MHI Proprietary

NAW200532

Composite Safety Meeting and Workshop
[CAANZ, Wellington, New Zealand]

MHI composite technology
- Status and Future -

Toshio Abe

2016 3 2

MITSUBISHI HEAVY INDUSTRIES, LTD.
Fixed Wing Aircraft Engineering Department, Integrated Defense & Space Systems

MITSUBISHI HEAVY INDUSTRIES, LTD.
Our Technologies, Your Tomorrow

Achievement and Challenge – MHI Composite Application History

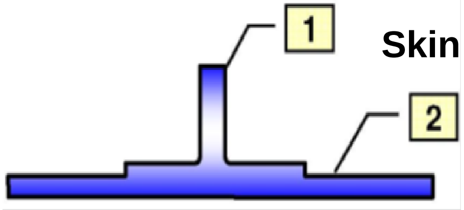
【MHI Composite Application History and Achievement】

Since early 1980's, Started Composite application in aircraft structure.
Aggressive development activities led by Japan's self-defense force has borne much fruit, such as co-cured wing-box in F-2 Support Fighter.
Turning into 21st Century, composite application has been spread out into commercial airplane.
MHI has been contributing to develop / produce wing-box on Boeing 787 and now making composite empennage on next coming MRJ.

◆ **Achievement**

To realize co-cured and co-bonded composite structure

Spar / Stringer



Co-cured Joint

◆ **Challenge** = Low Cost Volume Production

Cost Contributor

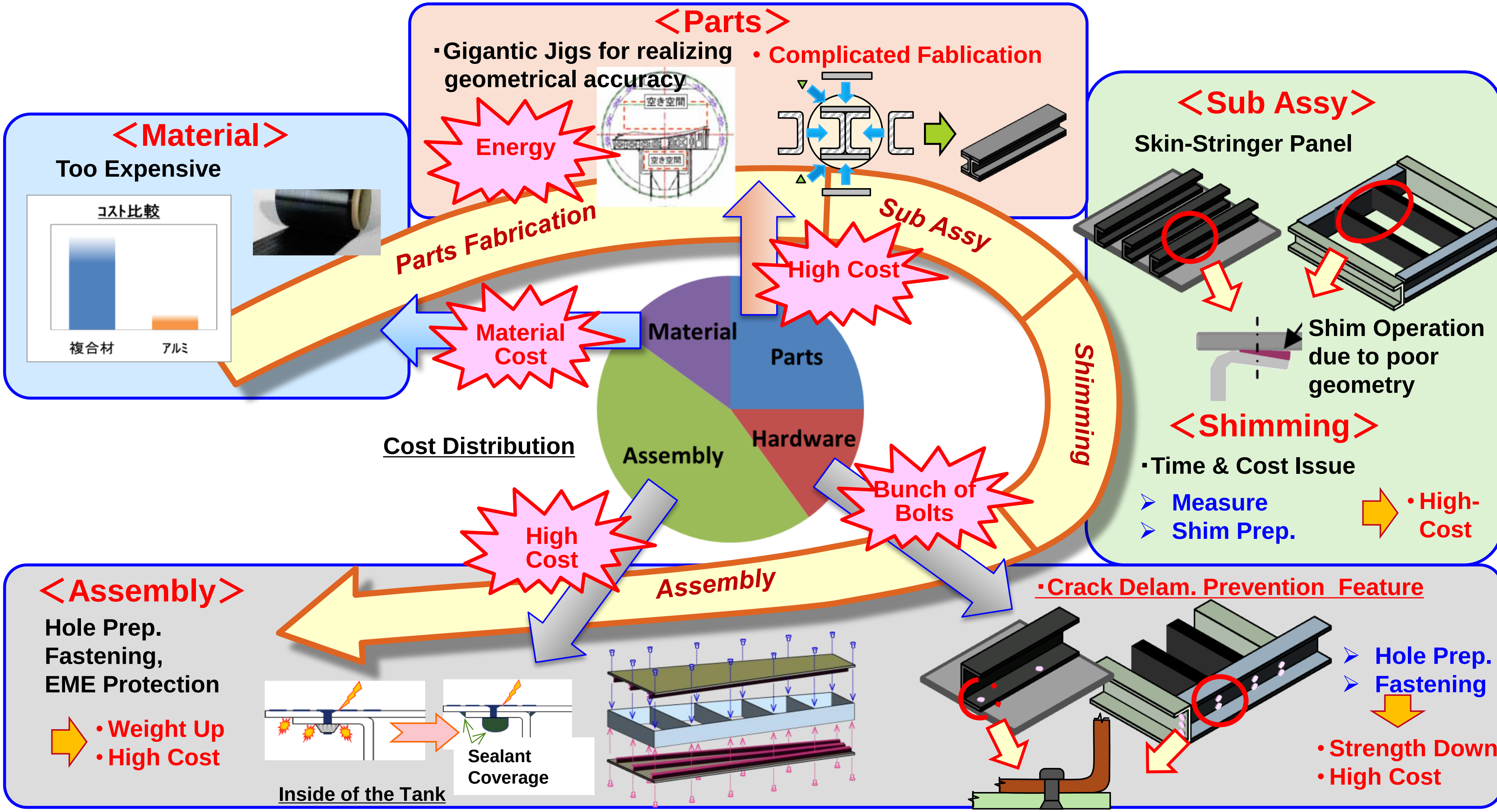
* Material / Fabrication Process - Too expensive compared to Metal

* Parts Fabrication - Bunch of elaboration compared to Metal counterparts

* Assembly - Bunch of Fasteners needed

Today — Composite Structure Production

- Parts Fabrication & Assembly are two major cost drivers, even though all process hold high cost issues.
- High Cost & Low Produce-ability compared to Metallic structure.



Cost Contributor - Parts Fabrication

Old Days ~2000

「Hand Craft Products」

◆ Hand Lay-up

Today 2003~ After Boeing787

「Industrial Products」

◆ Automated Lay-Down

SKIN

Ref : G. Hasko, An Introduction to Aerospace Composite Manufacturing Technology

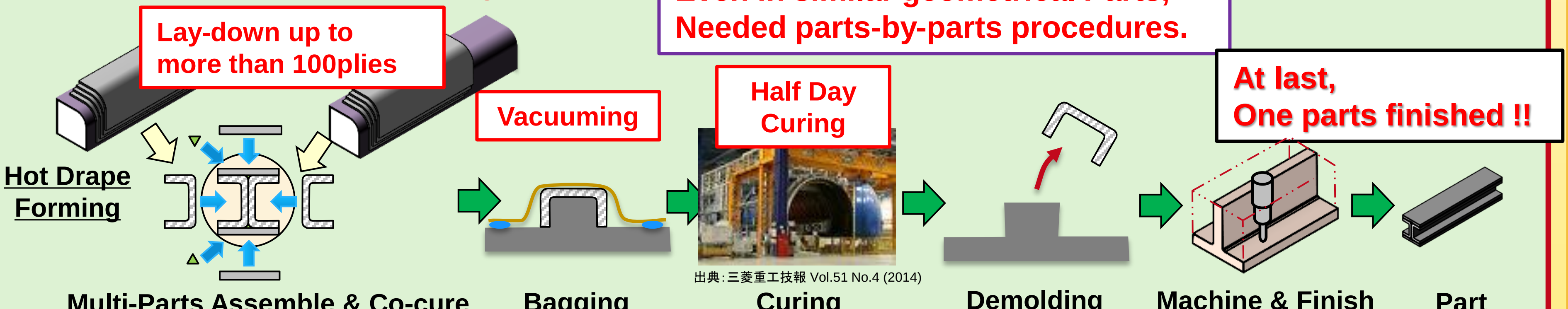
Ref : http://www.compositesworld.com/

Ref : M-Torres HP

Stringer and other Skeletal Parts

・In-efficient and Low Produce-ability

Even in similar geometrical Parts, Needed parts-by-parts procedures.



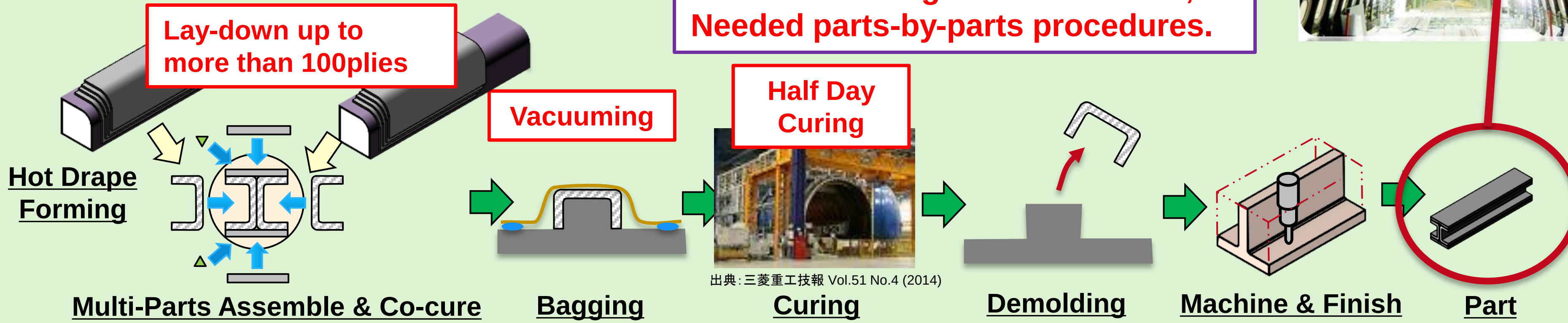
Cost Contributor – Parts Fabrication

Compared to Metal counterparts,
Bunch of elaboration = Cost Needed in Today's Composite Fabrication.

Stringer and other Skeletal Parts

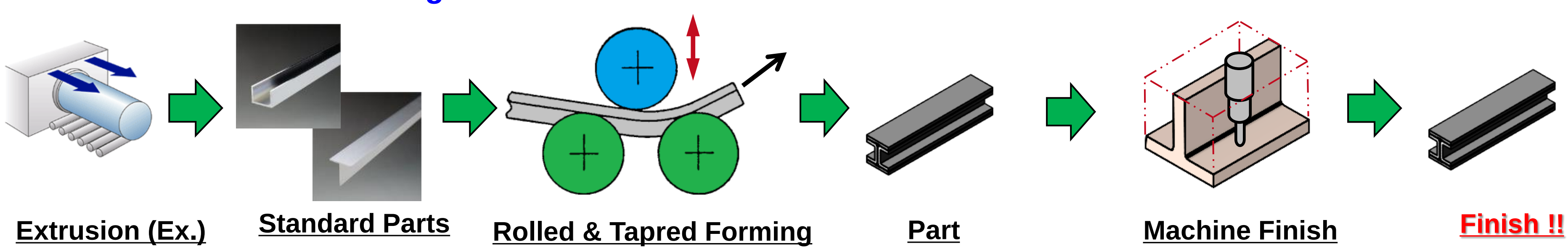
▪In-efficient and Low Produce-ability

Even in similar geometrical Parts,
Needed parts-by-parts procedures.



Metal Stringer Fabrication (Example)

▪Standard Parts & Finishing



MHI Proprietary

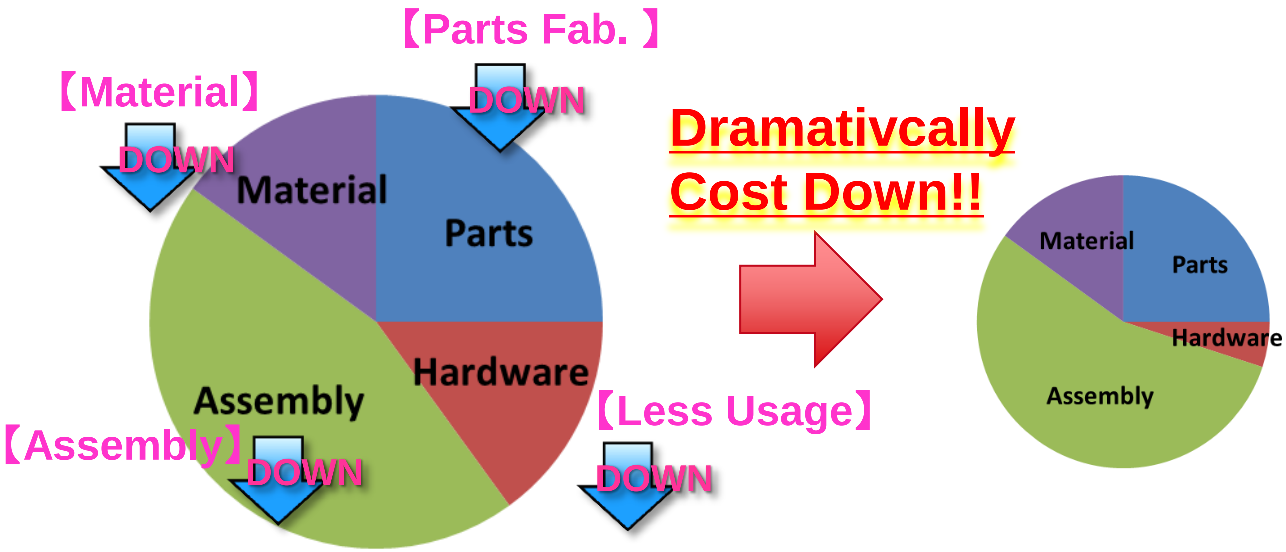
Cost Reduction Challenge

Composite application on aircraft have becoming popular.

But Need pursue more aggressive cost target for meeting fierce market challenge.

Thus, Future Target on Composite is

To realize head-to-head competitive production cost against traditional metallic structure



Today **Future**

<< Opportunity >>

- ◆**Innovation on Parts Fabrication**
- ◆**To realize Bonded Structure**

MHI Proprietary

How to achieve the Goal – Innovation on Parts Fab.

◆ Standardization

Today

Every single part has unique geometry.
Thus, Need independent fabrication tool / process even in very similar parts.

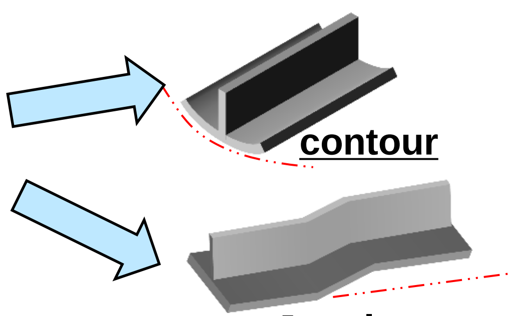
Quality Concerns, such as fiber wrinkles, due to aggressive contour , joggle …
Long process time is also concern.

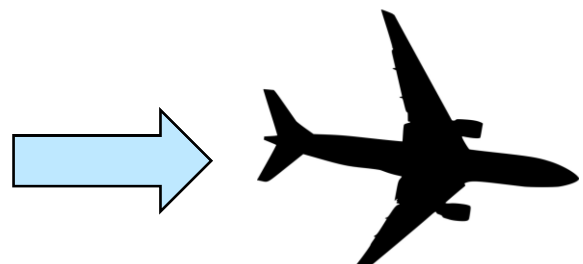
Future

Standardization needed for realizing Metal-equivalent fabrication cost.
Drape-ability suited for contour and joggle.
To realize short process time

Candidate Technology → Textile and Thermo-Plastic

Textile & CFRTP





Future Aircraft

CFRTP = Carbon Fiber Reinforced Thermo-Plastic

How to achieve the Goal – Bonded Structure

MITSUBISHI HEAVY INDUSTRIES, LTD.

◆ To realize Bonded Structure

Today

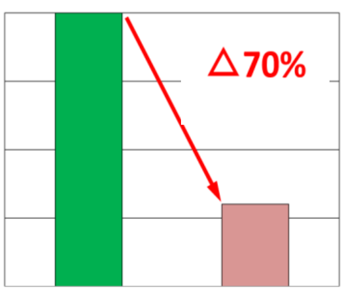
Panel-level unified structure realized utilizing co-cure / co-bond technology.
Still, Need far trek toward realizing bonded construction due to less-reliable process and lack in prevalent quality assurance procedures.

Future

To realize Bonded Structure and fully utilize composite advantage w/less Fastener counts.

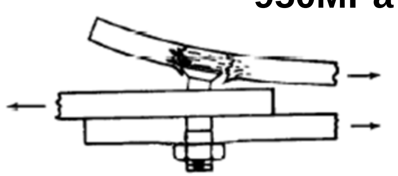
Expected Technology → **◆Stable Bond w/Robust Process**
◆Quality Assurance for Weak/Kissing Bond

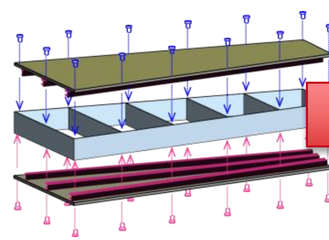
◆Strength Degradation due to Hole Prep.



Non-Hole Open-Hole

CFRP 370MPa < Al-Alloy (7050) 950MPa



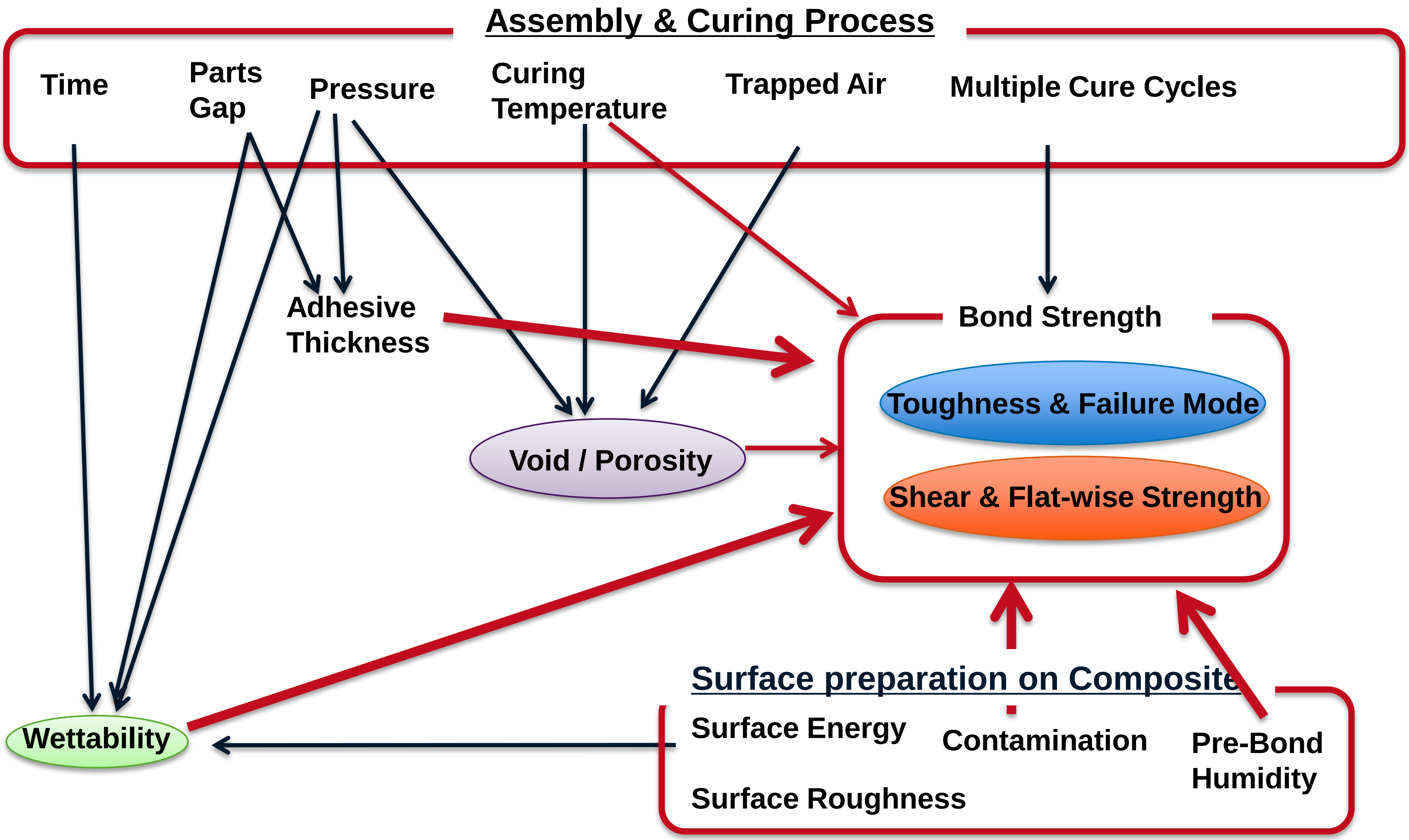


To eliminate / decrease Fastener counts using bonded technology

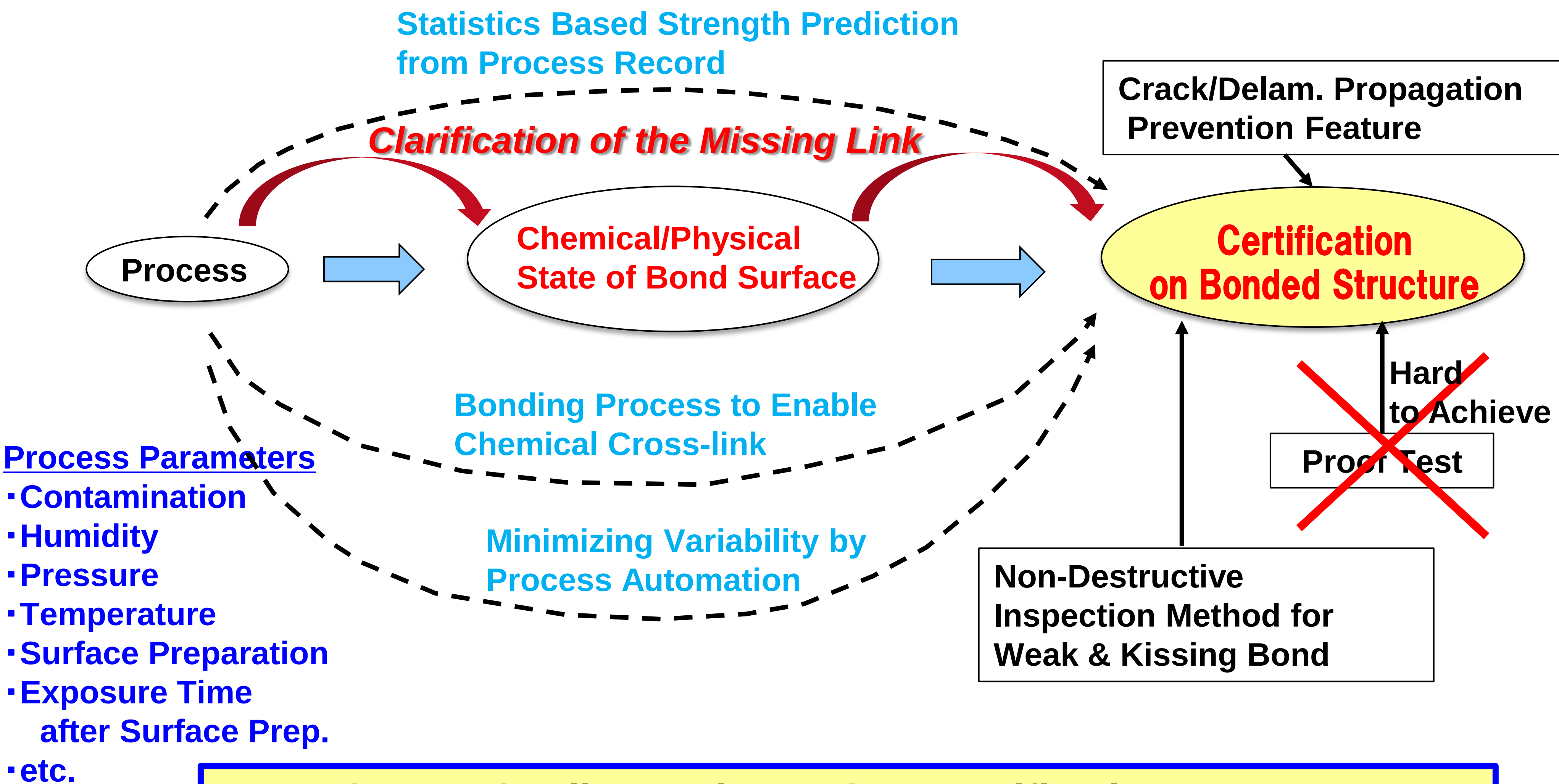
MHI Proprietary

How to achieve the Goal – Bonded Structure

Bunch of parameters affects Quality and Strength on Bonded Joints



How to achieve the Goal – Bonded Structure



Several Routs leading to the goal, or Certification.

⇒ Discuss & Find the Solution for future Aircraft !!

MHI Proprietary

Thank you for your attention !

Our Technologies, Your Tomorrow