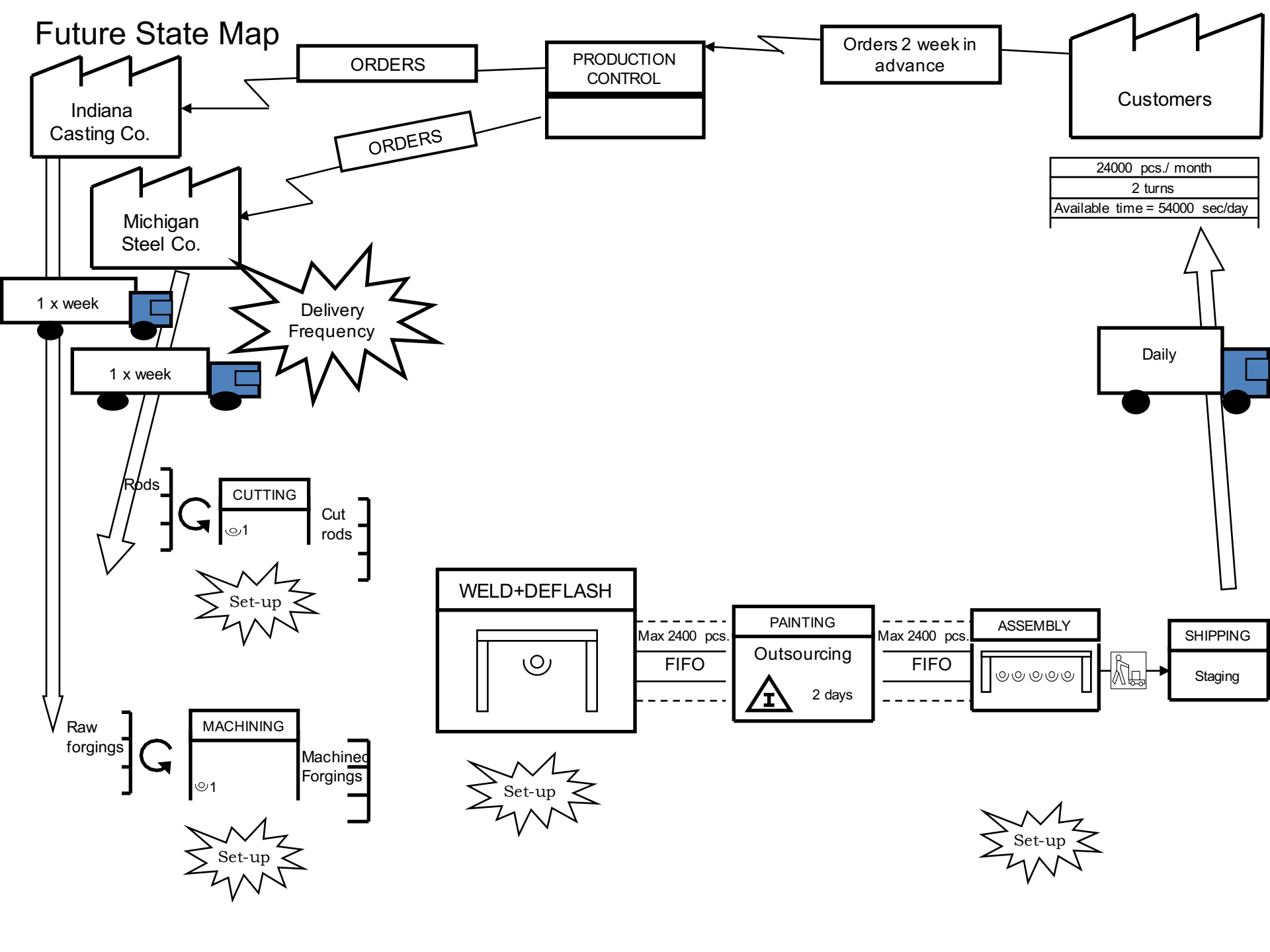
Store raw materials

Stock: 20 days.
Shipping frequency supplier: 2 times a month.

Acting on the supplier can increase the frequency of delivery, coming (for example) to weekly deliveries.
The stock could be organized with supermarket and controlled by kanban that will be transferred to the control of production. This last will send orders to suppliers at fixed time intervals.



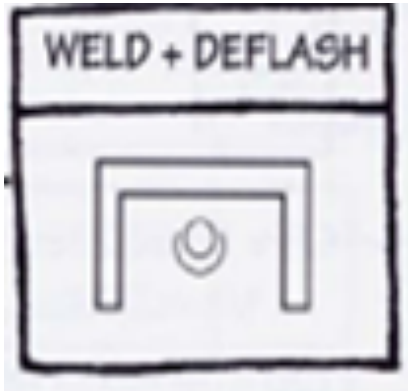



Future State Map
ORDERS
PRODUCTION CONTROL
Orders 2 week in advance
Customers
Indiana Casting Co.
ORDERS
Michigan Steel Co.
24000 pcs./ month
2 turns
Available time = 54000 sec/day
1 x week
Delivery Frequency
1 x week
Daily
Rods
CUTTING
1
Cut rods
Set-up
WELD+DEFLASH
Max 2400 pcs.
FIFO
PAINTING
Outsourcing
2 days
Max 2400 pcs.
FIFO
ASSEMBLY
SHIPPING
Staging
Raw forgings
MACHINING
1
Machined Forgings
Set-up
Set-up
Set-up

5. In what single point will be the production schedule?

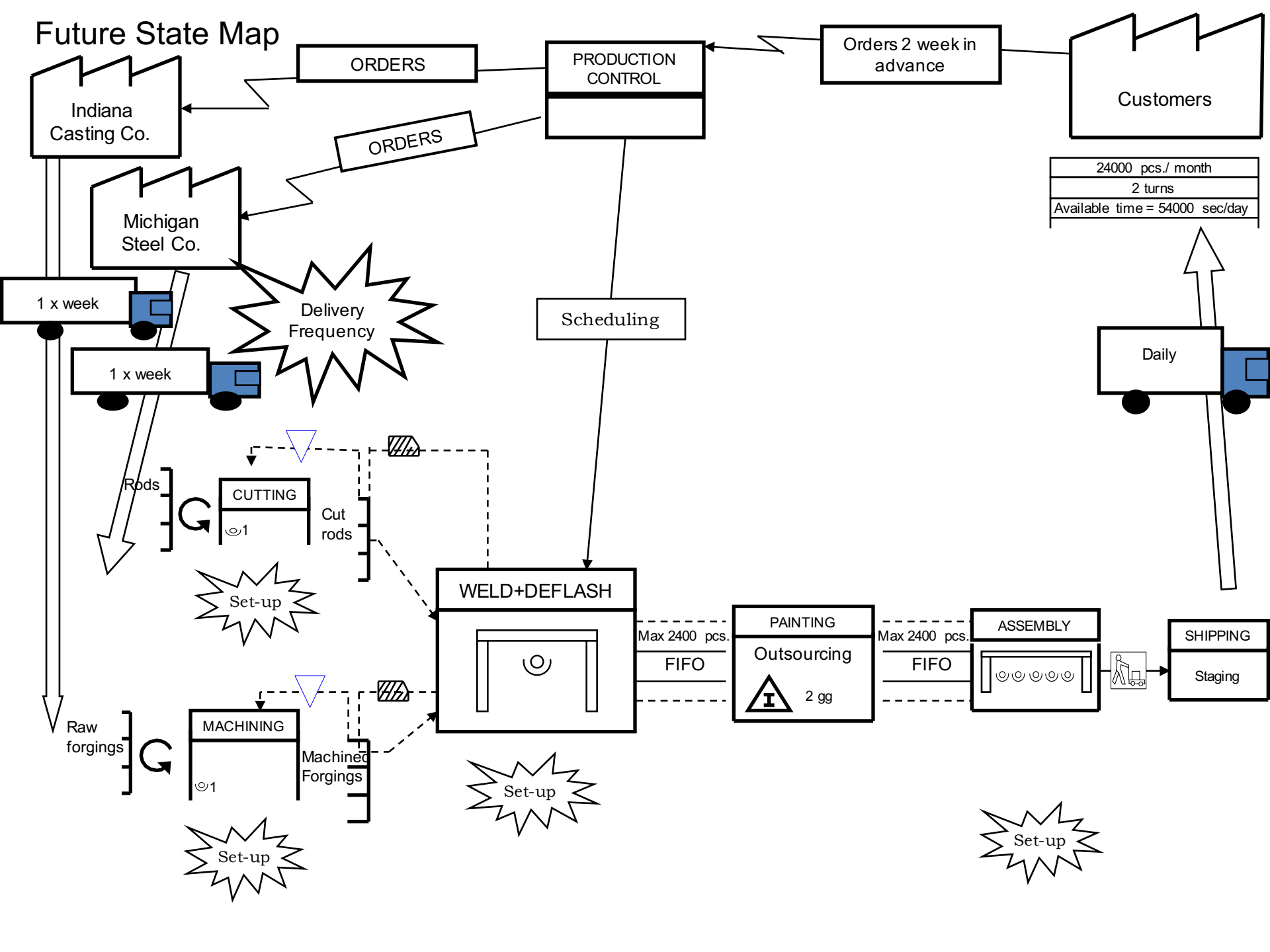
5. In what single point will be the production schedule?

Where, in the process, Starm must work with customer orders?



<u>The weld cell+ deflash cell needs to work with customer orders as:</u>

- At this point the customer can choose one of 240 different variations of the finished product.
- The mover person picking of the material to supermarket must have an indication of what is necessary to take.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Staging
Raw forgings
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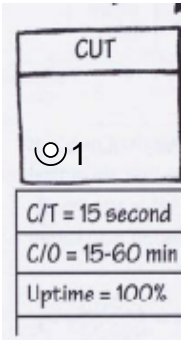
1
Machined Forgings
Set-up
Set-up
Set-up

Sizing supermarket

Stage Cutting



The stage of cut is shared among the various families productive and therefore must have a supermarket in downstream.

At the stage of cutting, for the family of the steering arms, there are 20 different lengths and two different diameters. The machine works on the family of steering arms for 50% of its total available time.

Now the EPE on the machine is 5 days.

To respect the time available is therefore necessary to parcel out five days of production on the stage of cutting.

To reduce the supply of rods cut and increase the flexibility you need to reduce time to C / O..

Stage Cutting

A first goal of improvement might be to obtain an EPE of 2 days, given the high impact of the set-up of the current situation.
Daily, the time allowed the set-up is:

C/O + (C/T)/A * daily demand * EPE ≤ (50% * 15 h/day) * EPE
C/O ≤ (50% * 15 h/day) * 2 – 15 * 1200 * 2/ 3600 = 5 h

If the goal is EPE = 2 days, the time of C/O target for product would be:

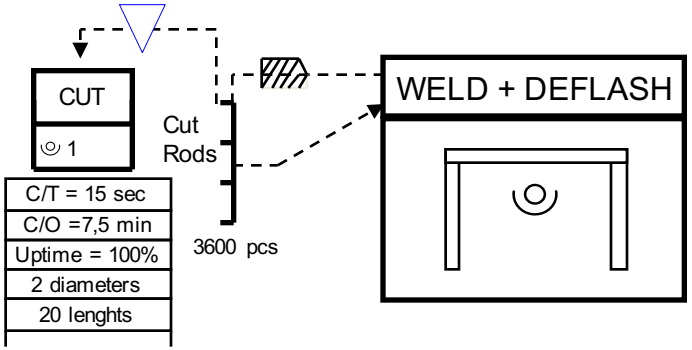
5 h * 60 min / 40 set-up = 7,5 min

In 7,5 minutes, the operator must be able to prepare the machine for cut any one of the 40 versions of the rods.

To size the supermarket, you need to think about the stocks cycle and safety stock.
In the current situation, Starm stock with EPE = 5 days 6000 products (1200 * 5) for 40 variants of rods.
With EPE = 2 days, you will have two days of stocks (2400 products) as stock cycle.
In addition to this stock of the cycle there will be a stock of safety, for example equal to 1200 products (half EPE).

Stage Cutting

The stage cutting will be managed by *kanban signal*. Withdrawals from the pacemaker will accumulate kanban in a special table When the accumulation of kanban will reach a threshold level, the stage of cutting will produce the complete lot of products taken.



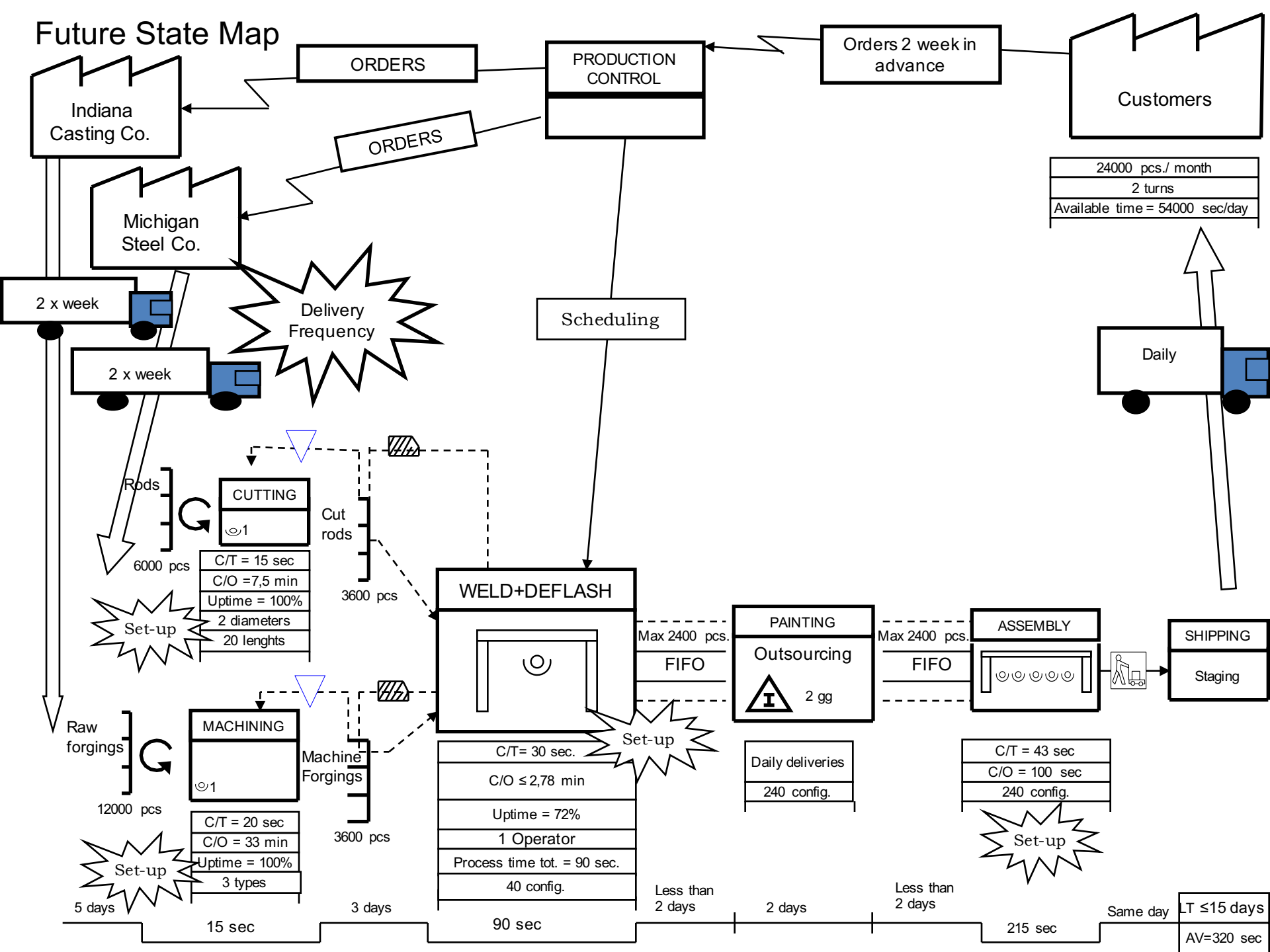
The threshold is reached in the number of kanban taken will activate a signal, which requires the cut stage of starting the production.

The objective on the reduction of EPE improves considerably the size of the store of rods cut and activates a process of continuous improvement that aims to raise the regularity of production on the stage of cutting.

Stage Machining

1. What said for the cutting stage can be replicated for machining stage.
2. Reducing the time of set-up will increase the flexibility and reduce stock levels downstream.
3. I assume its objective of initial EPE = 1 day for machining.

Future State Map



Comparison of the results

	Current State	Future State	Variation
Lead time	48 days	<15 days	-69%
# Operators	11	8	- 27%

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