

Topics covered include....

- Overview of scheduling
- Machine utilisation
- Effective deployment of staff
- Consider the entire end to end process
- Managing risk and disruptions
- Automated scheduling software

Scheduling

Aim of effective scheduling is to;

- Achieve the desired level of machine utilisation
- Ensure efficient use of staff
- Consider the entire end-to-end process

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Manage risks/disruption

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Meet customer delivery times



Same as most manufacturing processes

Machine utilisation

- Depreciation of equipment often accounts for a significant proportion of the cost of manufacture
- Maximise machine utilisation helps to reduce piece price and thus stimulates demand

BUT...

- **High machine utilisation can lead to longer lead times and may not be acceptable for some customers/end-use sectors.**

Efficient deployment of staff

- Manpower costs are a significant factor
- Managing workload is important for part quality, staff moral and safety

Challenges with AM.....

Machine changeover – manual operation on most AM machines
Plan the time when changeover will take place.

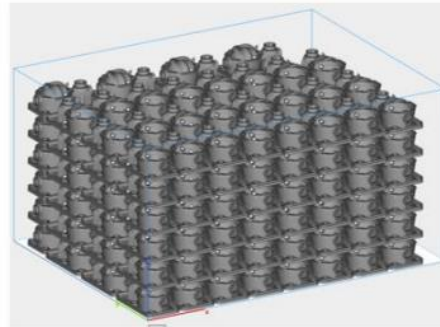
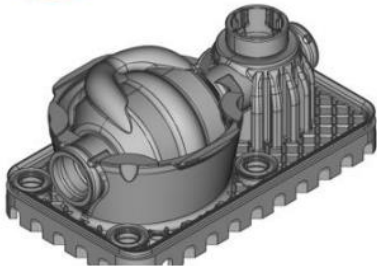
Batch production process – hours/days with no parts and then lots of parts to process

Weekends are different than weekdays

Batch Vs Continuous Processes

Batch processes – lots of parts made at once

Continuous process – parts made individually



Consider entire end-to-end process

- End-to-end AM process is complex
- Mix of batch and continuous processes
- Often conflicting requirements
- Changing one step in process can impact downstream steps
- Bottlenecks can easily occur;
 - Upstream (e.g powder testing and file preparation)
 - Downstream (e.g heat treatment, finishing, inspection)

AM build processes can be relatively fast and “painless”

Manage risks/disruption

- AM processes can be unreliable – build failures/ scrap parts
- Risk of failure increases with;
 - Build time
 - Challenging geometry
 - Difficult materials
 - Certain AM machines

This risk needs to be factored into the cost and also the scheduling

Avoid putting too many parts in a build

- 1.Example of a non AM batch processes ?
- 2.Example of a non AM continuous process?
3. What are the potential issues with too many parts in a PBF-LB build?

<https://www.menti.com/alf6gw82g7ad>



- [CU36-Topic2-Q1,2,3,4 - Mentimeter](#)

Meet customer delivery times

Need to manage expectations and make customers aware that;

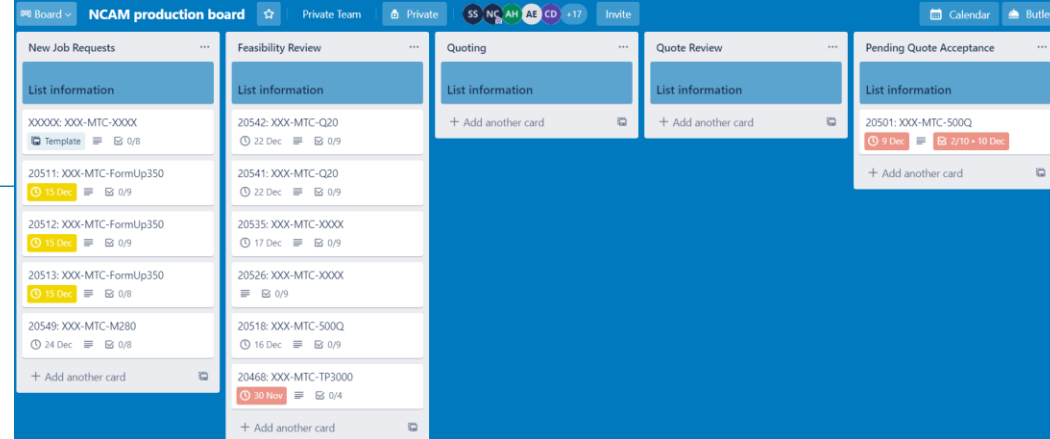
- Tight delivery = Higher price
- Flexibility = Lower pricing

Daily Production Scheduling Review

- Daily review needed for dynamic and agile scheduling
- Visible and live production boards are a necessity
- Plans may need to change (urgent priorities, failed builds etc.)
- Different AM machine types and processes adds complexity
- Review results (utilisation, customer satisfaction etc) and improve the process



Planning boards; Production board Machine schedule



Weekly machine schedule (Planned)														
	Mon		Tue		Wed		Thu		Fri	Sat	Sun			
	AM	PM	AM	PM	AM	PM	AM	PM						
M400-4	De-build		Setup & build CRP 2		Build		De-build		Non Work Day	Non Work Day	Non Work Day			
M280	De-build & setup		Build - Sigma labs build 1		De-build		Idle - Waiting on manufacturing information							
AM250	Setup & build		build monitoring		build monitoring		De-build pm with customer							
Matsuura	Material changeover													
Solukon	Material changeover		Repair				Build							
Q20	Idle - waiting on manufacturing information & results from previous build													
AM500Q	Setup & start CRP 1	De-build, setup & build CRP 2		De-build, setup & build CRP 3		De-build								
Trumpf	Idle - waiting on results from previous build													
Addup	Service													
Other	post processing		EBM trophies post processing											
Weekly machine schedule (Actual)														
	Mon		Tue		Wed		Thu		Fri	Sat	Sun			
	AM	PM	AM	PM	AM	PM	AM	PM						
M400-4	De-build		Setup & start CRP 2		De-build - rake crash		Idle - waiting on decision for CRP 3		Non Work Day	Non Work Day	Non Work Day			
M280	Build stopped - started again		Build		Build completion & de-build		Setup & build & de-built sigma labs 1							
AM250	Setup & build		Build monitoring		Build completion		De-build							
Matsuura	Material changeover													
Solukon	Material changeover		Repair & clean down		Build									
Q20	Idle - waiting on manufacturing information & results from previous build													
AM500Q	Setup & start CRP 1	De-build, setup & build CRP 2 - machine issue		Down		Down - Powder re-circ pump inverter issue								
Trumpf	Idle - results from previous build						Setup & build							
Addup	Service													
Other	post processing													

This project has been funded with support from the European Commission. This communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Automated scheduling systems include;

- <https://amfg.ai/>
- <https://www.3yourmind.com/agile-mes>
- <https://www.materialise.com/en/software/streamics>

Sven Hinrichs (sven.h@amfg.ai) will present on the AMFG automated scheduling system



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www.skills4am.eu



Thank you & Questions

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