

OPENHYBRID

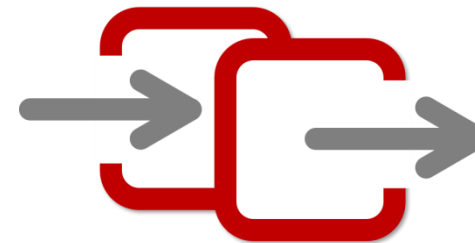
- CAD / CAM



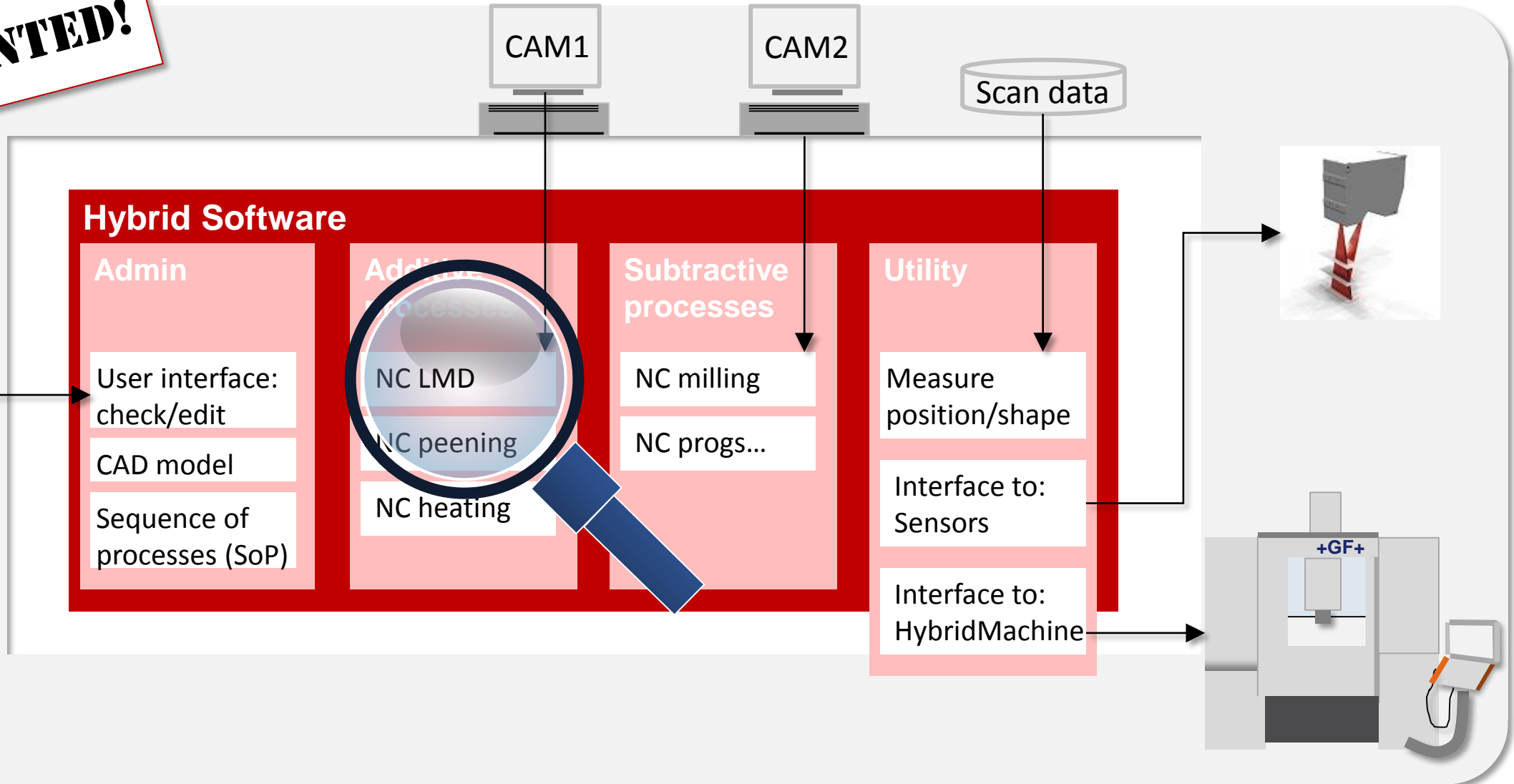
CAD/CAM

- Hybrid manufacturing: Requirements concerning CAD/CAM systems
- Path generation for **Laser Metal Deposition** LMD
- OpenHybrid approach
- The introduction of 'plugs'
- Outlook

Presentation based
on OpenHybrid WP6
Interface Development



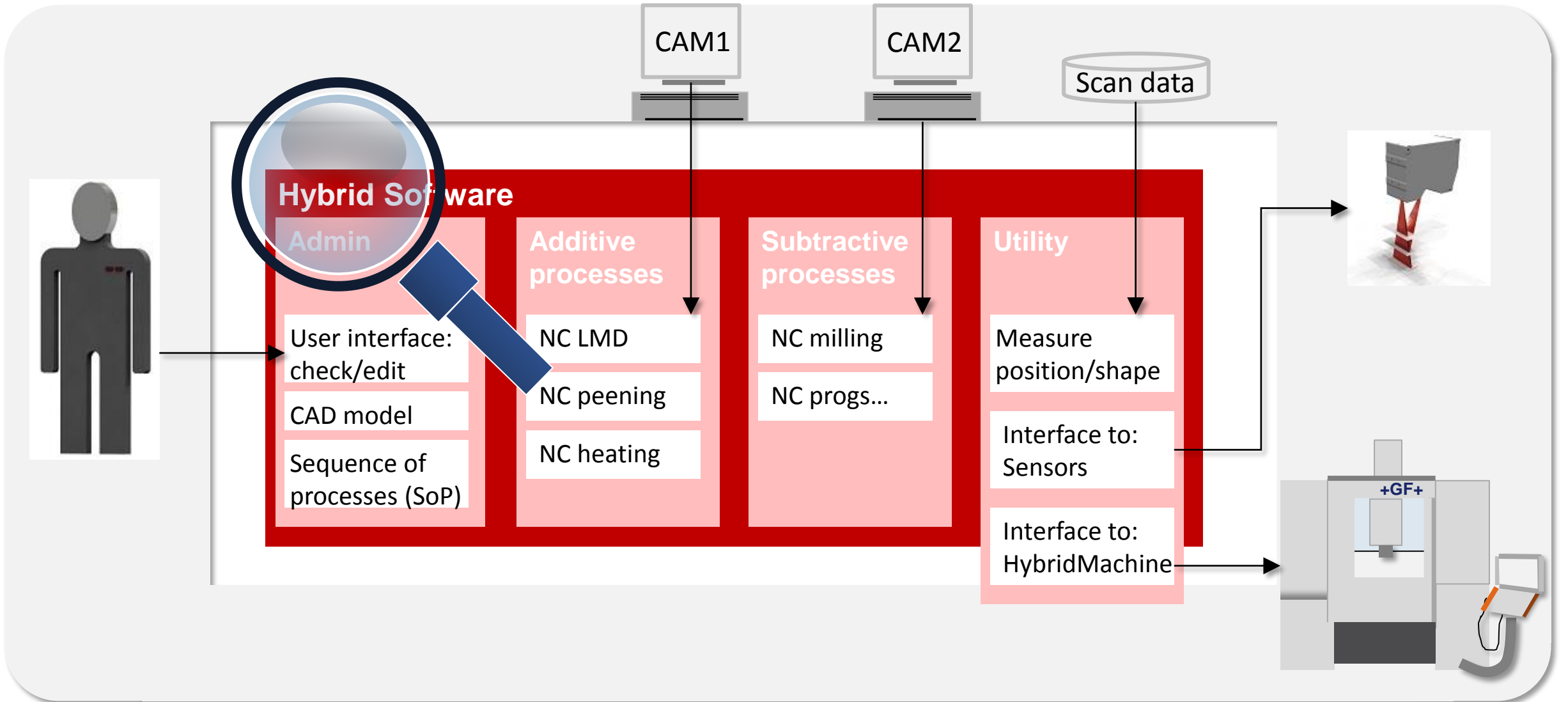
WANTED!









This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. H2020-FoF-2016- 723917-OPENHYBRID





OpenHybrid applications: 2 groups!

Sector	aPod #	Short Name of aPod	Component Type	Degradation Process	Repair area	Thumbnail	Process characteristics	Software approach	Realisation
Power generation	1	Blade	Blade	Erosion/Corrosion wear	LE / TE / BT		Process chain is fixed and can be adjusted in steps (also predefined)	Static, NC programs defined during set-up	Specific, new developed functions based on BCT software OpenARMS
Tool and Die	3	press tool	press tool	tribological/thermal deformations	corner, radius				
Oil & Gas	5	Pitot tube	pitot tube	Erosion	Tube inlet				
Oil & Gas	6	Volute	volute	Erosion-corrosion & impact	Varies		Process chain modules defined. Process to be defined corresponding to the individual damages	High level of user interactivity to be supported	NEW development to support the interactivity level, required



User
Expecta
tion

Damages:
Classified to adjust the
processing

Process-Flow:
Defined, no individual
treatment required

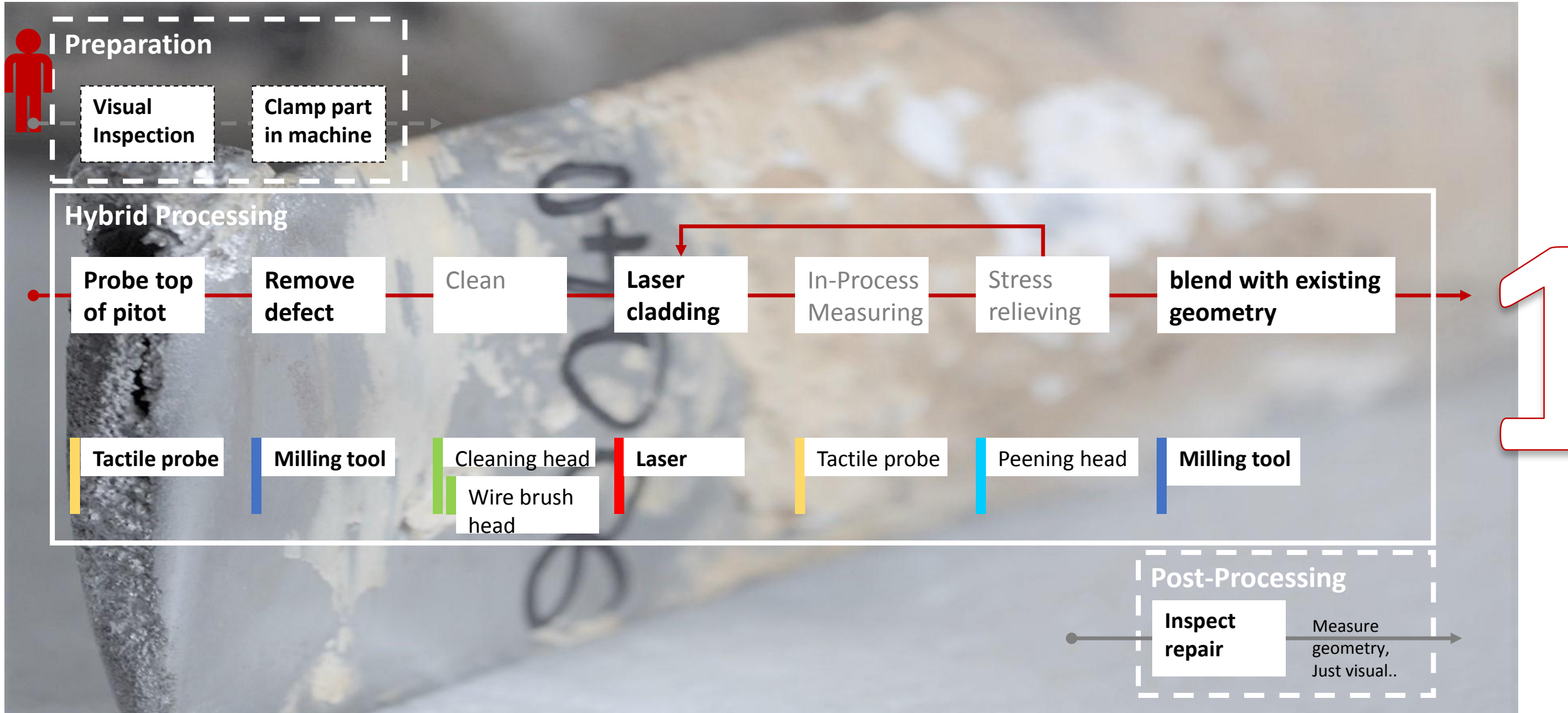
Less user interaction:
Select damage case;
minor additional settings

START



1

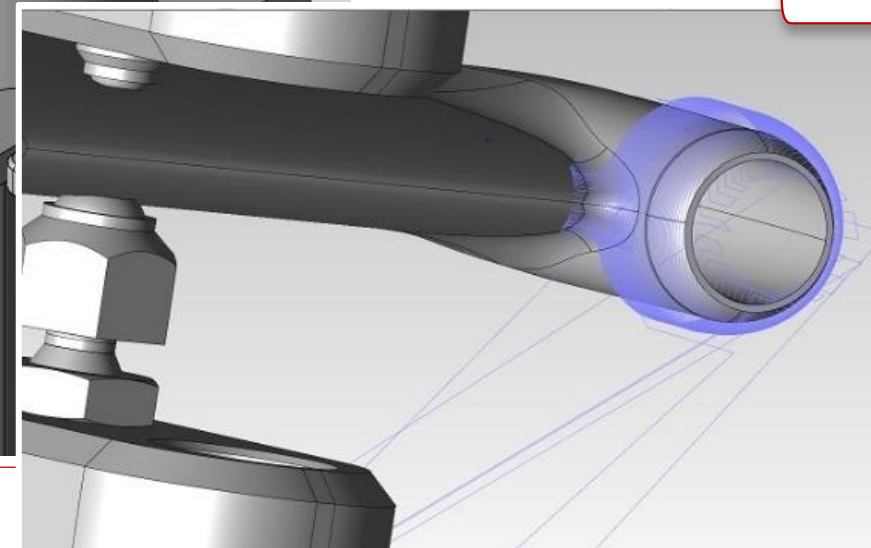
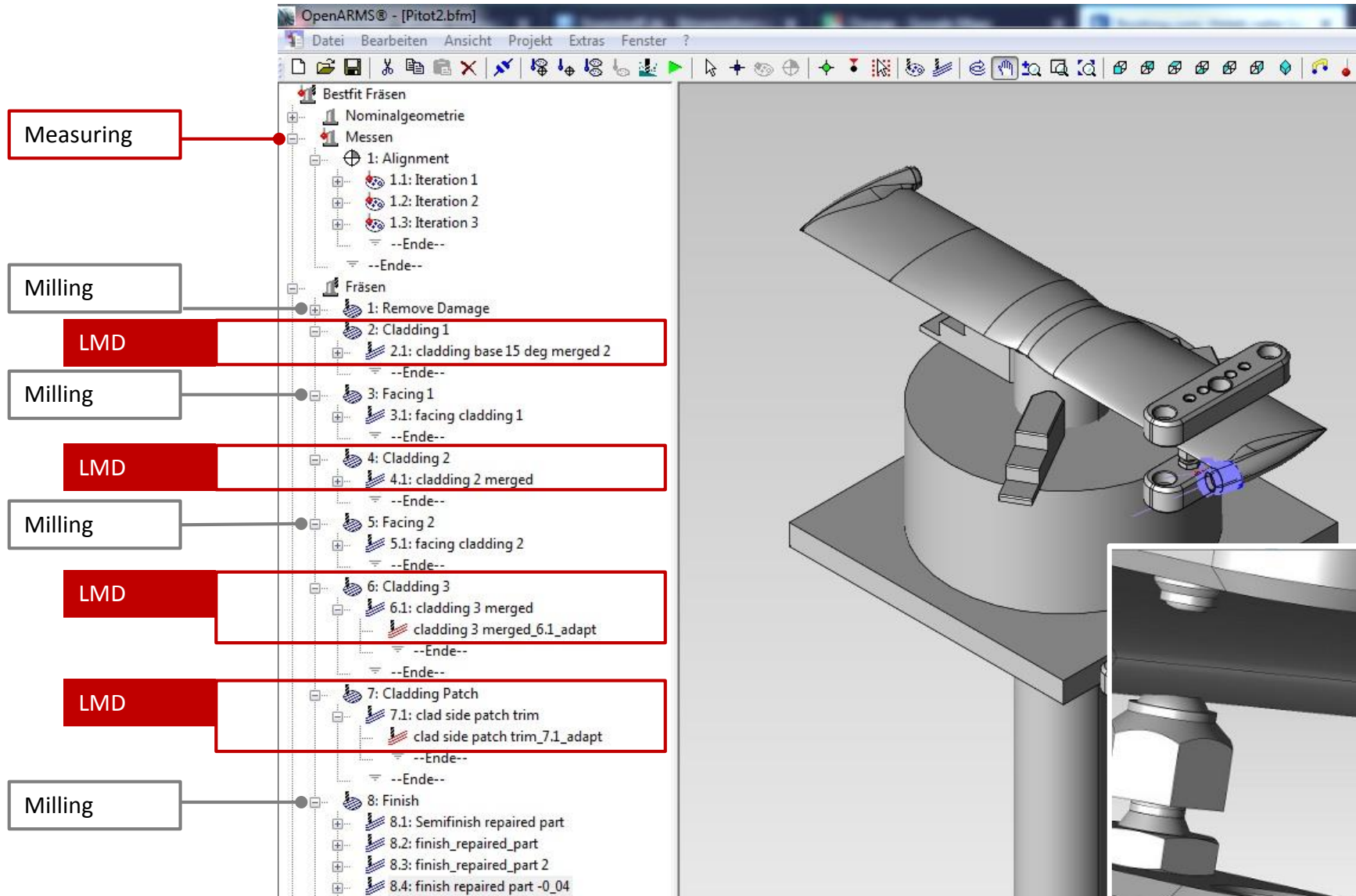
Hybrid process: Sequence of Processes to be realised



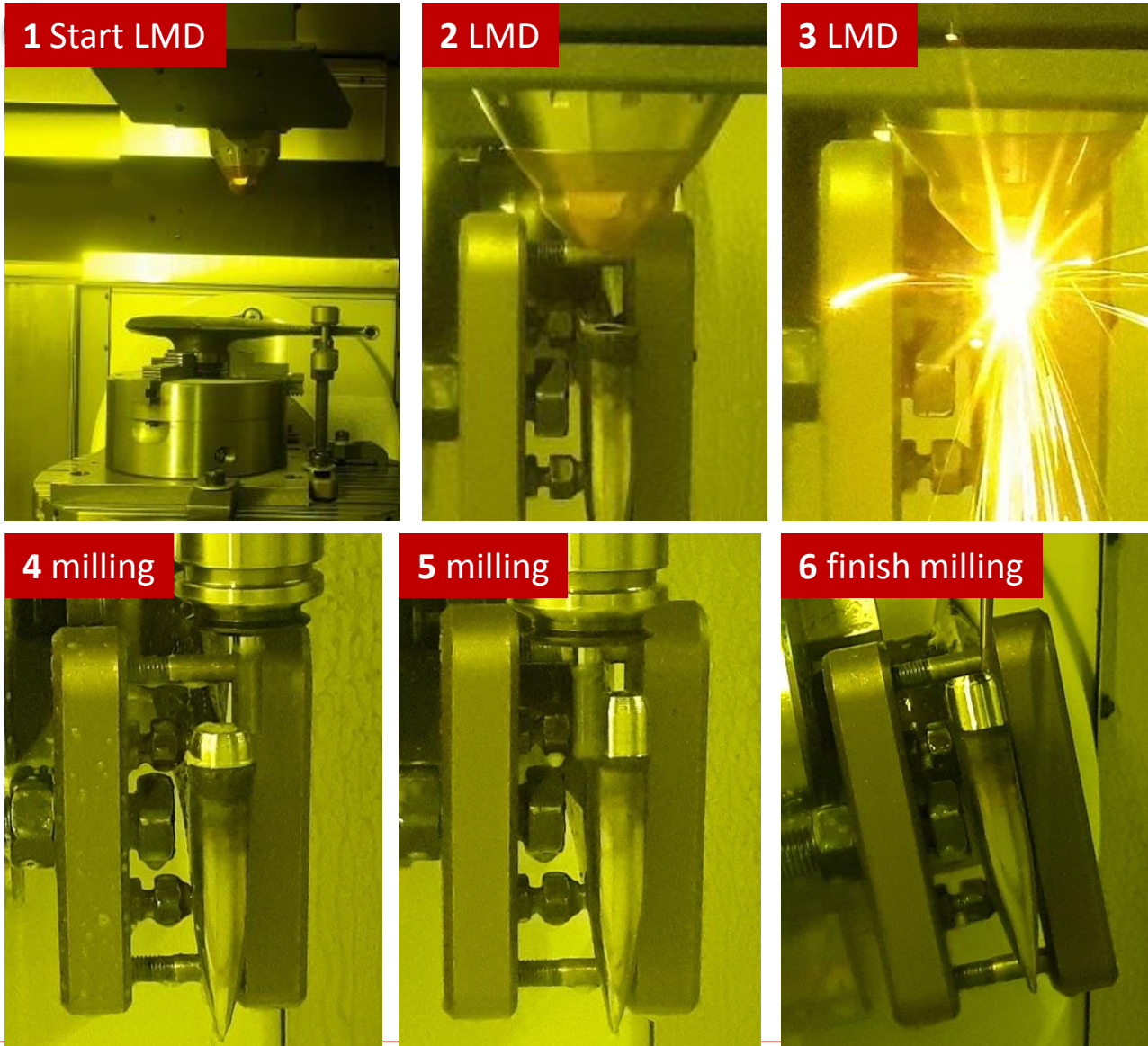
Capture position



Add material by LMD and reprofiling by milling

finish



Repair: Hybrid processing



Machine	GF test machine HP 450U	+GF+
Nozzle	HMT	
Fixture		
LMD prog.		
NC mill prog.		
Adaptation/ BestFit	OpenARMS + OpenHybrid specific developments	
Proces flow		

1 Remove damage



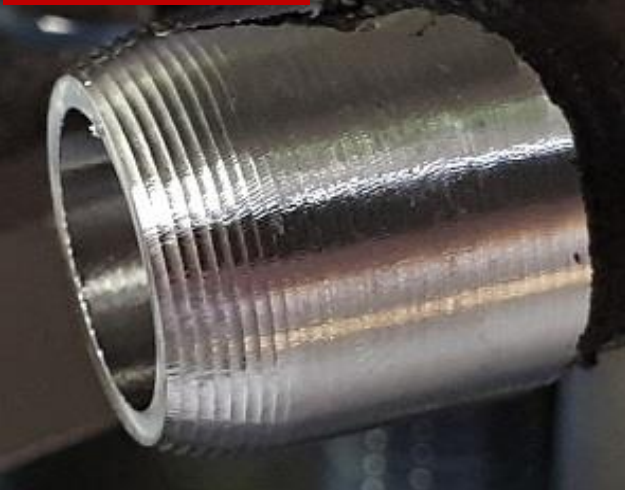
2 LMD



3 LMD



4 Rough milling



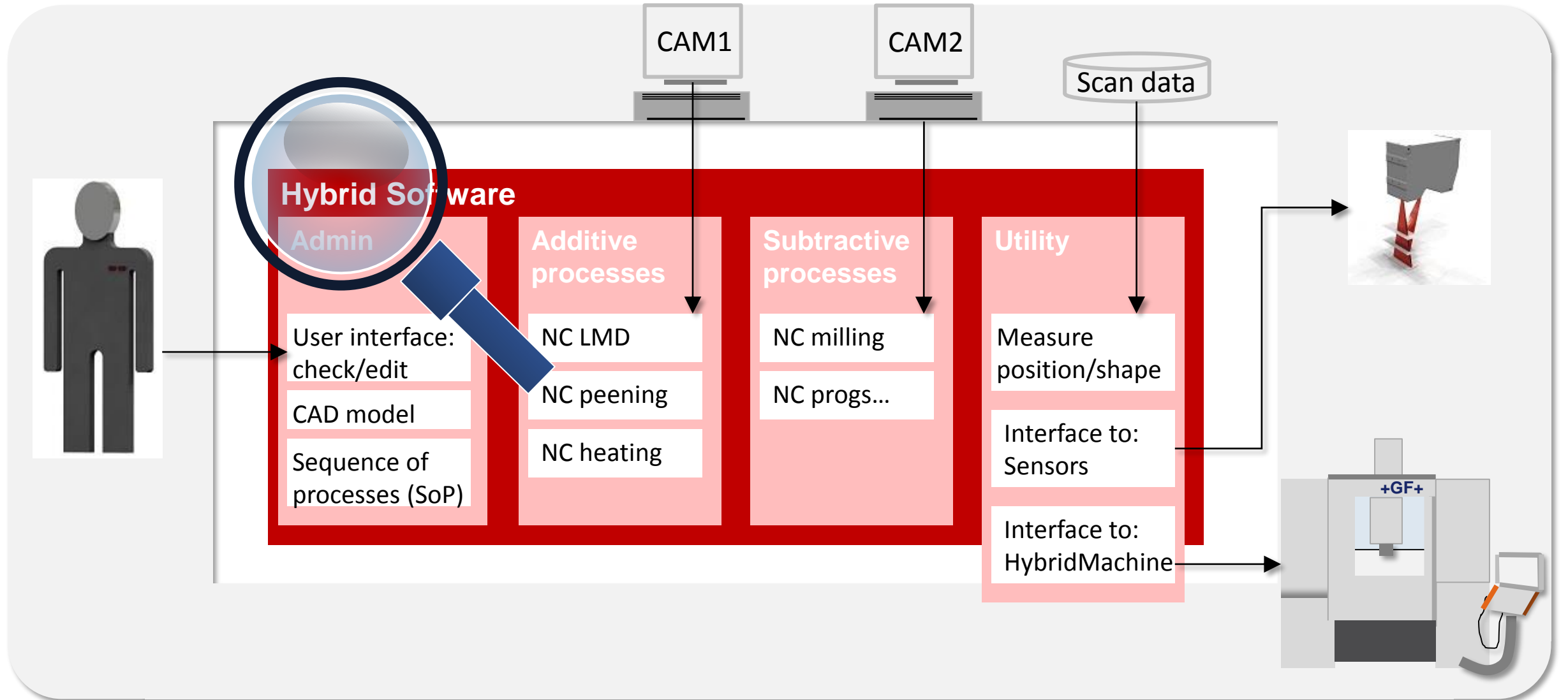
5 Finish milling







6 Result



1

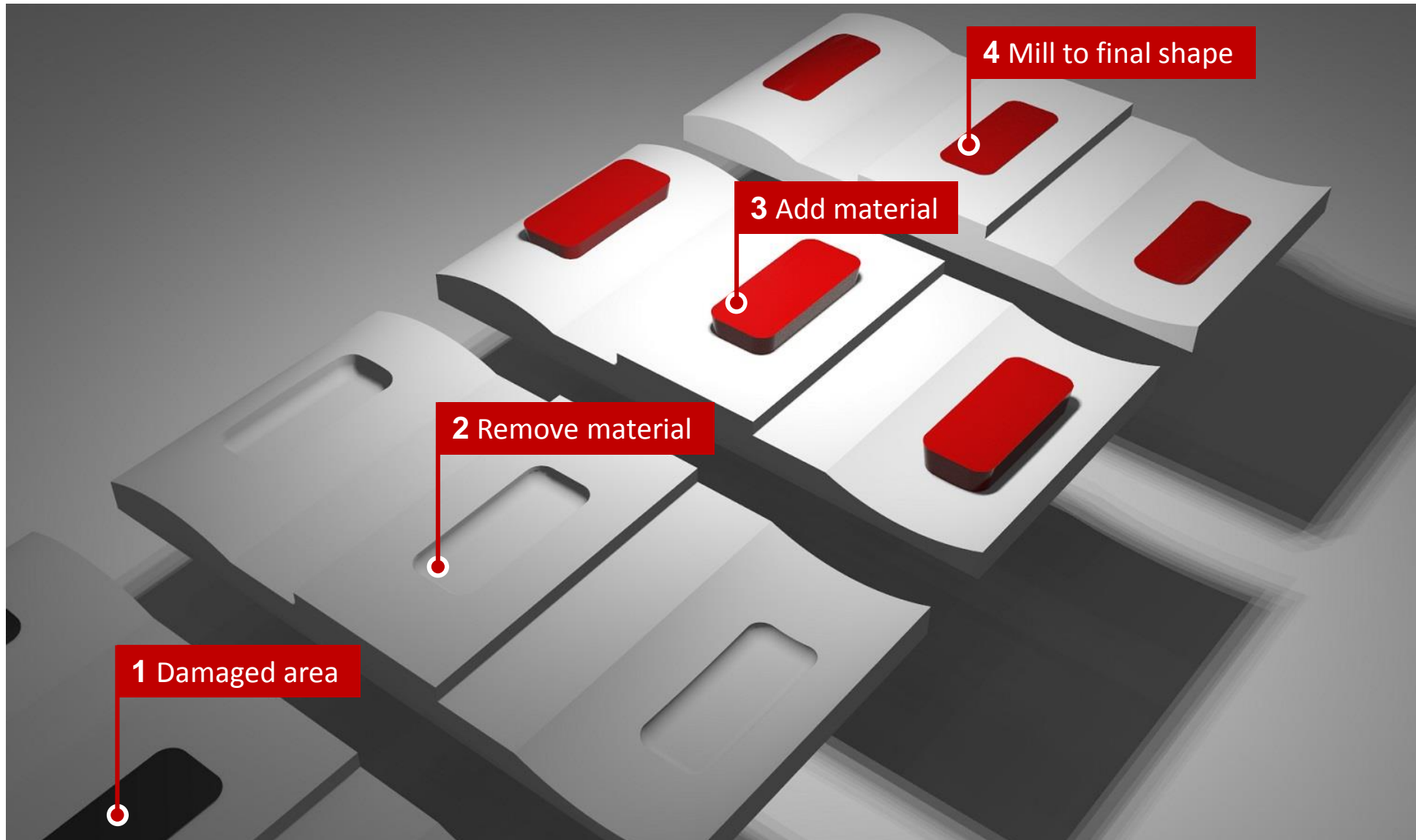


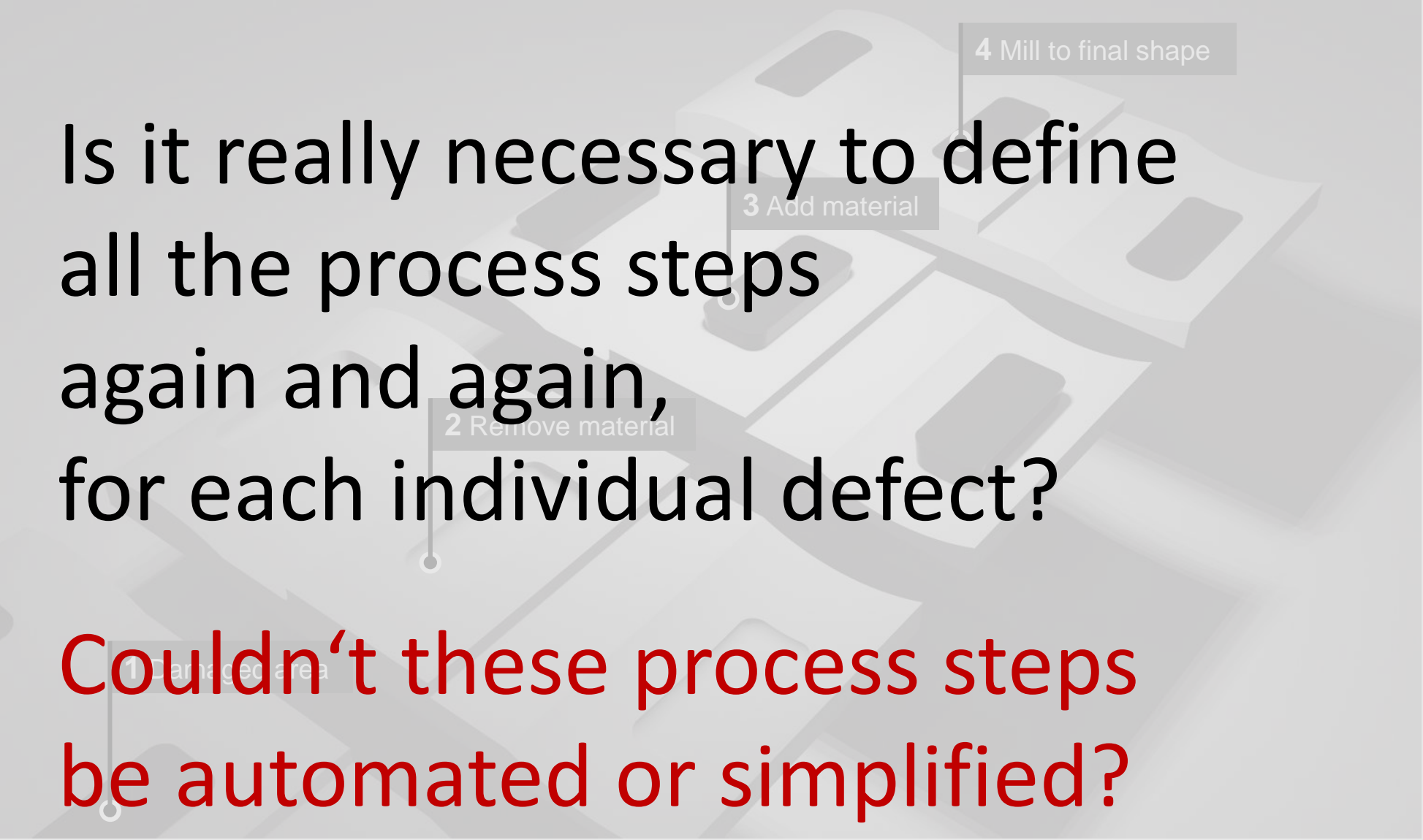
OpenHybrid applications: 2 groups!

Sector	aPod #	Short Name of aPod	Component Type	Degradation Process	Repair area	Thumbnail	Process characteristics	Software approach	Realisation
Power generation	1	Blade	Blade	Erosion/Corrosion wear	LE / TE / BT		Process chain is fixed and can be adjusted in steps (also predefined)	Static, NC programs defined during set-up	Specific, new developed functions based on BCT software OpenARMS
Tool and Die	3	press tool	press tool	tribological/thermal deformations	corner, radius				
Oil & Gas	5	Pitot tube	pitot tube	Erosion	Tube inlet				
Oil & Gas	6	Volute	volute	Errorsion-corrosion & impact	Varies		Process chain modules defined. Process to be defined corresponding to the individual damages	High level of user interactivity to be supported	NEW development to support the interactivity level, required

1

2





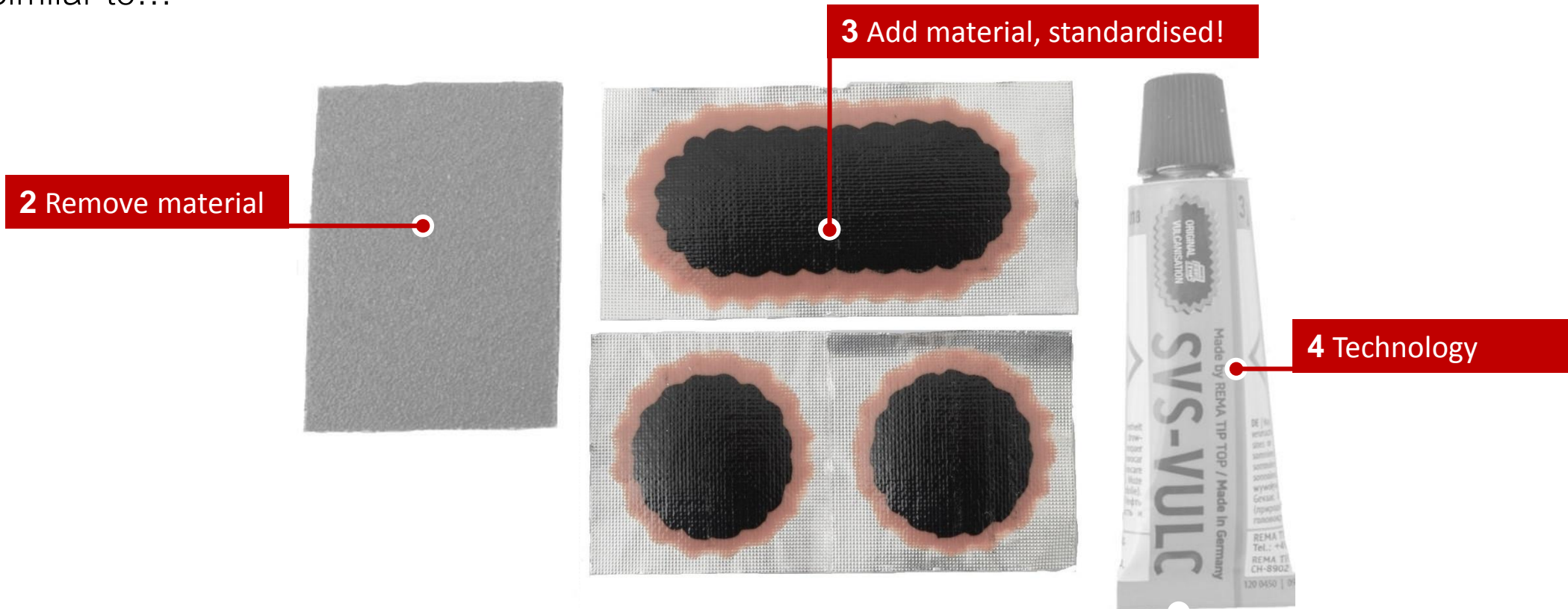
Is it really necessary to define
all the process steps
again and again,
for each individual defect?

Couldn't these process steps
be automated or simplified?

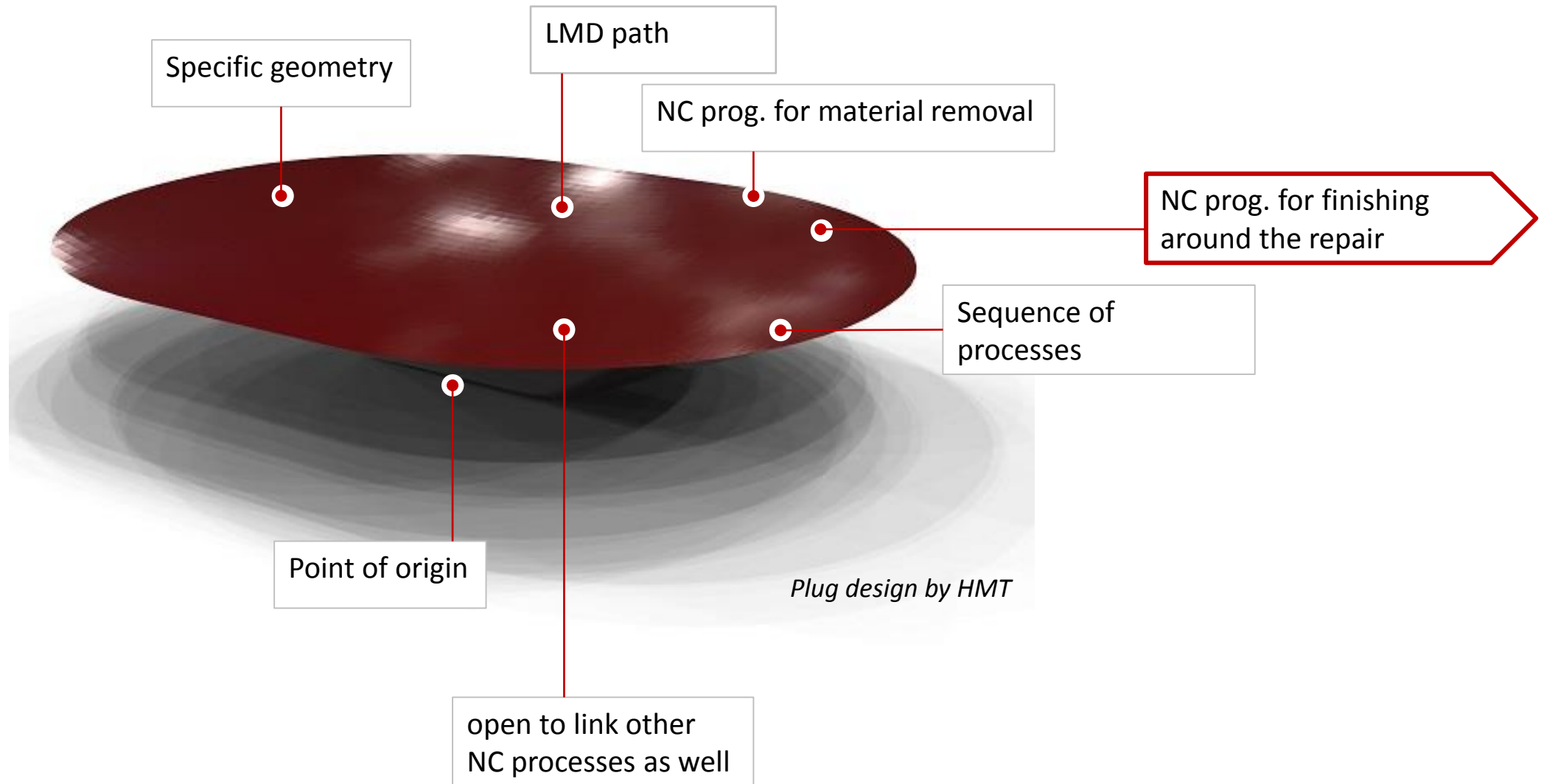
Approach: Hybrid repair using standard strategies

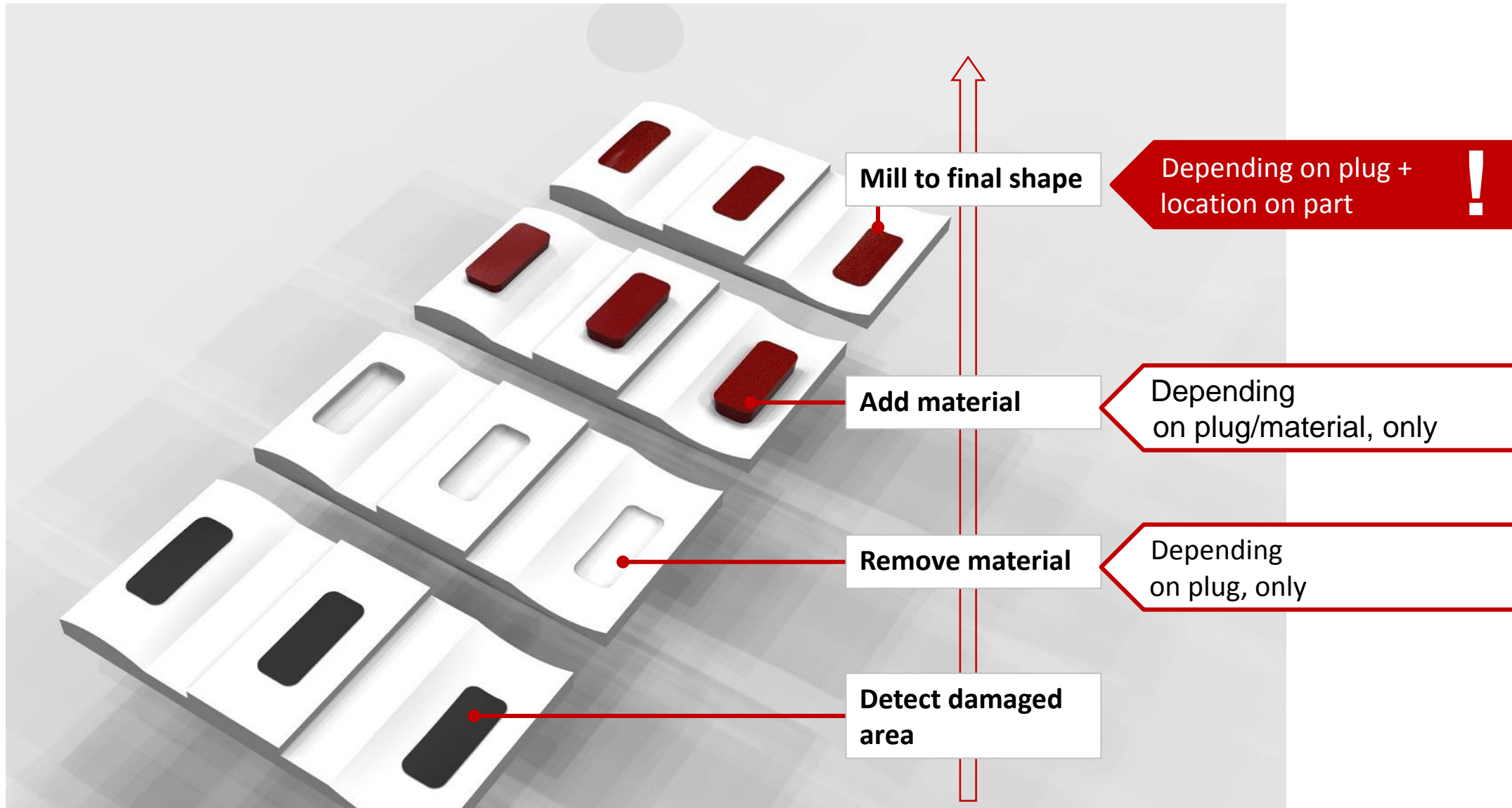
Is it possible to use predefined repair strategies?

Similar to...



Sports: Repair bicycle tube with predefined patches





Hybrid repair: How to consider indiv. geometry?

How to adjust a standardised process to the individual repair area?

~~Solution A: Use individual programs!~~

- ~~→ in contrast to standardisation approach~~
- ~~→ Huge number of NC programs. Difficult to handle!~~

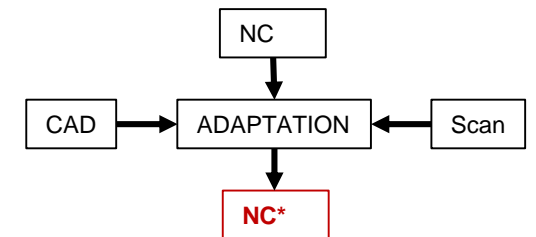
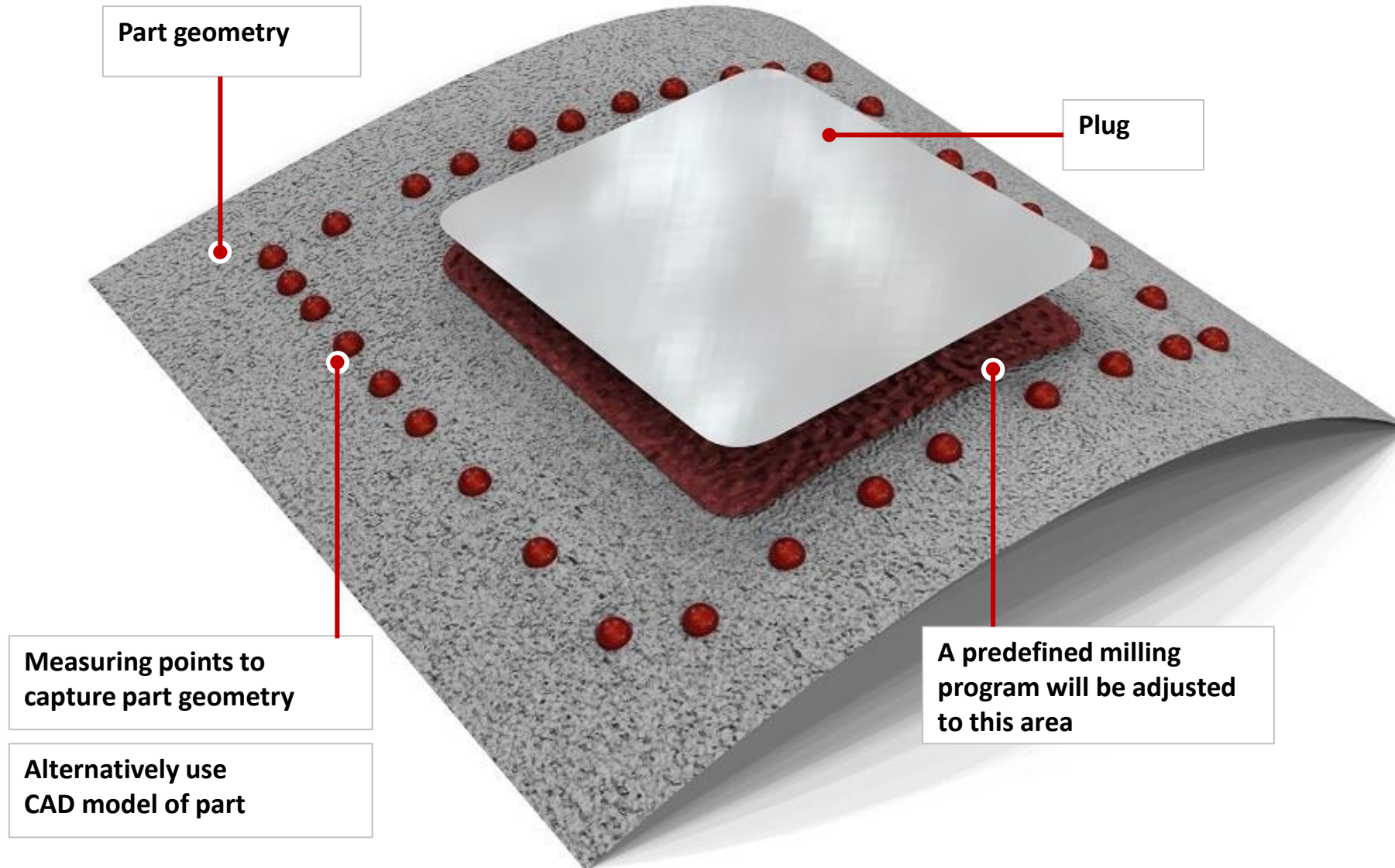
NO!

Solution B: **Adapt** a predefined NC program to the individual location, automatically!

- Introduce some “intelligence” to the plugs
- No specific user interaction required
- Plug reacts on the specific situation



Hybrid repair: Adjust NC finishing process



Hybrid repair: Prototype Software developed

- OpenHybrid Software
 - Developed by BCT GmbH, Dortmund (Germany)
 - Path generation by Picasoft, Vierzon (France)
 - LMD background provided by HMT and MTC, Coventry (UK)

BCT.



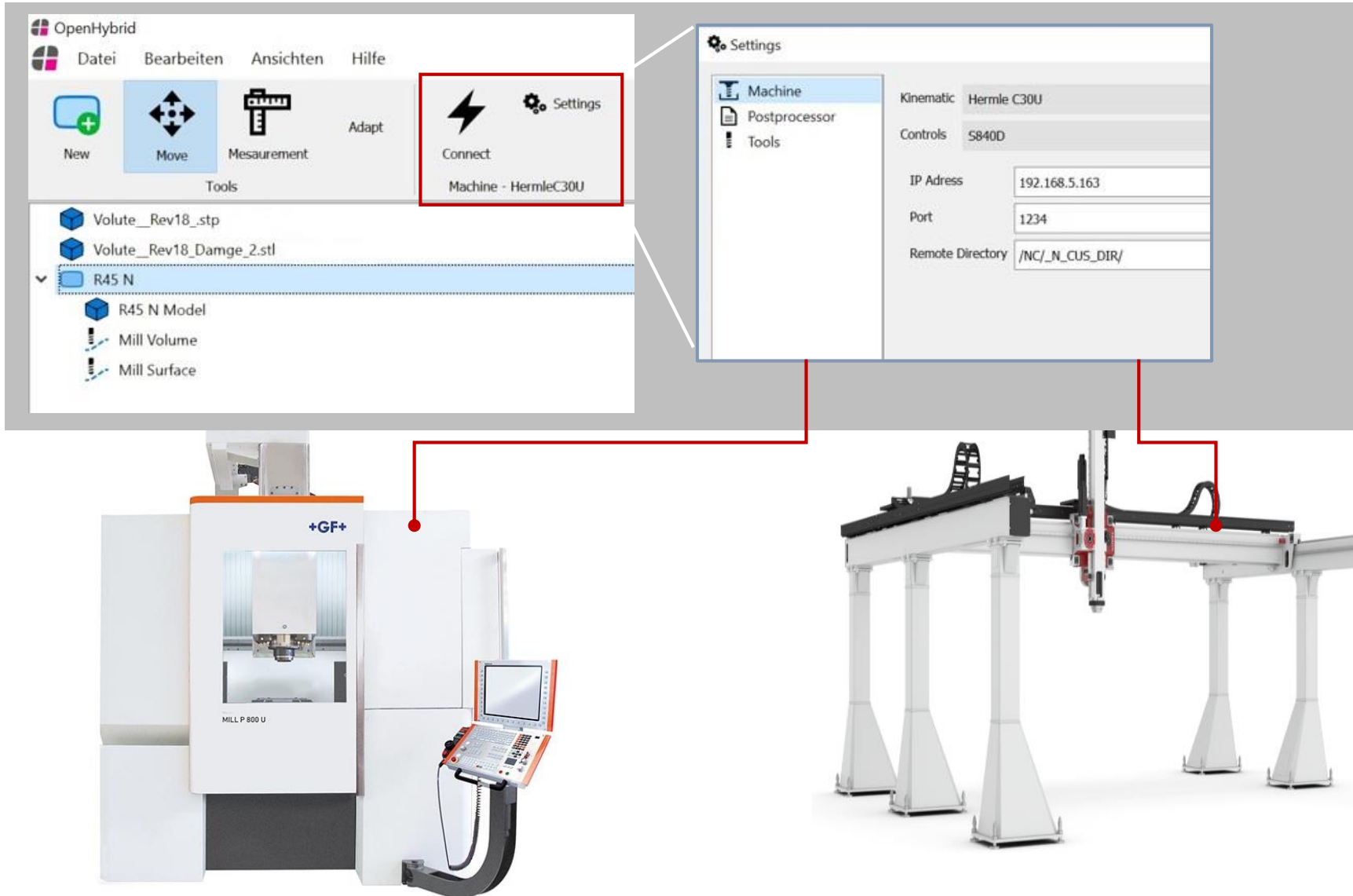
Process Flow

Example: How to use **plugs** inside the OpenHybrid software



This project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 723917 – OpenHybrid.

Hybrid repair: 6. Send NC progs. to machines



- Different solutions developed
 - for generating NC paths for milling and LMD
 - for predefined repair cases/applications (fully automatically, and directly connected to the machining equipment)
 - using standardised proved **PLUGS** for individual repairs, final milling to shape by adaptation
- Solutions not depending on specific machines and controller types

Comments appreciated!



BCT.

Thomas Kosche

BCT GmbH
Carlo-Schmid-Allee 3
44263 Dortmund, Germany
+49-231-97 50 10 25
t.kosche@bct-online.de
www.bct-online.de