Economic impact of LOCOMACHS results

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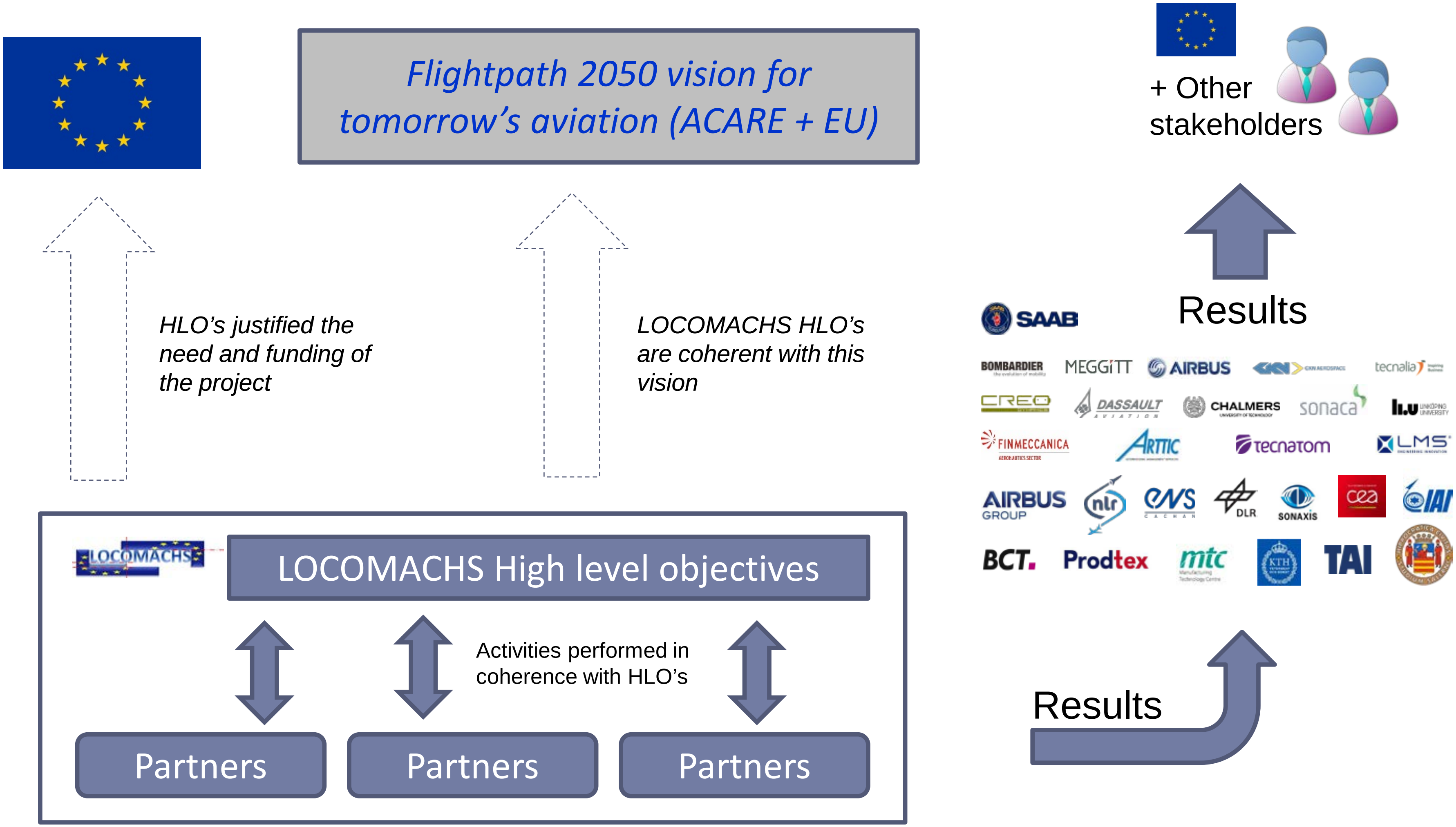
Content

- Introduction to LOCOMACHS High Level Objectives
- Assessing cost benefits
- LOCOMACHS use-case results
- Conclusions

The Context of LOCOMACHS



Global Goals of FP7

Flightpath 2050

- **Involving SMEs based on cutting-edge research and education**
- Cost effective transport chains
- No negative effects on the environment
- **Maximising the aviation sector’s economic contribution and creating value: directly from aviation manufacturing**
- Protecting the environment and enabling the use of sustainable energy
- **Maintaining and extending industrial leadership: very cost effective and energy efficient products**

Reminder – LOCOMACHS HLOs

Based on Flightpath 2050:

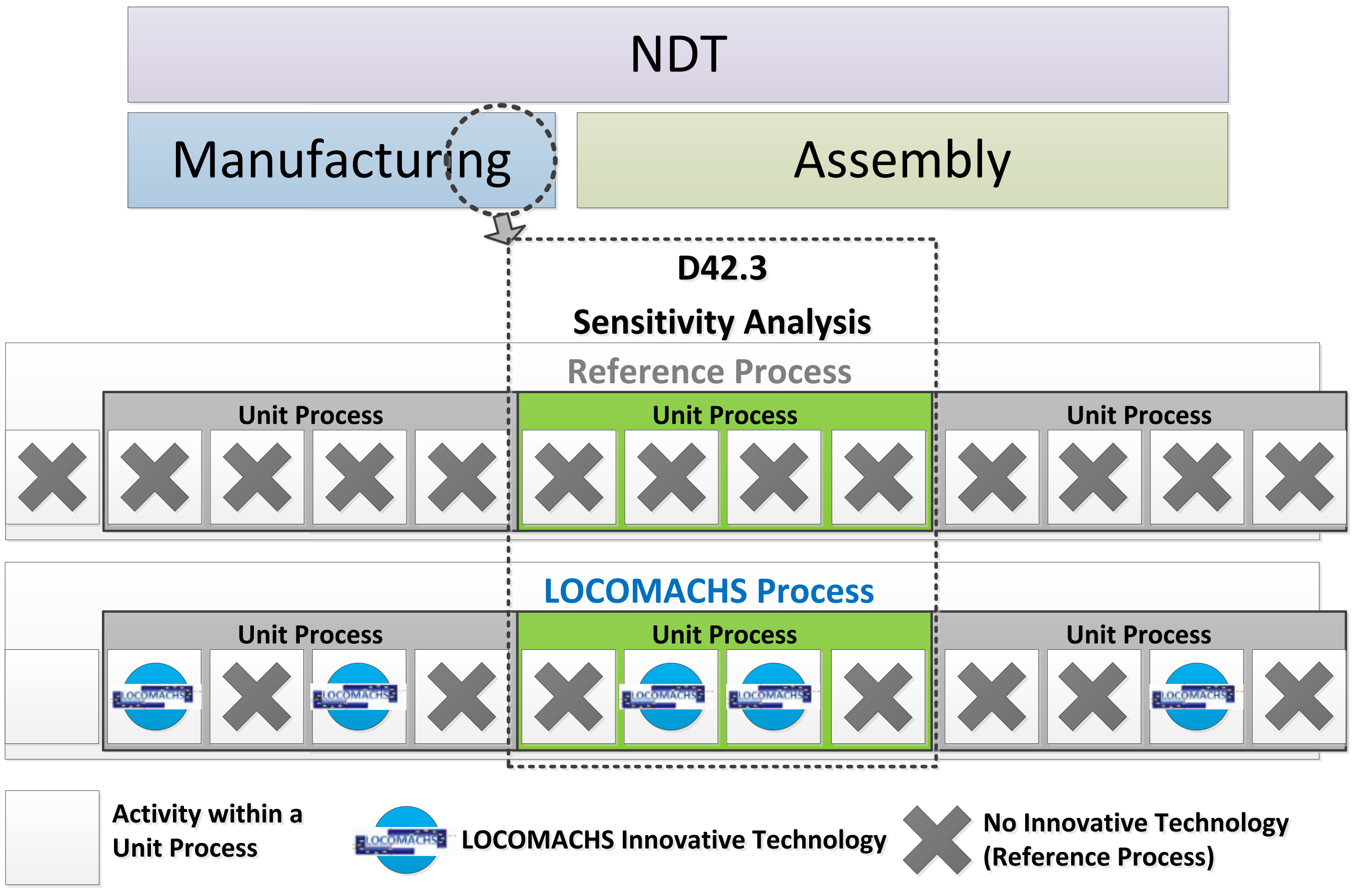
1. **Maximising the aviation sector's economic contribution and creating value**
2. **Maintaining and extending industrial leadership: very cost effective and energy efficient products**

The LOCOMACHS High Level Objectives were defined

LOCOMACHS HLOs

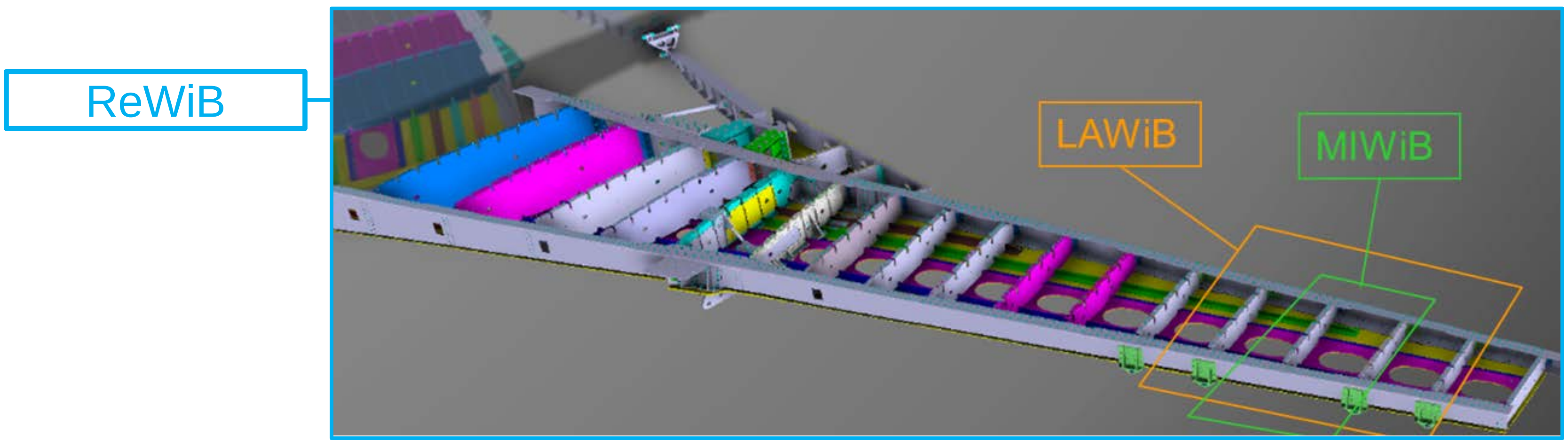
- **Define and validate a set of design and manufacturing rules for more complex structural parts**
- **Fully integrate geometrical tolerance and variation management in a representative airframe assembled wingbox structure**
- **Reduce by 50% the recurring costs of non-added value shimming operations in structural joints**
- **Reduce by 30% the recurring costs of non-added value dismantling operations**
- **Increase level of automation to reduce recurring cost during part joining by 30%**
- **Reduction of NDI / NDT lead time by 30%**

Framework of Cost sensitivity analyses:

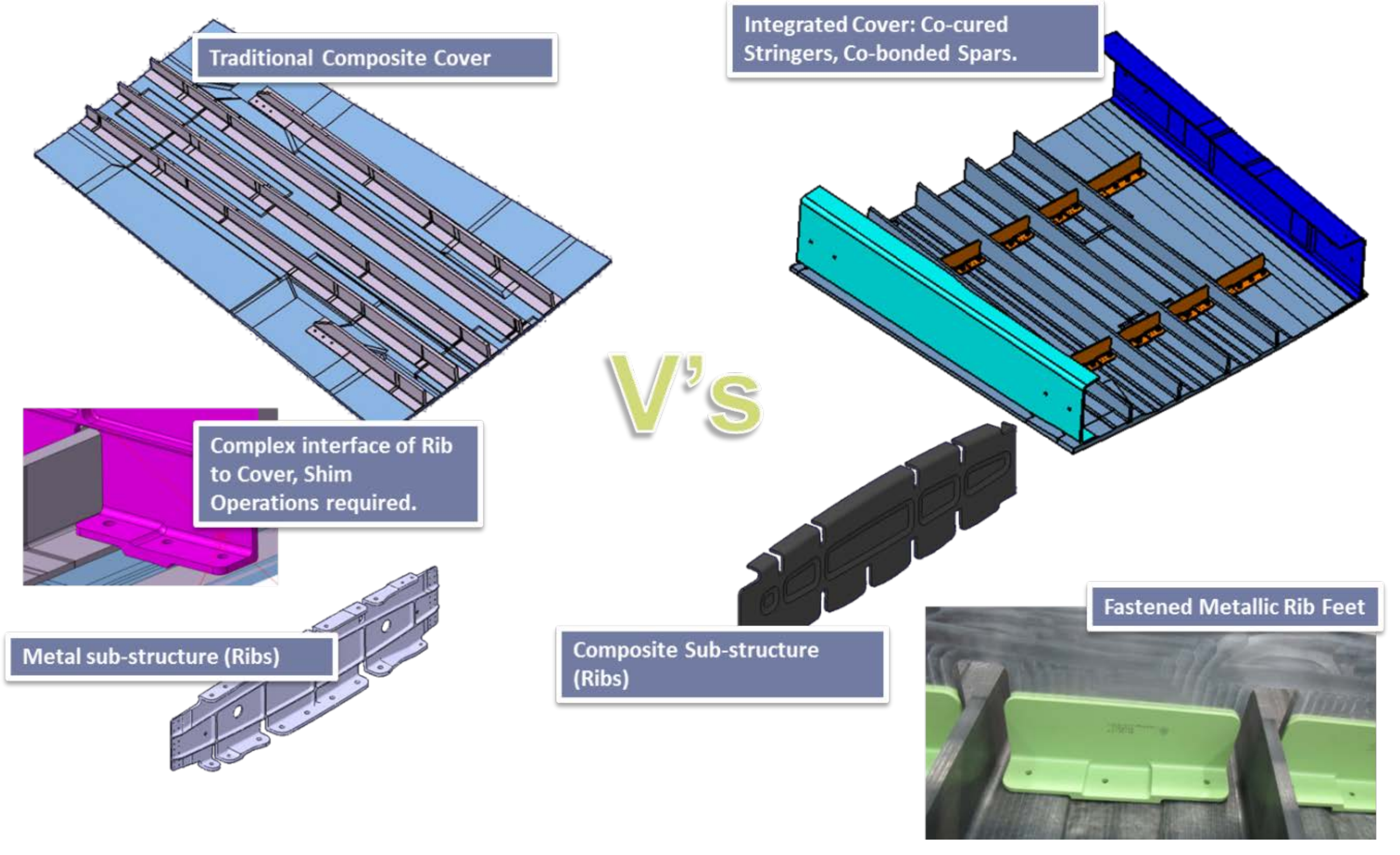


LOCOMACHS Demonstrators:

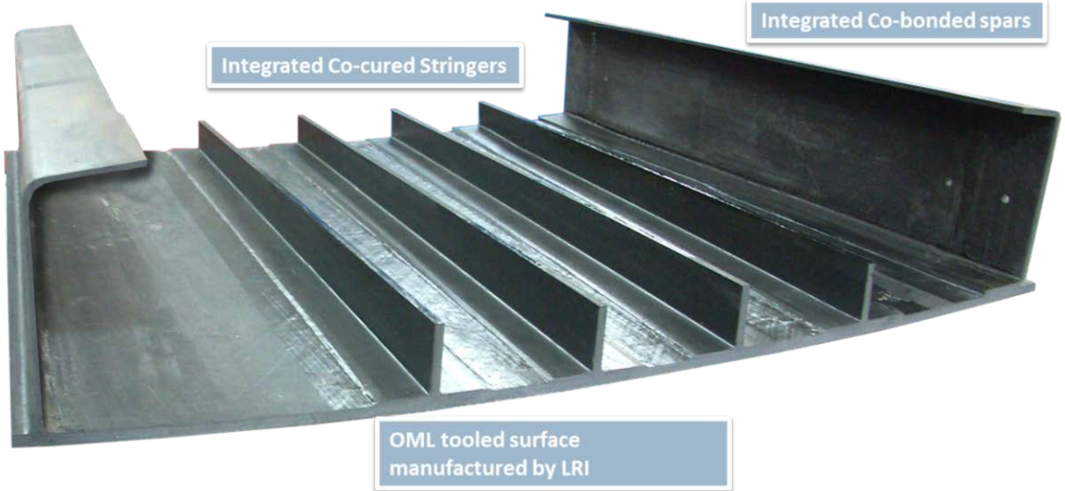
- **Case Studies of MIWiB**
- **Case Studies of LAWiB**
- **Case Studies of ReWiB**



- **MIWiB Case study**
  - Co-bonded Upper Cover



Co-bonded Upper Cover



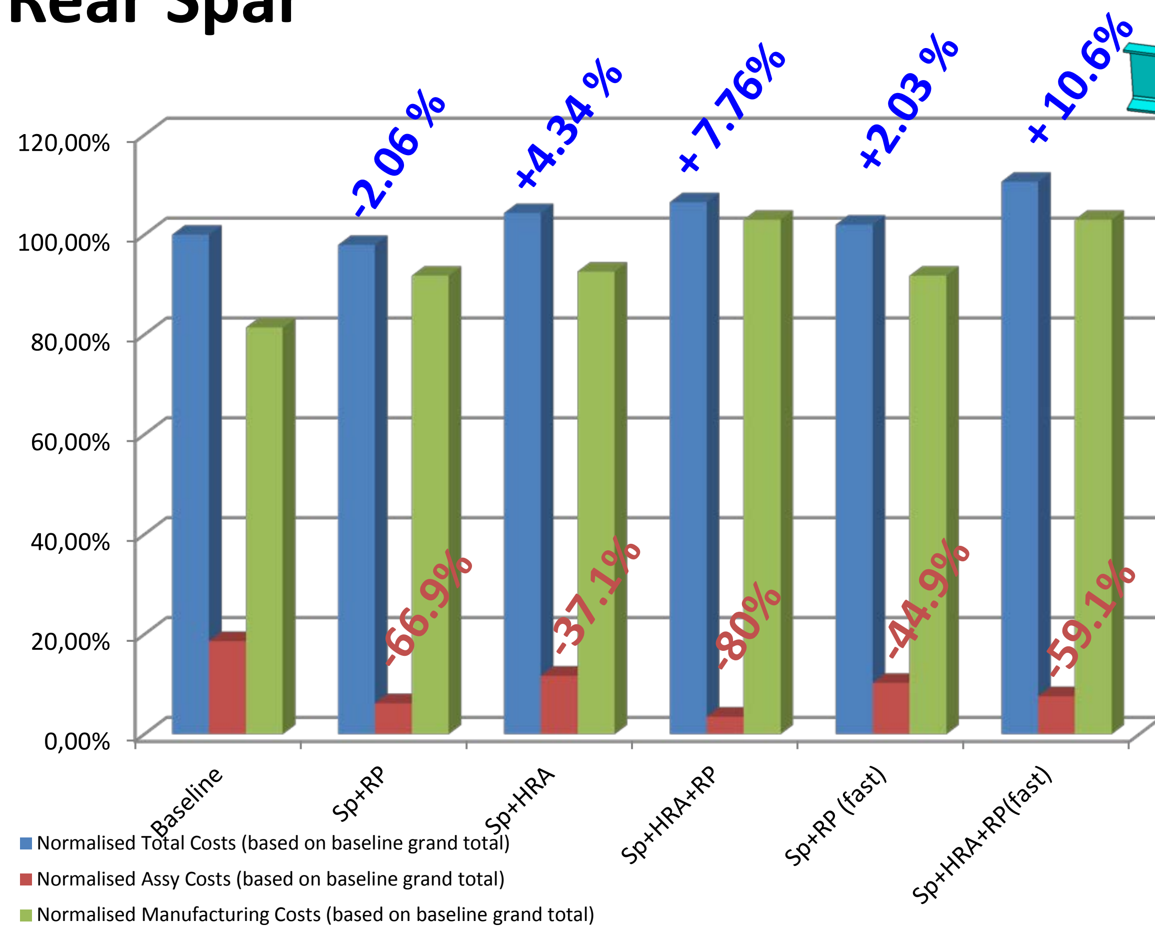
Technology strand	Cost saving	Targeted components and processes
Co-cured/Co-bonded part (Integration vs. Separate details)	**-10%**	Integrated CFC structures **(lower assembly costs)**
Possible dry fiber placement vs. handlay	**-15%**	Automated CFRP deposition **(to reduce material deposition time)**
Automated drill and fastening vs. Manual assembly	**-5%**	Automated drill, fasten, seal **(lower sub-assembly costs)**

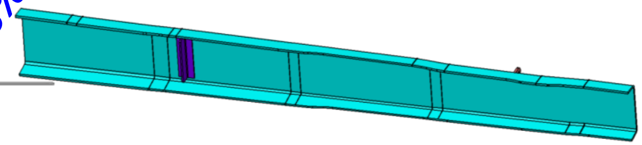
LAWiB Cost sensitivity analyses

- **Case studies of LAWiB**
  - Rear Spar
  - Upper cover production
  - Rapid curing of liquid shimming
  - Laser surface treatment
  - RTM composite spar and wing box
  - Ultra-Sonic laminate thickness control
  - Countersink scan
  - Hexapod-assisted positioning
  - Improved drilling
  - Improved NDT/NDE: AUT

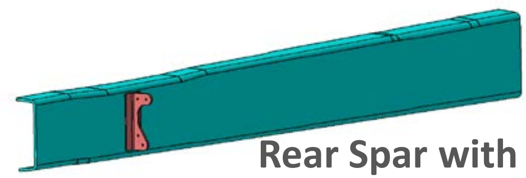
BOMBARDIER
the evolution of mobility

Rear Spar

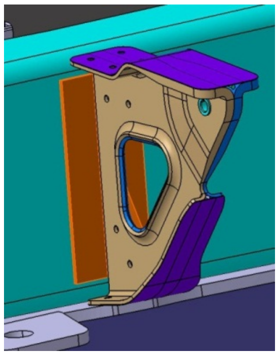




Rear Spar with Rib Post



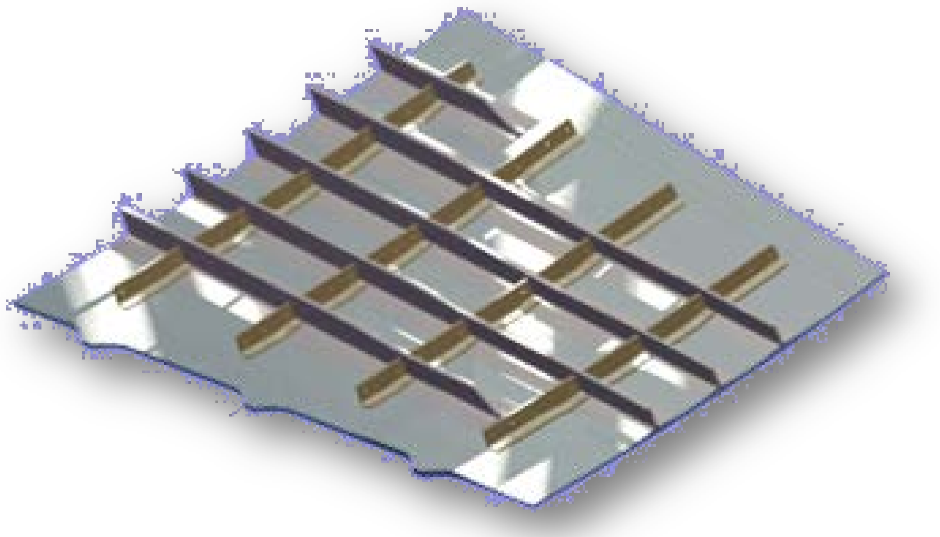
Rear Spar with Hinge Rib Attachment

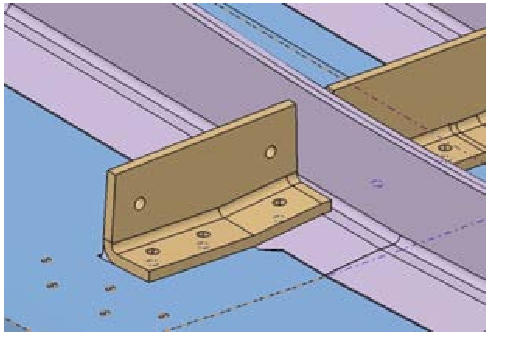


Hinge Rib located to its Hinge Rib Attachment

Cost sensitivity analyses for different production scenarios

Upper cover production





Cost sensitivity analyses for wing skins/ structures

Technology Strand	Cost saving at TRL3
Co-cured/ Co bonded part integration	**-5%**
Automated deposition of composite material (prepreg)	**-15%**
Automated drilling and fastening	**-4%**

Rapid curing of liquid shimming

SAAB

Cost

-58%

Conventional Process

LOCOMACHS

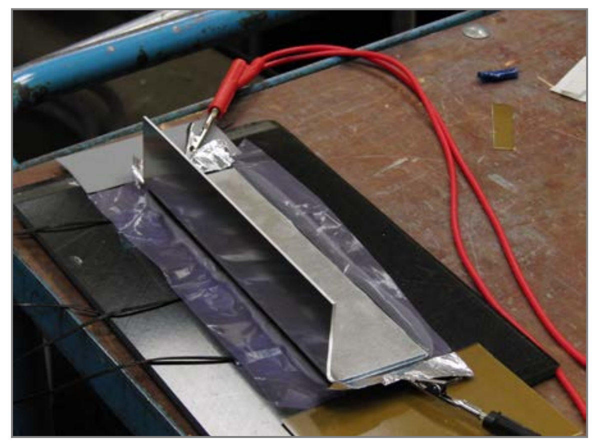
Time
10 h

1.5 h

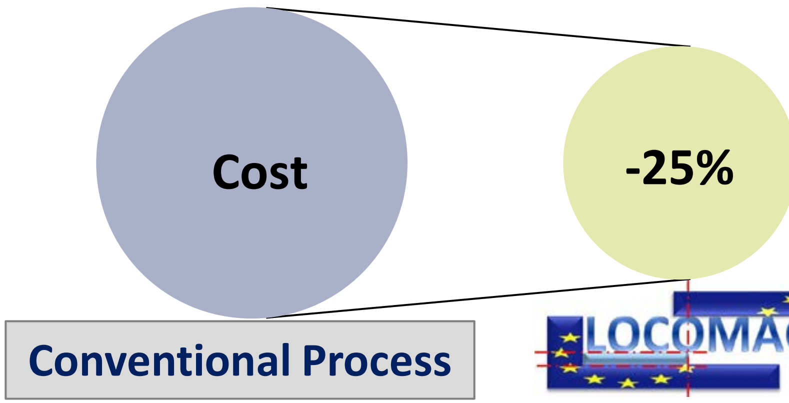
Conventional Process

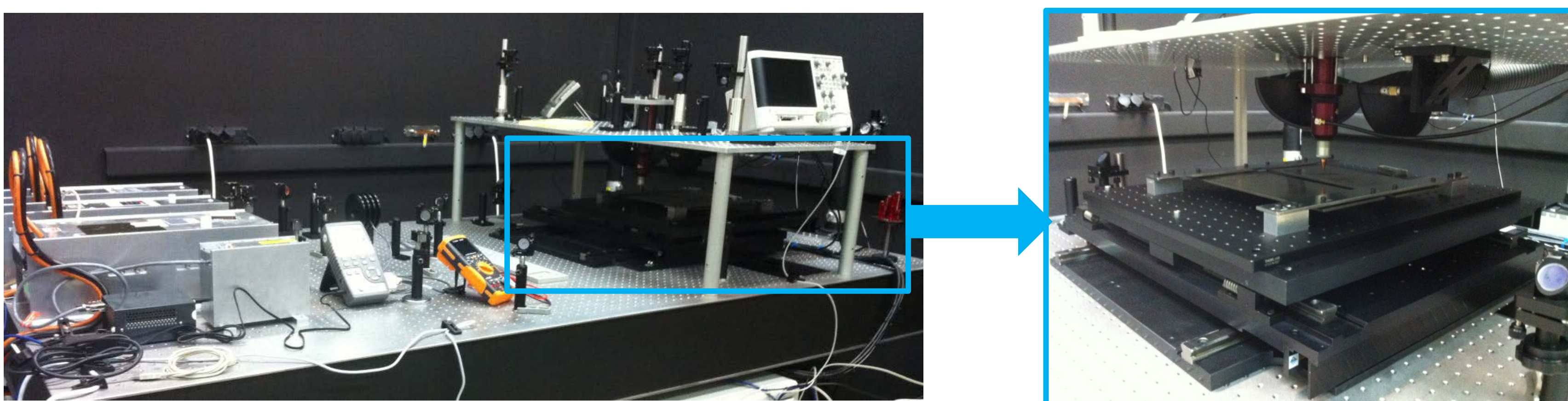
LOCOMACHS

Boing 787 Cargo Door – 290 parts until 2024



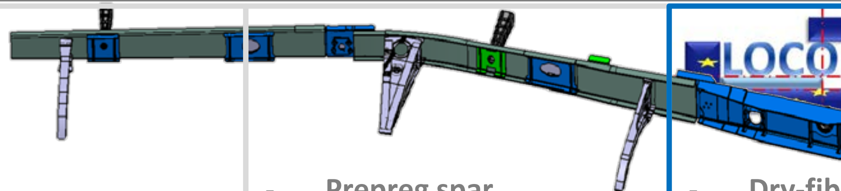
Laser surface treatment



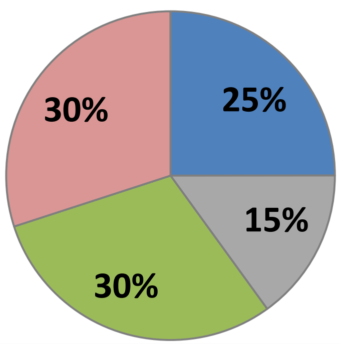


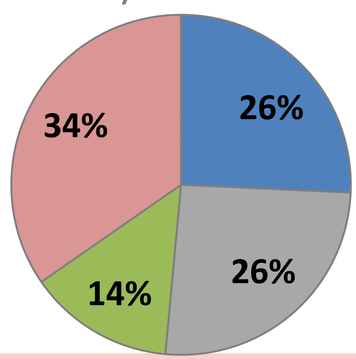
RTM composite spar and wing box

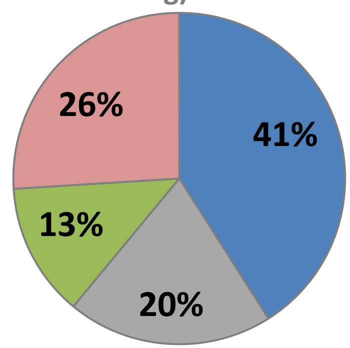
DASSAULT AVIATION

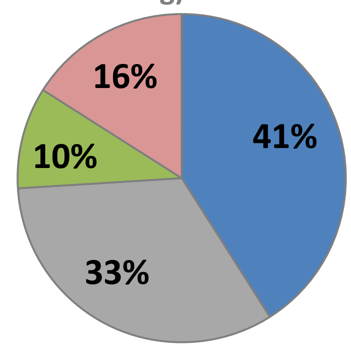


	Conventional Process	Composite solutions (after re-engineering)		
	- Machined aluminum spar - Direct Assembly	- Prepreg spar - Assembly (liquid/ solid shims)	- Prepreg spar - Machining - Direct assembly (liquid shimming)	- Dry-fibre placement spar + RTM injection - Direct assembly (liquid shimming)
Overall cost evolution	Reference	+46%	+52%	**-8%**









- Primary part manufacturing
- Assembly of local sub-components (reinforcement etc..)
- Spar full assembly (inboard/ outboard)
- Spar integration in the wing box

Ultra-Sonic laminate thickness control

DLR

Infusion

Cost

- 10%

Conventional Process

Curing

Cost

-7%

Conventional Process

Stiffened Panel Structure

sonaca

Main landing gear door
(1 skin + 3 stiffeners)

Reference process

- Skin → Hand lay-up → Curing in OML tool → Secondary bonding in OML tool
- Stiffeners → Hand lay-up → Curing → Secondary bonding in OML tool

Locomachs process

- Skin → AFP on OML tool → Cocuring in IML tool
- Stiffeners → Hand lay-up → Cocuring in IML tool

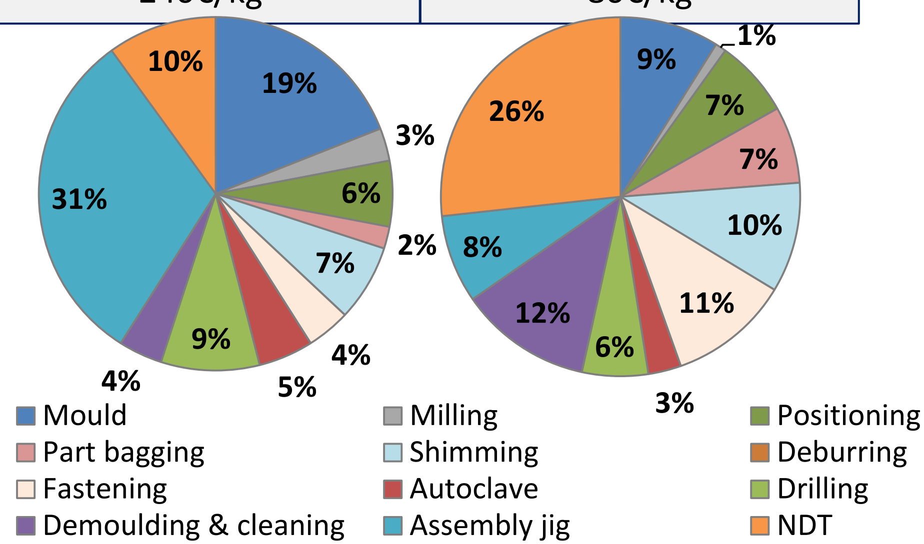
Cost → **-9%**

LAWiB Case studies - KTH

Conventional Process

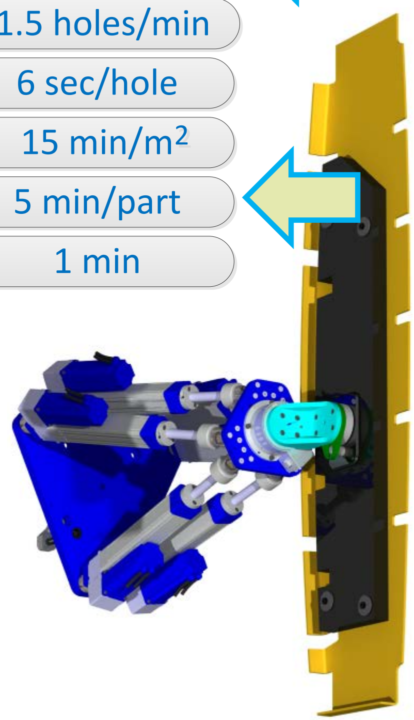
Process	Time
Mount part (s)	5 min/part
Shim	Measure shim: 5 min/m ^{2}; Manufacture shim: 20 min/m ^{2}; Unmount part (s): 5 min/part; Mount shim: 5 min; Mount part (s): 5 min/part
Tack	33%
Unmount part (s)	5 min/part
Drill	1.5 holes/min
Deburr	6 sec/hole
Clean	15 min/m ^{2}
Mount part (s)	5 min/part
Fasten	1 min
NDT	

n=50	n=600
43600€/structure	14400€/structure
240€/kg	80€/kg

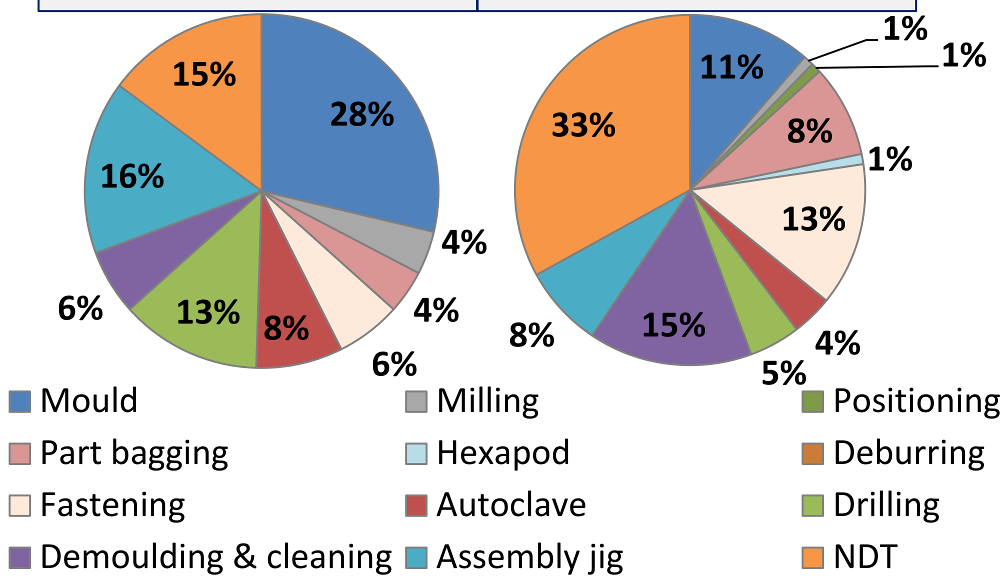


Hexapod-assisted positioning

Process	Time
Mount part (s)	5 min/part
Tack	33%
Unmount part (s)	5 min/part
Drill	1.5 holes/min
Deburr	6 sec/hole
Clean	15 min/m2
Mount part (s)	5 min/part
Fasten	1 min
NDT	

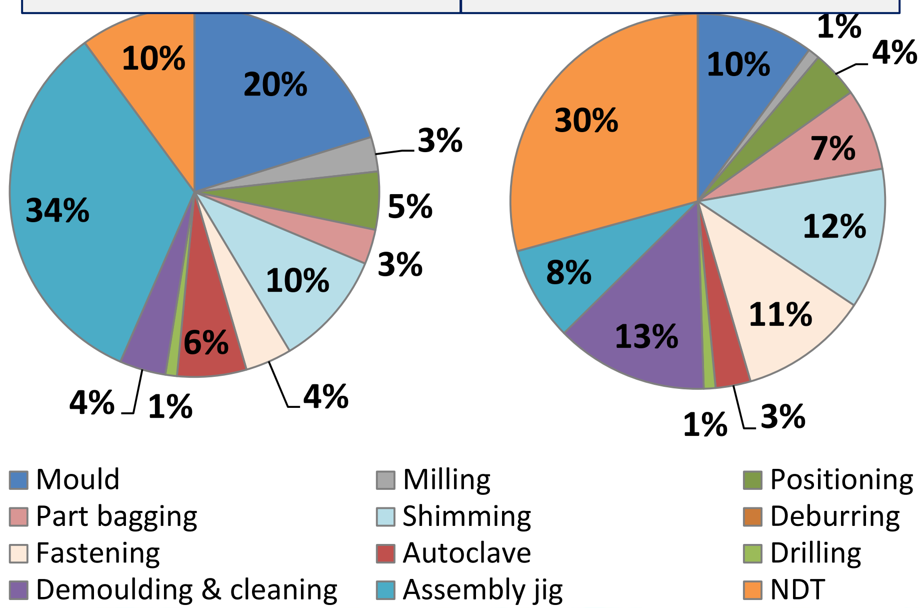


n=50	n=600
28900€/structure	11100€/structure
160€/kg	60€/kg



Improved drilling

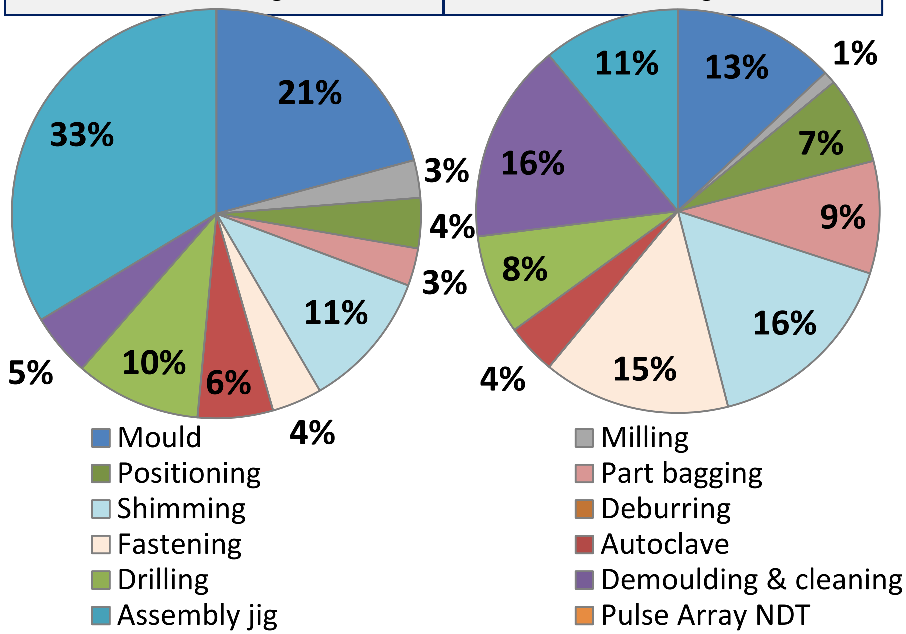
n=50 40500€/structure 220€/kg	n=600 13500€/structure 70€/kg

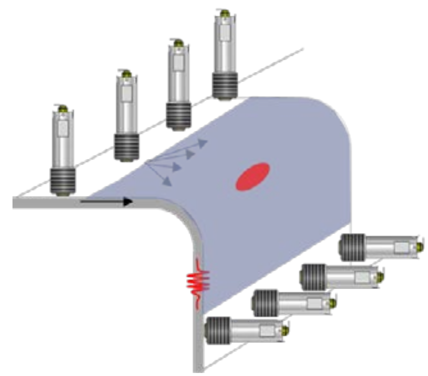


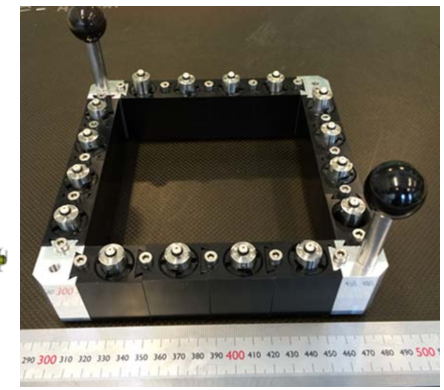


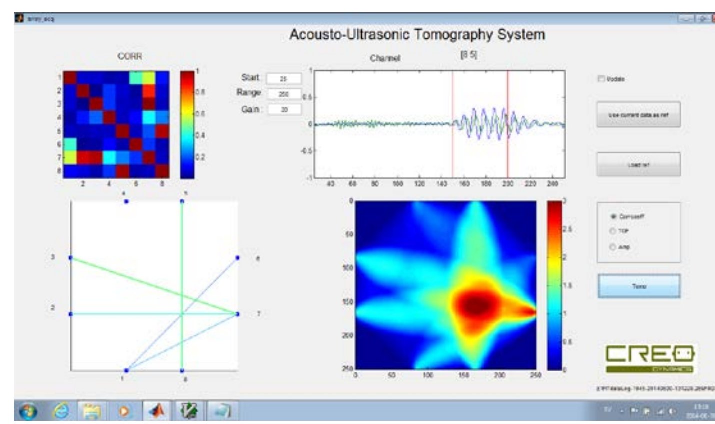
Improved NDT/NDE: AUT

n=50 39400€/structure 220€/kg	n=600 10500€/structure 60€/kg



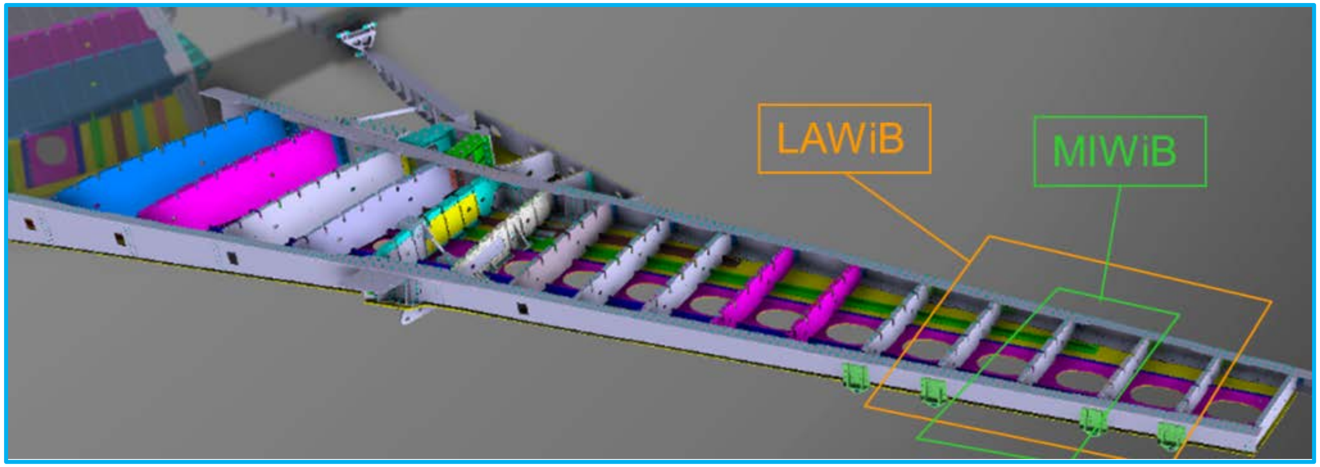






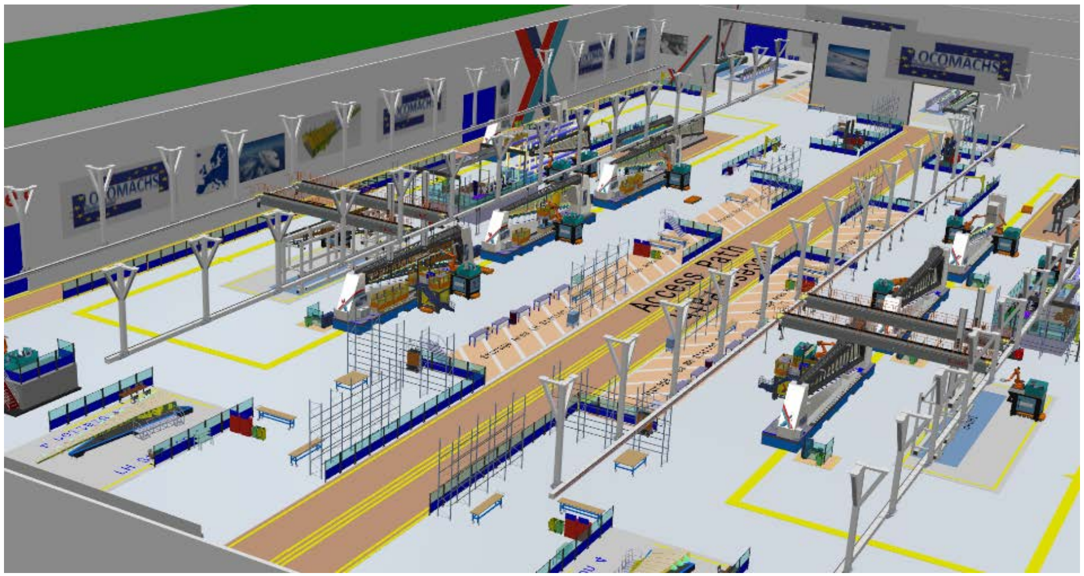
ReWiB Case study

– Conventional build vs. ReWiB incl. LOCOMACHS technologies



ReWiB Case study

ReWiB vs. conventional build



FINMECCANICA
AERONAUTICS SECTOR

Recurring Cost		
Labour Fab. (h)	Labour Assy. (h)	Material (€)
-11%	-31%	+11%

Economic impact - conclusions

- Define and validate a set of **design and manufacturing rules** for more complex structural parts →**Smart shifting of functionalities between parts of the LAWiB proves to save time in assembly**, **Design and manufacturing rules will be adressed in various deliverables to come**
- Fully **integrate geometrical tolerance and variation management** in a representative airframe assembled wingbox structure. →**Linked the tool design with geometrical assurances process**
- **Reduce** by **50%** the recurring costs of **non-added value shimming operations** in structural joints → **no shimming on interface rib to UC**, **no shimming between LC and ribs due to new build philosophy, shimming should be further reduced**
- **Reduce** by **30%** the recurring costs of **non-added value dismantling operations** → **not fully verified…**
- **Increase the level of automation** related to part joining operations. → **Yes**
- **Reduce the NDI/NDT lead time** by **30%** → **not fully verified…**

“Finding new Friends in LOCOMACHS”

Co-funded by the
European Union