Identifying business cases for 3D printing in service logistics

To print? Or not to print?

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A New Business Model in Service Logistics?

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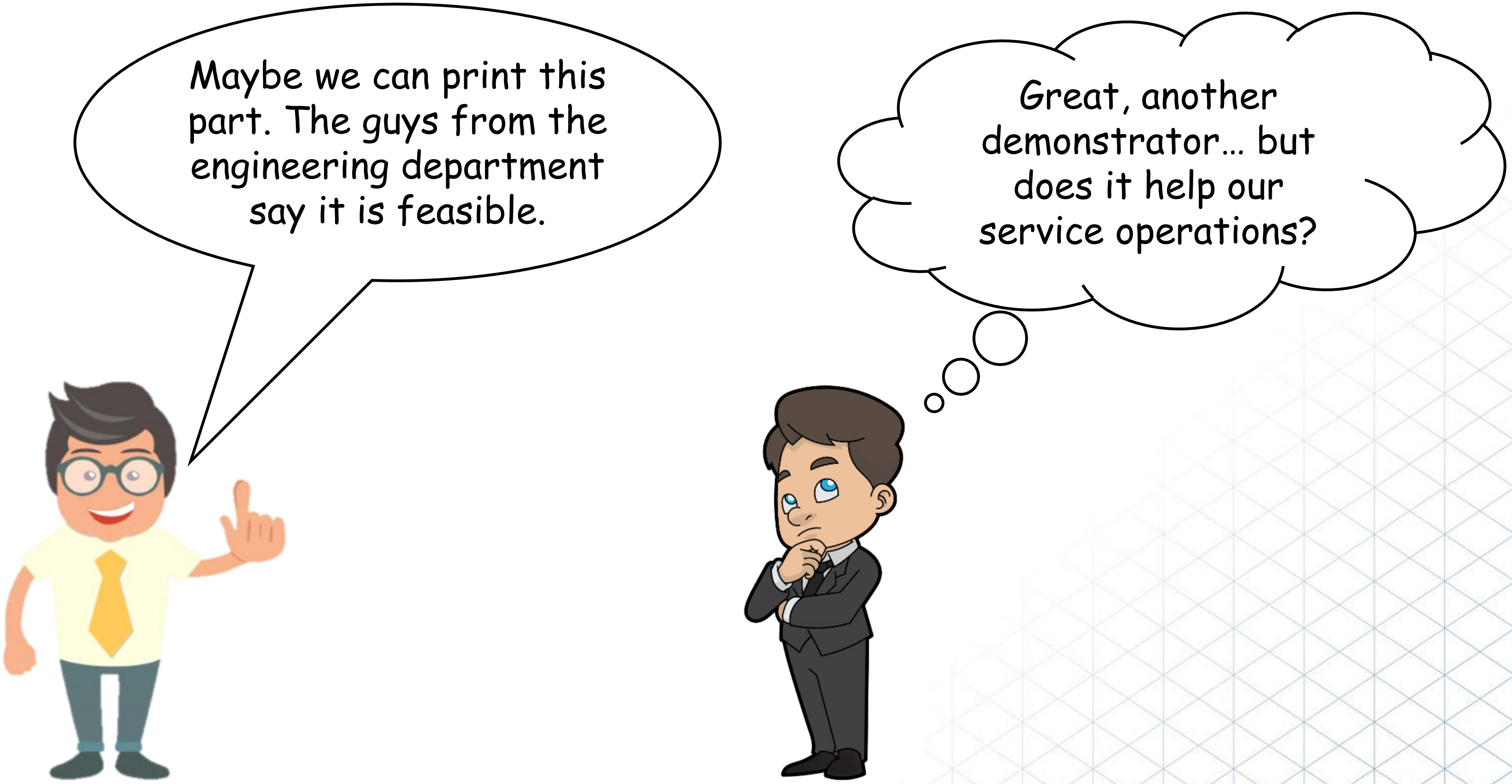
Bottom-up Approach

The common practice

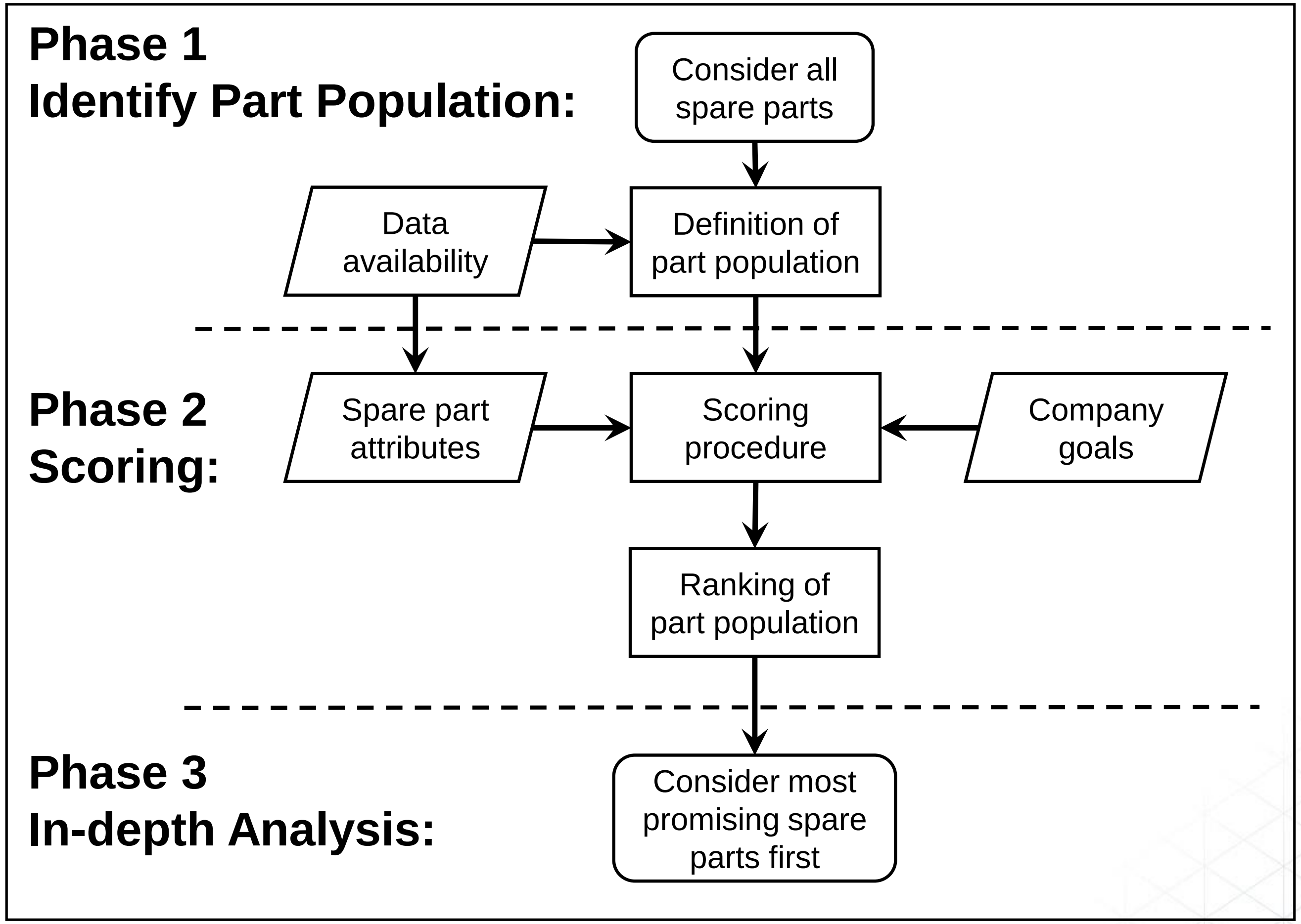


Bottom-up Approach

Often does not work for service logistics

1. Selection based on technological/design aspects
2. “Low hanging fruits” are overlooked in large spare parts assortment
3. Disappointing cases of 3D printing for service logistics

Top-Down Approach
An Alternative



Top-Down Approach: Phase 1

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Considerations:

- Larger Spare Part Assortment vs. Higher Data Consistency
- Data Cleaning

Output Phase 1:

Attributes	**Item 1**	**Item 2**	**Item 3**	**…**
Type of part (Electronics, Metals, Plastics)	E	P	M	…
Part size (dm^3)	1	3	4	…
Resupply lead time (days)	21	50	35	…
Customer order lead time (days)	2	5	1	…
Design ownership (Yes/No)	Y	N	N	…
Order /Manufacturing costs (Teuro)	5	15	1	…
⋮	⋮	⋮	⋮	⋮

Example:

~400,000 Spare parts

35,933 Spare parts

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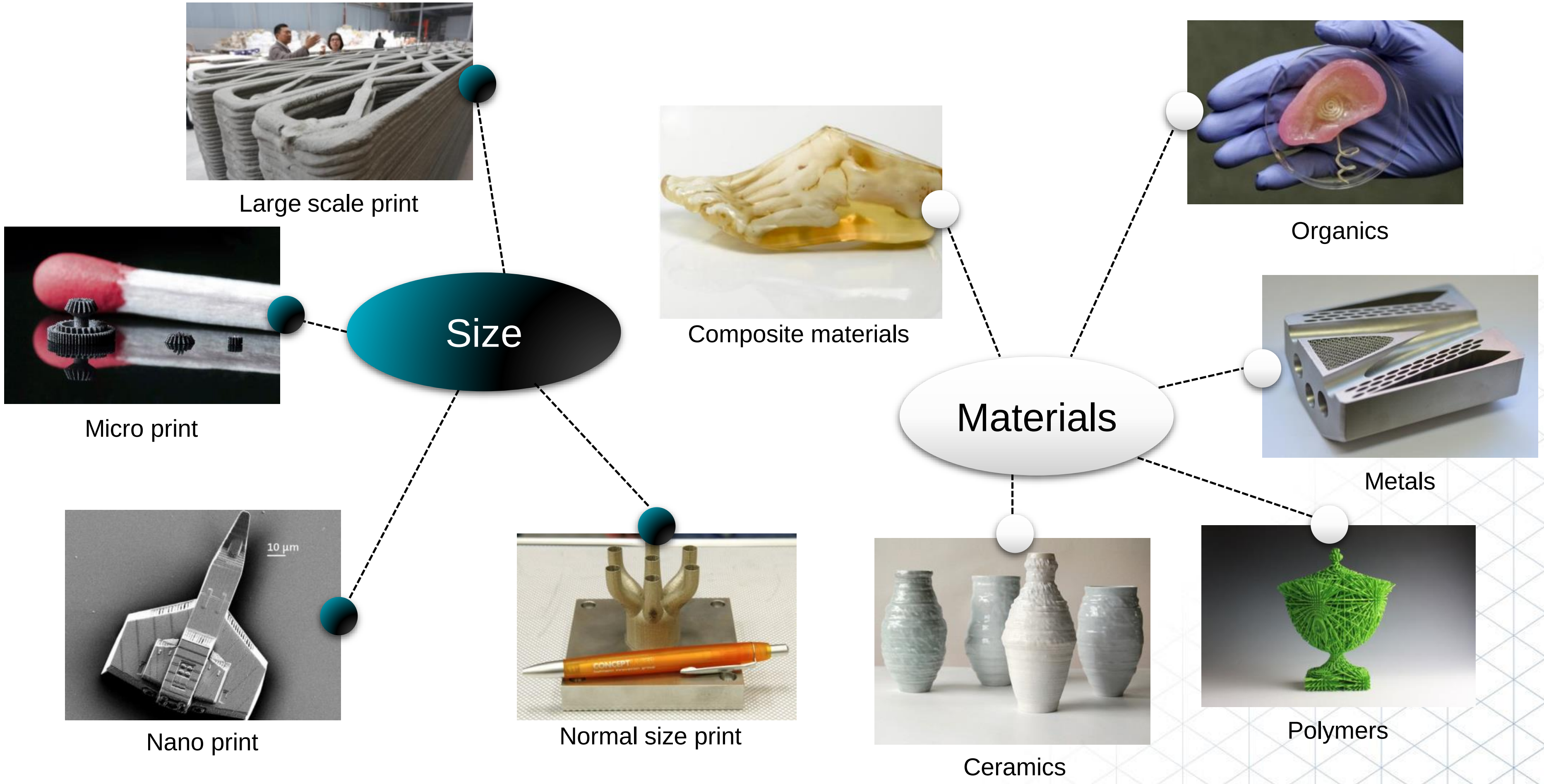
Top-Down Approach: Phase 2
Technological Constraints



Top-Down Approach: Phase 2

Technological Constraints

Size

Normal size print

Materials

Metals

Polymers

Top-Down Approach: Phase 2

How to Measure Technological Feasibility?

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Use basic characteristics that give insights about:

- Material category (often encoded in part id, description etc.)
- Size (number of sub-components, storage type etc.)

Output:

Attributes	Value	Score	Weight	Weighted score
Materials (**M**etals, **Pl**astics, etc.)	M	-	-	Fulfilled
Size (dm³)	0,5	-	-	Fulfilled

Go\No-Go Attributes

Example:

35,933 Spare parts

6,190 Spare parts

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Top-Down Approach: Phase 2

How do we identify economic value?

		Improvement potential with 3D printing						
		Reduce manufacturing/ order costs	Reduce direct part usage costs	Reduce safety stock costs	Improve supply chain responsiveness	Postponement	Temporary fix	Reduce effect of supply disruptions
Spare part attribute	Demand rate	Low		Low		Low		
	Resupply lead time			Long	Long	Long	Long	
	Remaining usage period		Long					
	Number of supply options	Few			Few			Few
	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Top-Down Approach: Phase 2

How to calculate score?

Scoring of spare part attributes:

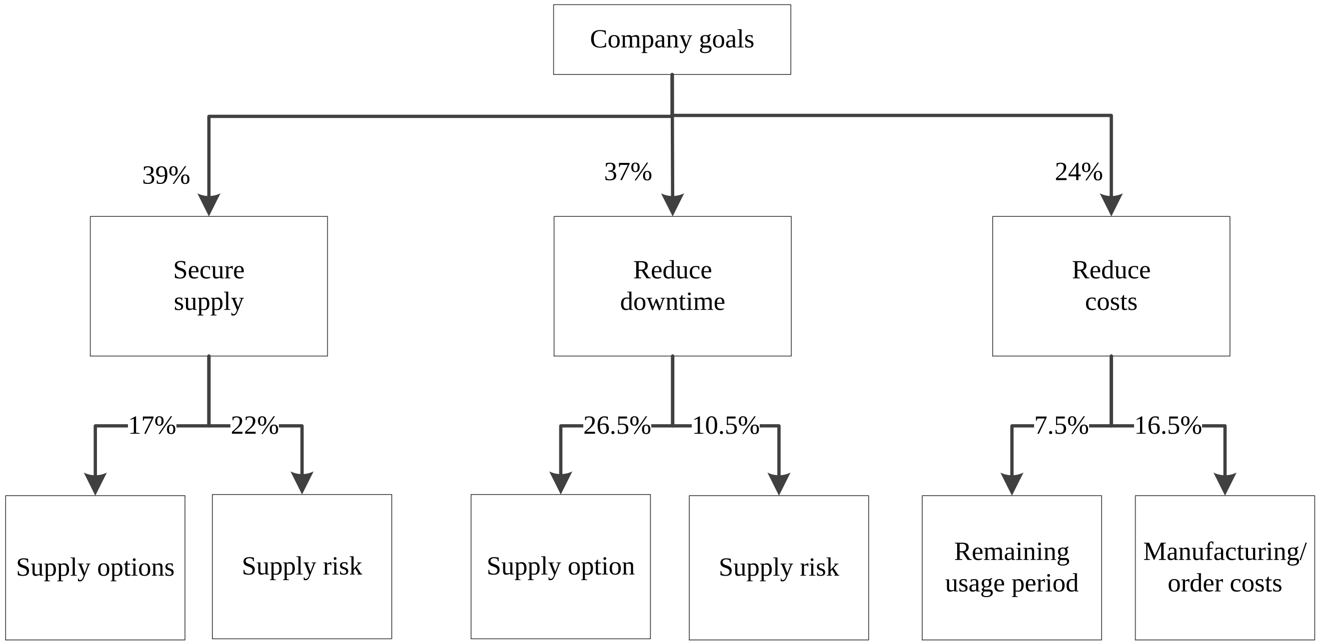
- Different options, e.g., normalize item values between 0 and 1
- Protect against data pollution by excluding extreme values

Output:

Attributes	Value	Score	Weight	Weighted score
Materials (**M**etals, **Pl**astics, etc.)	M	-	-	Fulfilled
Size (dm³)	0,5	-	-	Fulfilled
Supply options (#)	2	0,32		
Demand (parts/year)	15	0,105		
Remaining usage period (years)	5	0,11		
Resupply lead time (days)	48	0,175		

Top-Down Approach: Phase 2

How do we regard company goals?



Use pairwise-comparison interview technique (Analytical Hierarchy Process)

- Reduces decision complexity and improves decision consistency
- Use to engage management

Top-Down Approach: Phase 2

Calculate the weighted score

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Output Phase 2:

Attributes	Value	Score	Weight	Weighted score
Materials (**M**etals, **P**lastics, etc.)	M	-	-	Fulfilled
Size (dm³)	0,5	-	-	Fulfilled
Supply options (#)	2	0,32	43,5%	0,1392
Demand (parts/year)	15	0,105	32,5%	0,034125
Remaining usage period (years)	5	0,11	7,5%	0,0825
Resupply lead time (days)	48	0,175	16,5%	0,028875
			Total:	**0,2847**

Example:

6,190 Spare Parts

>250 Business Cases

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Next Steps:

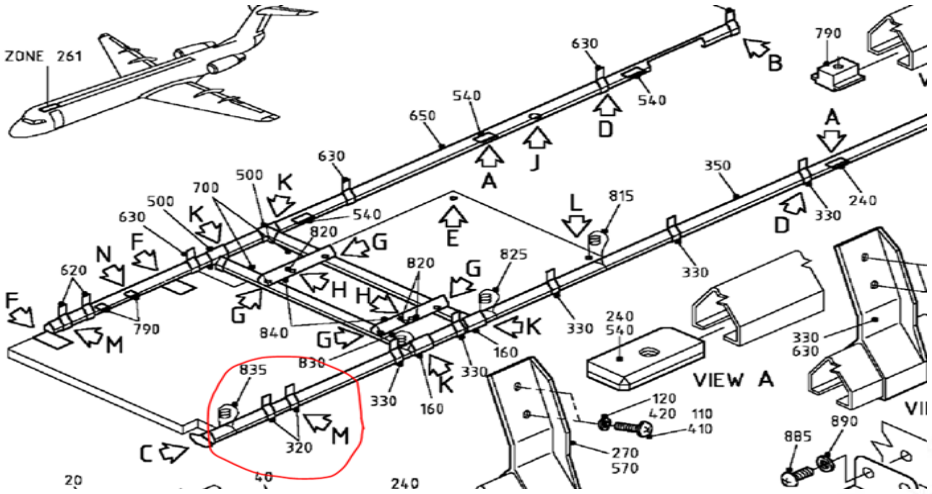
- Use spare parts scores to rank the analyzed spare parts assortment.
- Analyze best scoring spare parts first

First case study: ceiling bracket

Demonstrator selection

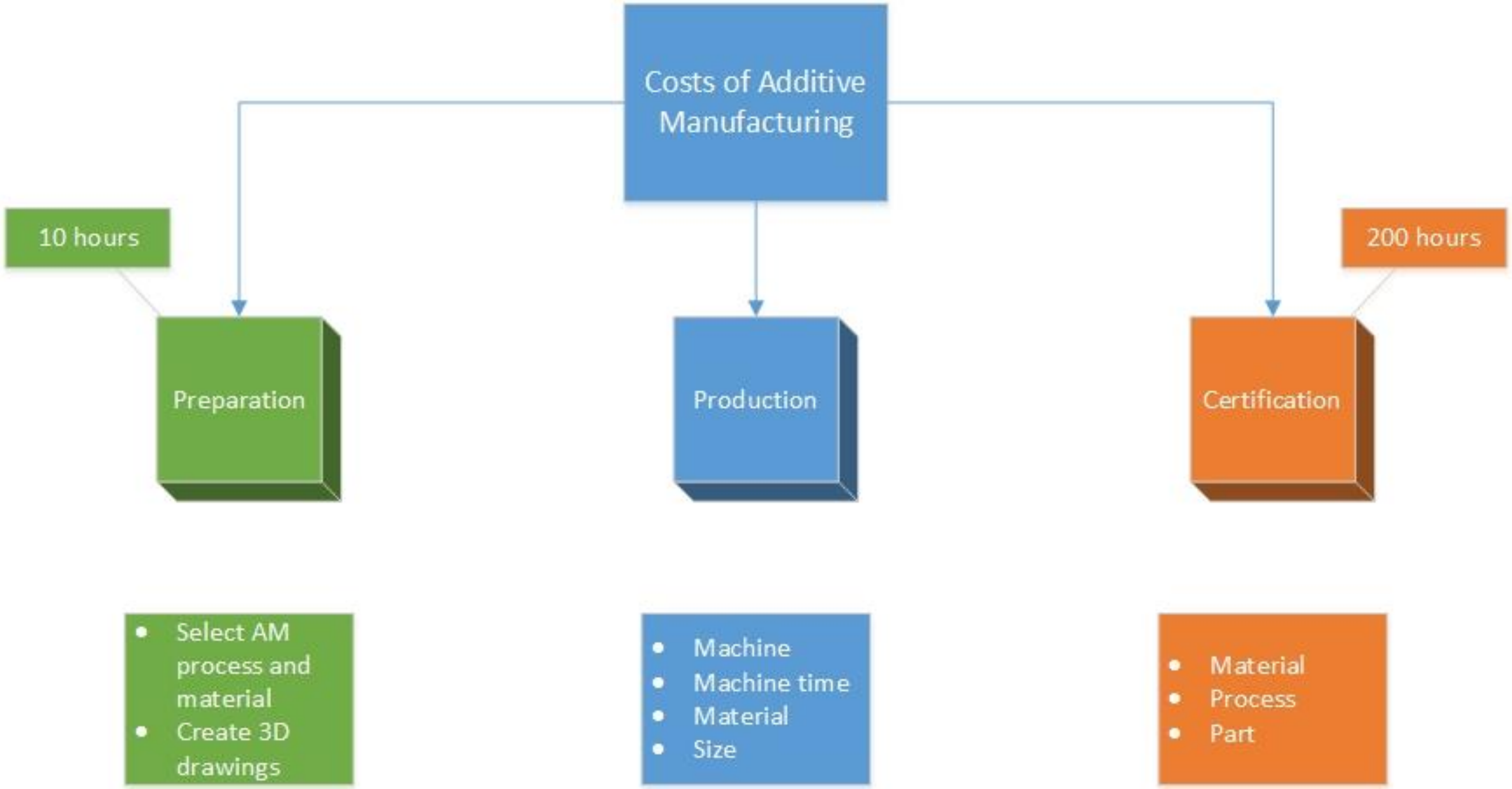
Reasons for selection:

- Immediate need (because of obsolescence)
- Reasonable fit with the quick scan
- Provided sufficient learning potential (somewhat complex geometry, subject to some loads, used in the interior)
- Material Ultem 9085 was suitable for 3D printing



First case study: ceiling bracket

Business case



First case study: ceiling bracket
Business case

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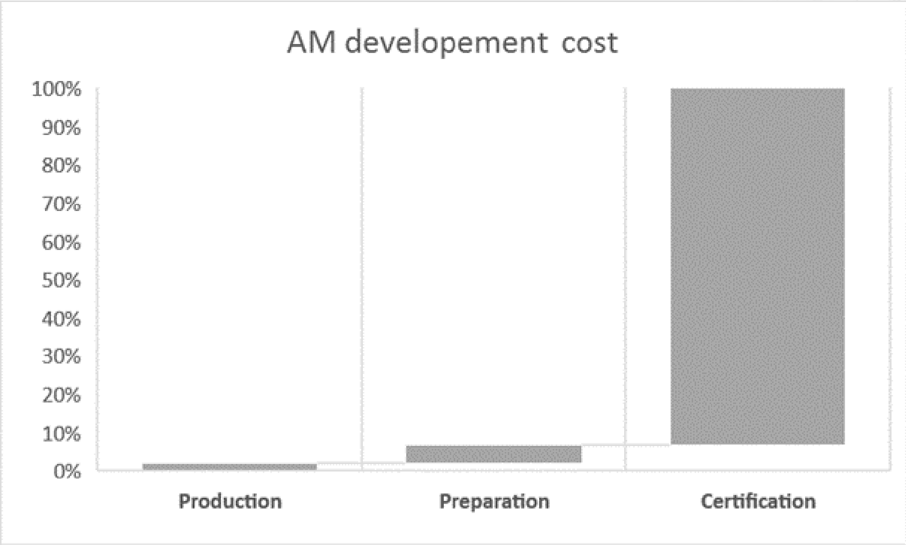
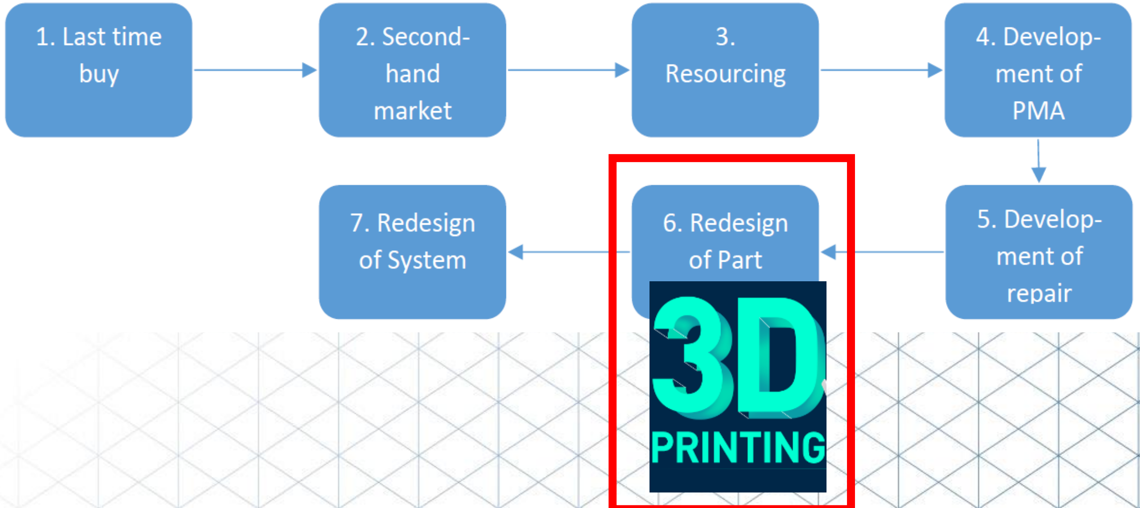
- **Major obstacle:**
  - Certification, Certification, Certification, …
  - Certification contributes to > 90% of total cost
  - AM is economically beneficial in case of supply disrupt should only be considered as one of the last resorts



- **Conclusion:**
  - AM is economically beneficial in case of supply disruptions BUT should only be considered as one of the last resorts



First case study: Certification aspects

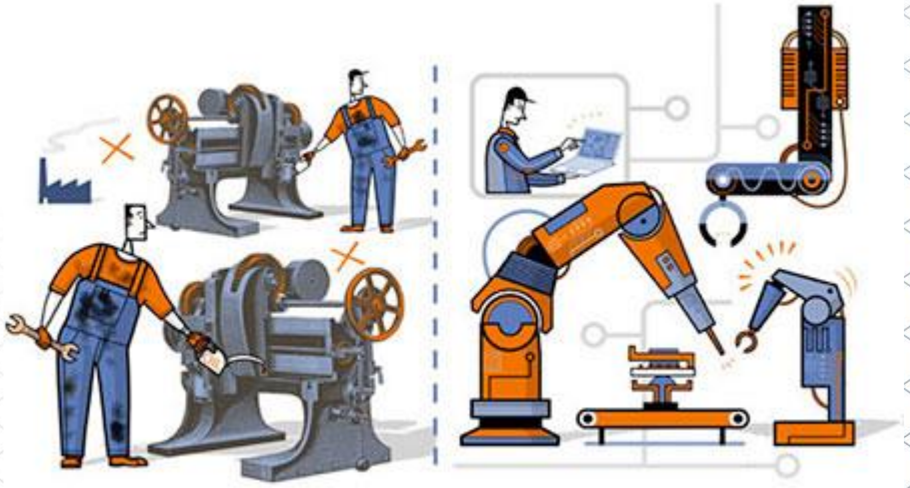
The road to airworthiness

- **Authorities request to prove airworthiness by:**
  - Identicality (compare processes, materials, specifications, tolerances and dimensions)

or

  - Test and computation (Strength and failure tests)

- **Caveat:**
  - In case of AM, **process** is different which rules out identicality unless…..



First case study: Certification aspects

The road to airworthiness

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Change Classification
- Major
- Minor

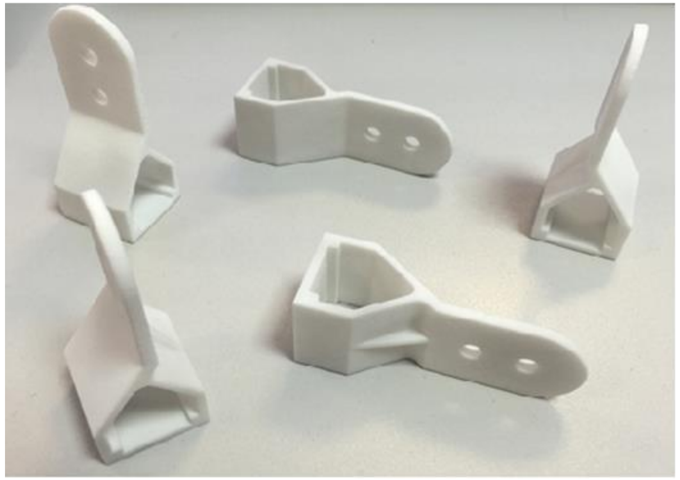
Requirements definition
- Material
- Manufacturing Process
- Test plan
- ….

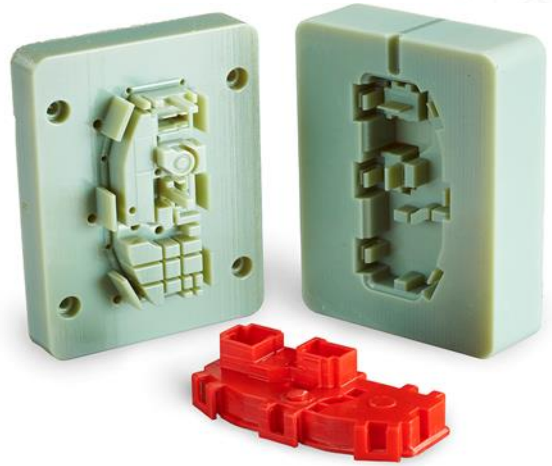
Testing
- Sample testing
- Flammability testing

Reporting
- Compliance Record Report (package of reports)

Second case study: Production tooling
Let’s avoid certification costs

Reasoning:
- Solving obsolescence cases where tooling is not available
- Avoid excessive certification for spares when printing directly
- Avoid high initial investment for conventional tools and molds





Second case study: Production tooling
Let's avoid certification costs

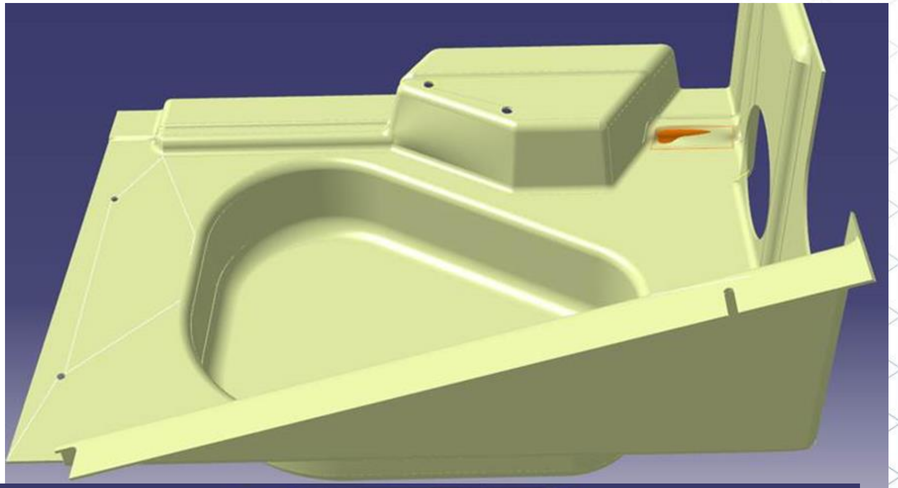
- **Advantages:**
  - Limited (qualification) requirements
  - Possibility to change the tooling material (switch from metal to plastic is highly desirable)
  - Suitable for low demand volume parts

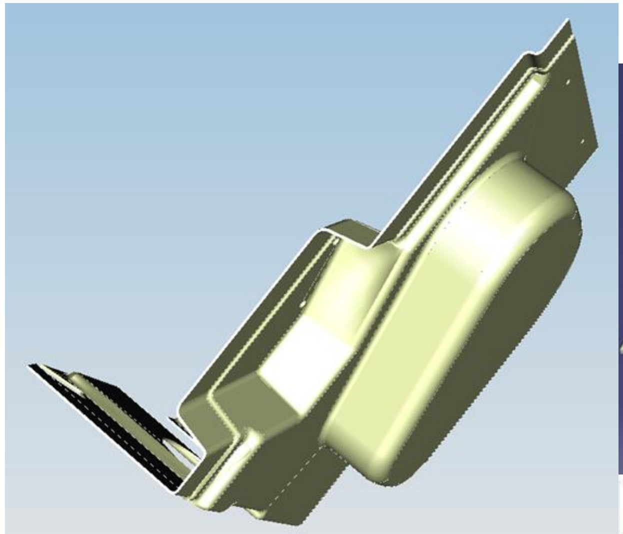
- **Dis-advantages:**
  - Unpredictable tooling failure behaviour
  - Difficult to get the parts manufacturer on board to switch from tooling production technique

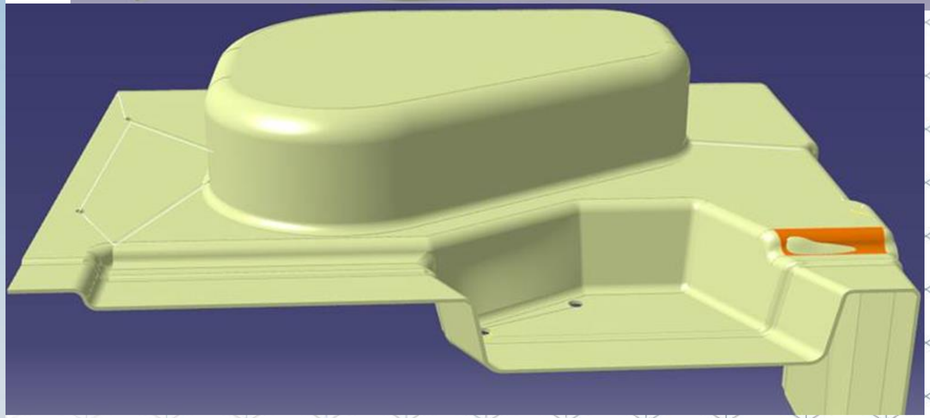
Second case study: Production tooling
Let's avoid certification costs

- **Application potential:**
  - Vacuum forming & injection molding

- **Current case:**
  - Vacuum formed floor cover
  - Complex design
  - Switching from a metal to plastic (Ultem1010) molding







Third case study: SRU printing
Mitigate the certification costs

- **Reasoning:**
  - (Often) Long lead times
  - Unpredictable and low demand
  - High Out-of-Stock costs (workstopage because of unavailability of a single SRU)
  - Possibility for (Inhouse) production at limited cost
  - Less stringent certification requirements

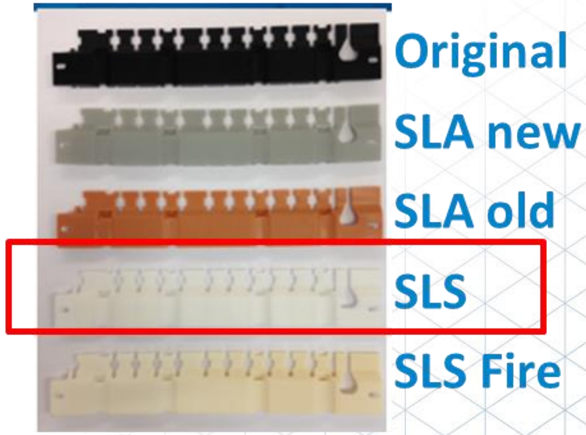
- **Expectations**:
  - Introduce AM as a viable SRU sourcing/manufacturing method
  - Reevaluate our stocking strategy considering AM
  - Reduce working capital while ensuring high availability (**what else?)**

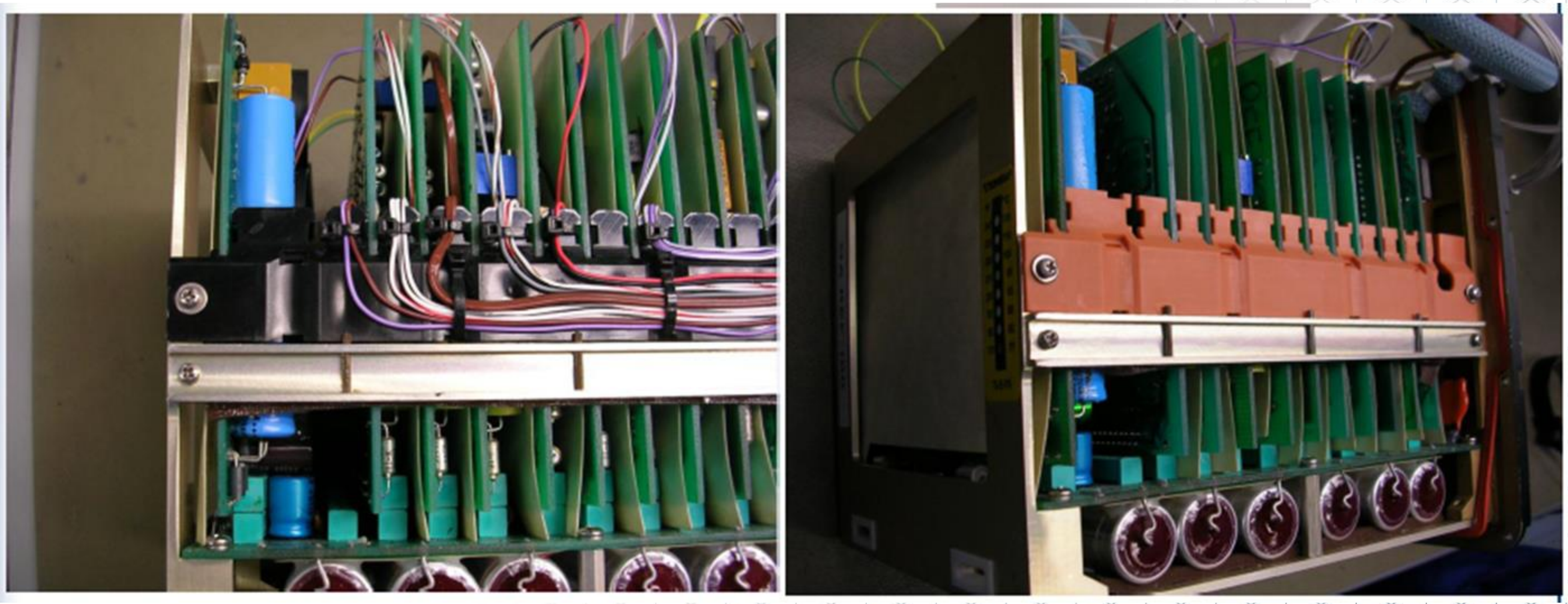
- **Project is still in progress……**

Third case study: SRU printing
Proven concept

- **An example of an already implemented case: PCB holder**

Obsolescence → No longer available & expensive to replace





Next steps: The journey ahead
Where to go from here?

- **Finish SRU business potential**
- **Workout & Implement some more cases**
- **Explore further application of AM such as repairs, hybrid production or ….**
- **Further pave the AM supply network**
- **Catch the next SINTAS train???**