Compact Light WP4 Progress meeting

20-09-2018

Industrialization

Content

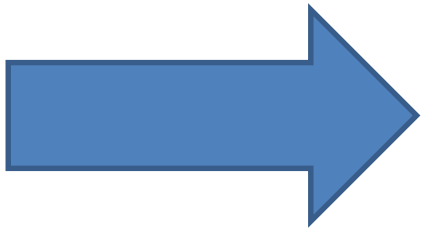
- XLS WP4 progress
- Approach of industry/VDL ETG in industrialization
  - DfX
  - Generic approach for all high tech systems
  - Specific examples in accelerator projects

XLS WP4 Progress

- Most added value towards end of project
- Find way of working to connect with other members in WP4
- Generic tools are in place
- Share with WP4 members to get equal mindset and expectations

Goal of industrialization

proven prototype/concept



Economically feasible series production

Economically feasible

- Entire chain from raw material to shipped end-product
- High yield
- Industry proven production processes
- Stable supply chain
- Unambiguous and measurable specifications
- Straight forward assembly and test
- …

DfX an illustrative example (1)

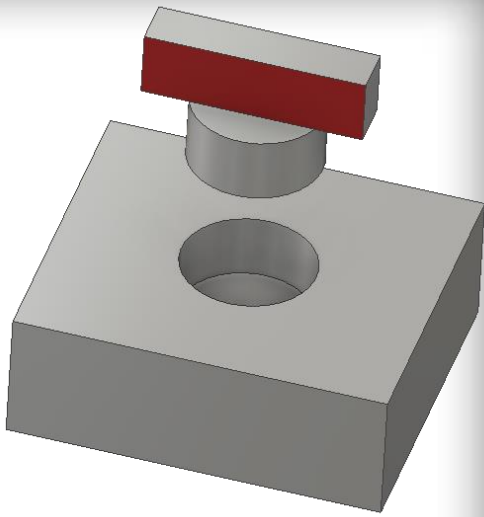
Design for X (DfX) X = manufacturability, assembly, test

Illustrative example: A high tech mirror on a base

Customer:
- Physicists: focused on optimized design of reflective surface
- Procurement: large scale volume production at low cost
- Quality department: 100% control of reflectivity and orientation (CtQ)

Industry:
- Clear and measurable specifications for acceptance/reject
- High yield with manufacturing processes proven for series production
- Take addition of tolerances into account i.e. If mono-parts meet specifications, (sub)assemblies should also meet specification
- Assembly by trained personnel without detailed knowledge on application
- …

DFx an illustrative example (2)



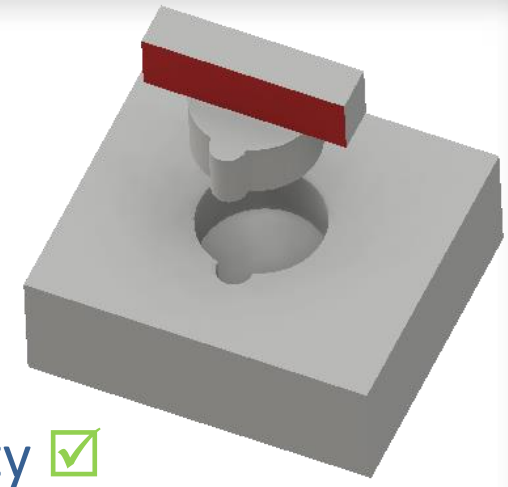
1st iteration: Mirror on a stem

- Monopart level → Design for manufacturability ☑
  - Mirror surface fully engineered by customer
  - Mirror surface found to be manufacturable to specification in series production

- (Sub)assembly level → Design for assembly ☒
  - Only basic function of mount are met i.e. holding mirror in place
  - Assembly allows tweaking → perfect for functional prototype testing
    → not optimized for series production
  - Detailed application knowledge needed to assure function

- Unit level → Design for test/quality control ☒
  - Alignment on measurement tool by skilled optical engineer/physicist

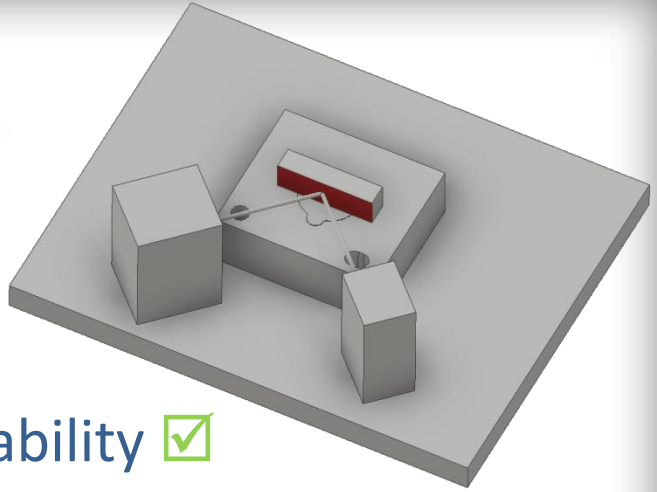
DFx an illustrative example (3)



2nd iteration: A stem with a protrusion

- Mono-part level → Design for manufacturability ☑
- (Sub)assembly level → Design for assembly ☑
  - Assembly unambiguous and fail safe
  - Part more complicated → slightly more expensive but compensated by cheap assembly with high yield
- Unit level → Design for test/quality control ☒
  - Alignment on measurement tool by skilled optical engineer

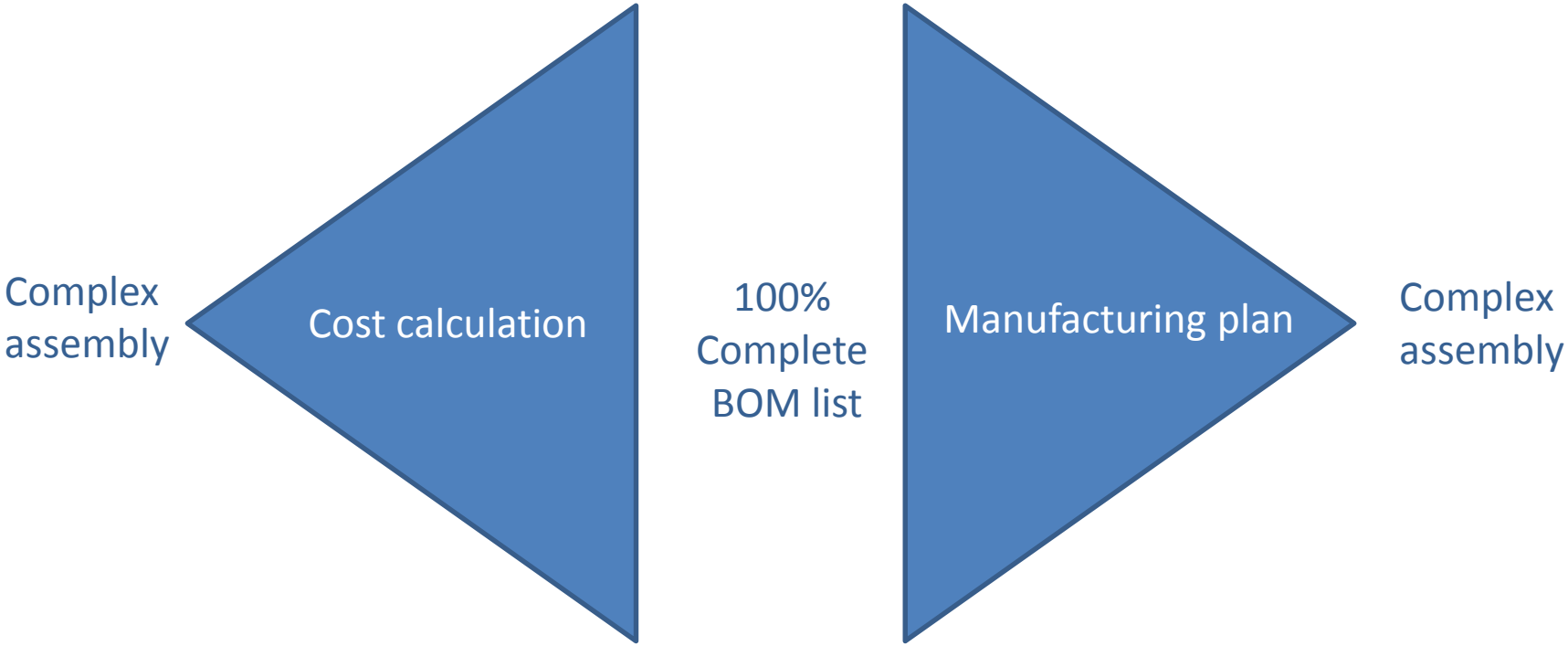
DFx an illustrative example (4)



3nd iteration: Dedicated measurement tool

- Mono-part level → Design for manufacturability ☑
- (Sub)assembly level → Design for assembly ☑
- Unit level → Design for test/quality control ☑
  - Unambiguous orientation on test rig
  - Single button inline measurement by production mechanic
- Delivery level → Design tooling for save shipment ☒
- Install level → Design tooling for installing the mirror ☒
- Maintenance/Repair → Design accessibility ☒
- …
- End of life level → Design for proper decommissioning ☒

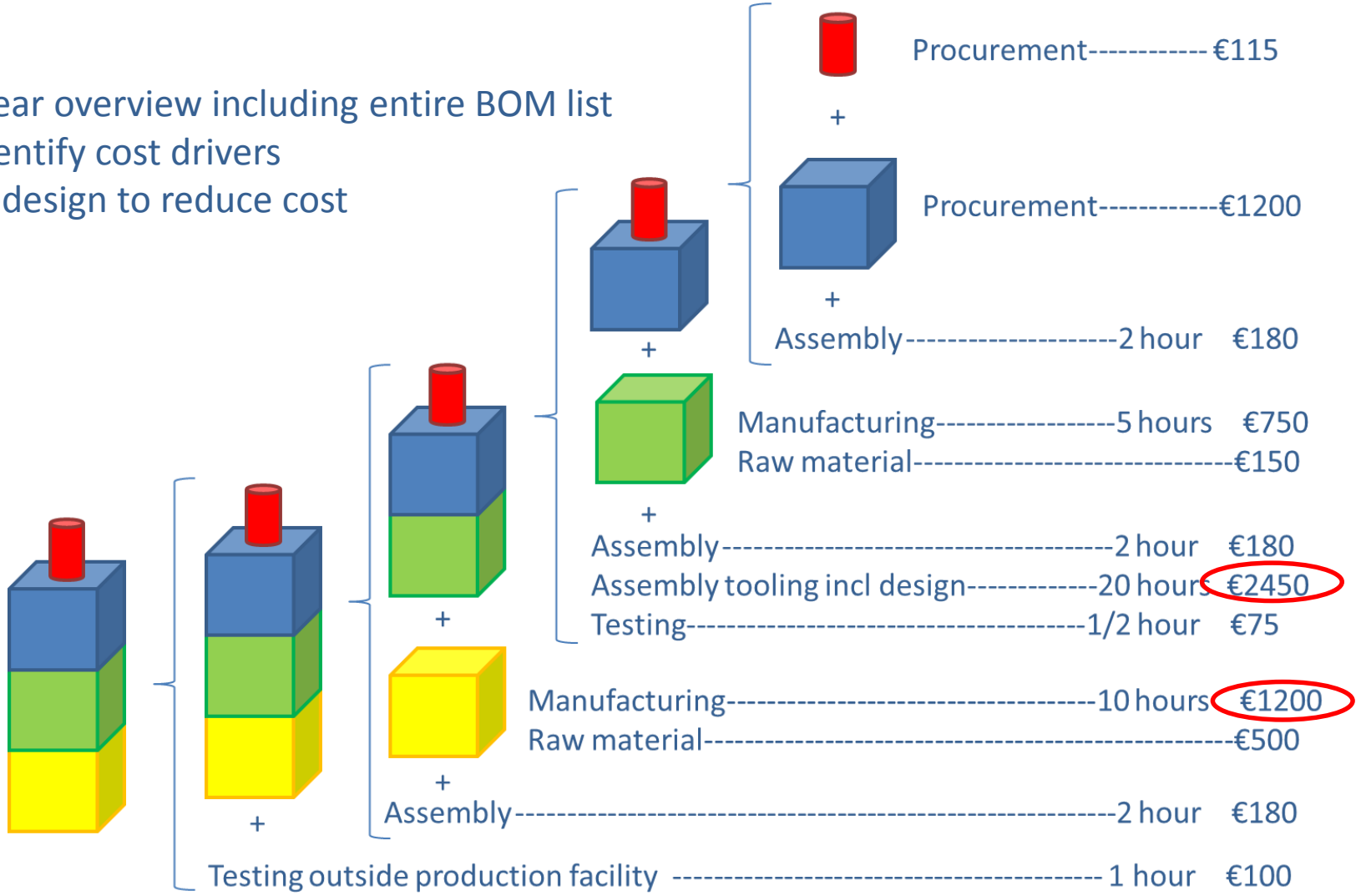
Industry approach: breakdown into “bite-size” pieces



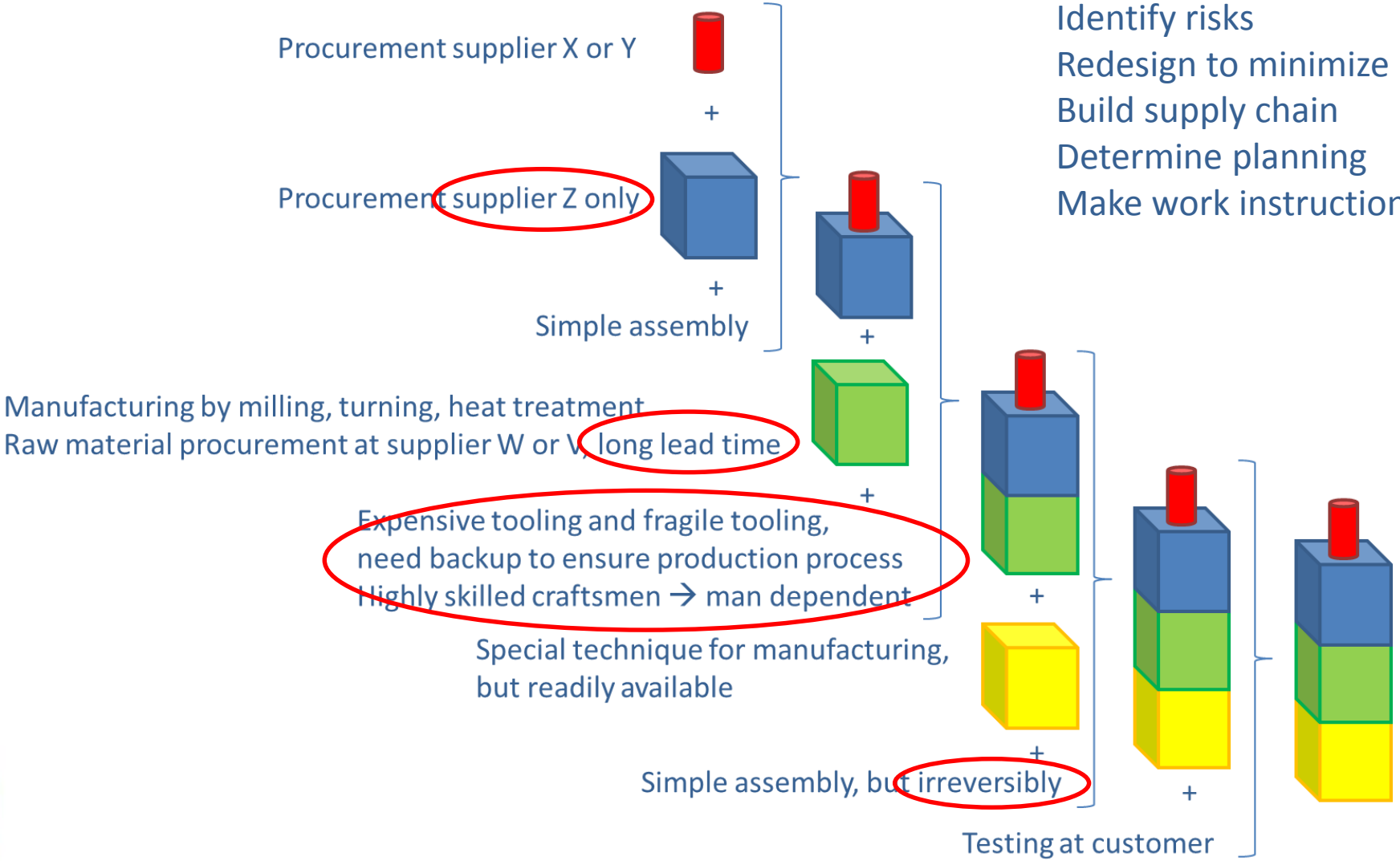
Make sure to take EVERYTHING into account, including the last nut/bolt

Breakdown → cost calculation

Clear overview including entire BOM list
Identify cost drivers
Redesign to reduce cost

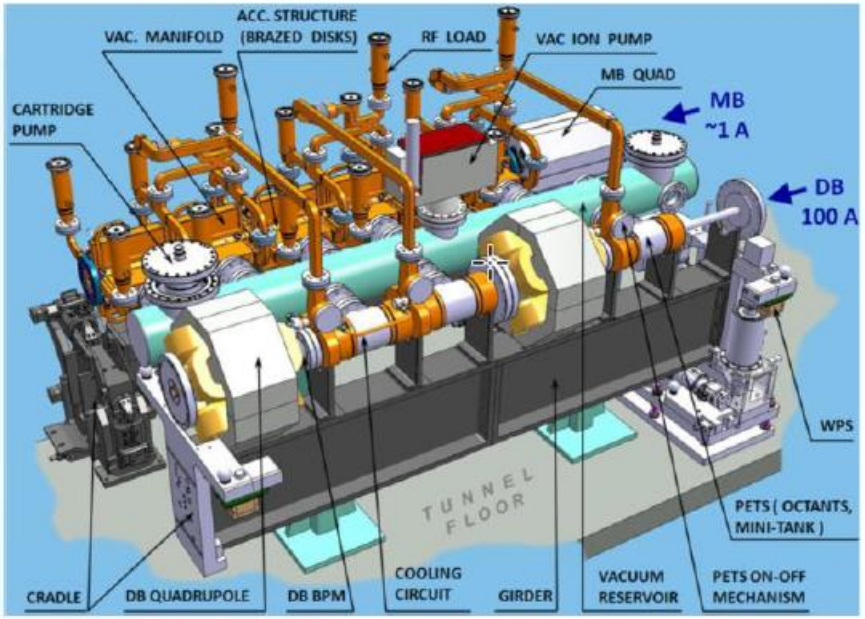


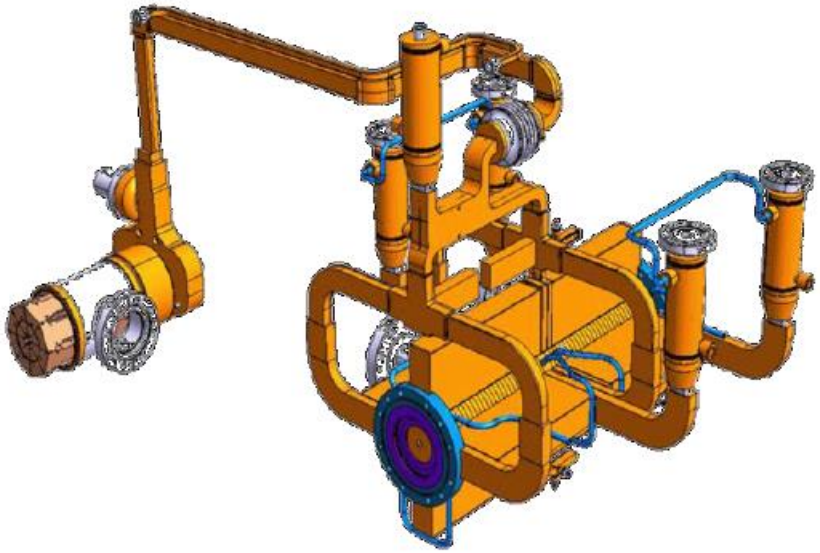
Build-up → manufacturing plan

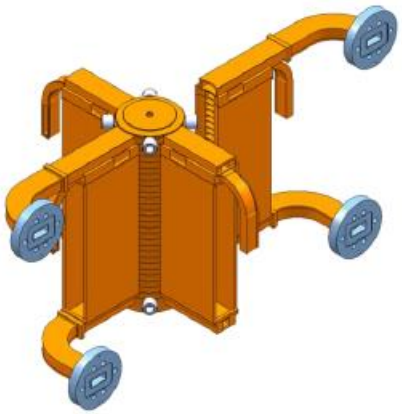


Identify risks
Redesign to minimize risk
Build supply chain
Determine planning
Make work instructions

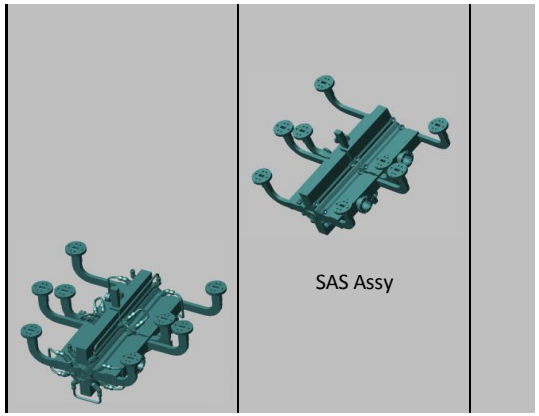
Example: CERN CLIC

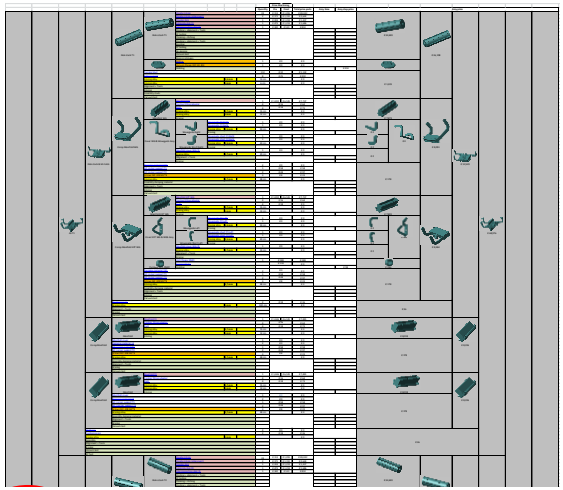






Example: SAS Unit studied by VDL

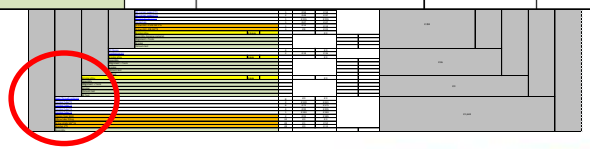




			Price Machining					
			Quantity	Pre	Final	Total price parts	Assy time	Assy step price
Disk stack T1	Disks stack T1	Standard disks						
		Standard disks (allignment)						
		Coupler disk						
		Extremity disk (1)						
		Interconnection disk (1)						
		Stacking + alignment + Tools						
		RF testing						
		Cleaning + Etching						
		Stacking + alignment + Tools						
		Bonding						
		RF testing						
		De-gassing						
		Vacuum test						
		Store in nitrogen						
	Bellow	Bellow						
		Vacuum Flange QCF 40-304						
		Welding						
	Tunning Stud							
	Sphere Insert							
	Brazing alloy	0,5 mm						
	Brazing alloy	1 mm						
	Alignment + Tools							
	Brazing							
	Assembly studs							
	Vacuum test							

Cost for subassembly

Cost for sub assembly



Example: PSI Swiss FEL

- Multiple iterations on design: first focus on physics, later on series production/assembly and finally on commissioning
- Final specification: +/- 25 um
- Prototypes made more accurate ~+/- 5 um
- Prototypes successfully tested ☺
- However, not representative for series production ☹
- New prototype(s) with representative spread of +/- 25 um
- Successfully tested ☺

- Go for series production

- Successful series production and commissioning ☺

Example PSI Swiss FEL (2)

Project gained enormous amount of insight in series production of high tech accelerator structures.

High overall yield over entire range from single parts to final accelerator structure

Only possible due to:

- Early and long lasting industry involvement
- Focus of customer on manufacturability
- Concessions on ultimate performance

Take home message

- Connect with WP4 members from now on, early involvement
- Keep series production in mind from start of design
- Most likely concessions have to be made regarding performance
- Industry has already generic tools for breakdown of high tech systems
- Tools have been used successfully in accelerator applications
- Start applying together with physicists in XLS

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