MBD For Dimensional Quality Within a Heterogeneous Supply Chain

ARMY/NIST MBE Summit – December 13th 2011

Nick Orchard Rolls-Royce plc

Ron Snyder Rolls-Royce Corporation

Rolls-Royce today

We design, develop, manufacture and support power systems for use on land, sea and air.

Civil

Defence

Marine

Energy

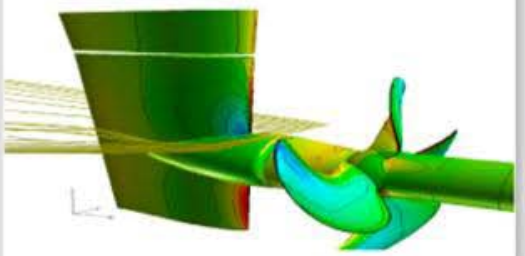
Extending our portfolio

Trent 1000 – Boeing 787

TP400 – A400M

MT30 – LCS

BR725 – G650



PROMAS

Trent XWB – A350 XWB

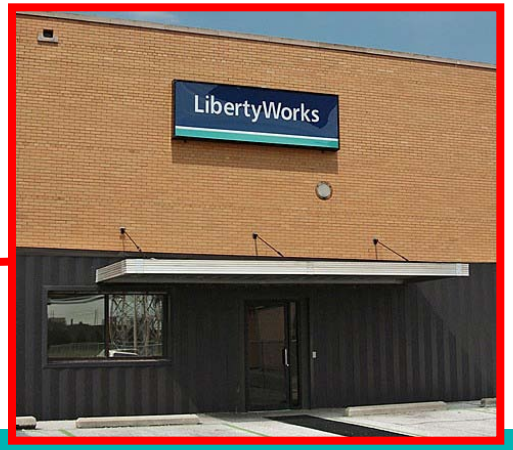
A truly global company

9000 engineers spread over 8 countries worldwide

Rolls-Royce

Rolls-Royce Indianapolis facilities

Rolls-Royce Corporation
and LibertyWorks®



RRC Engines for Military and Commercial Applications

V-22 Osprey

C-27J Spartan

Kiowa

C-130 Hercules

Joint Strike Fighter

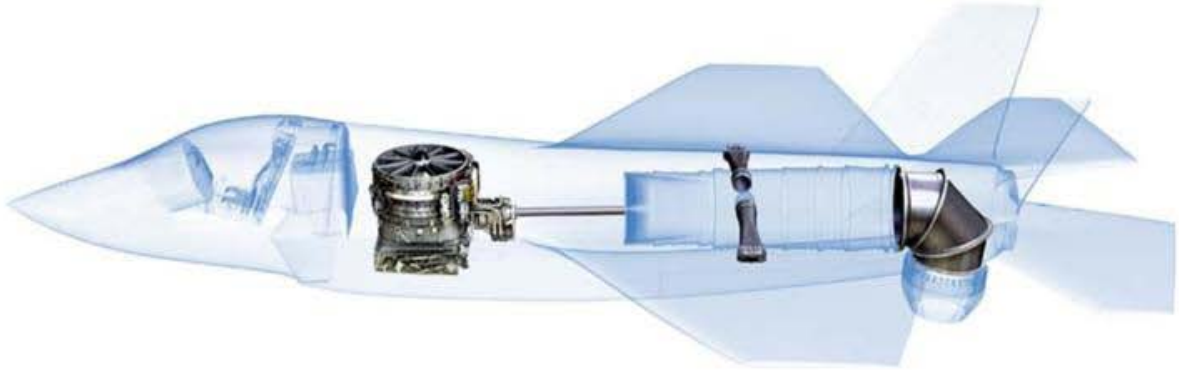
SAAB 2000

ERJ-135

RQ-4A Global Hawk

Sea King

Unique STOVL technology for JSF



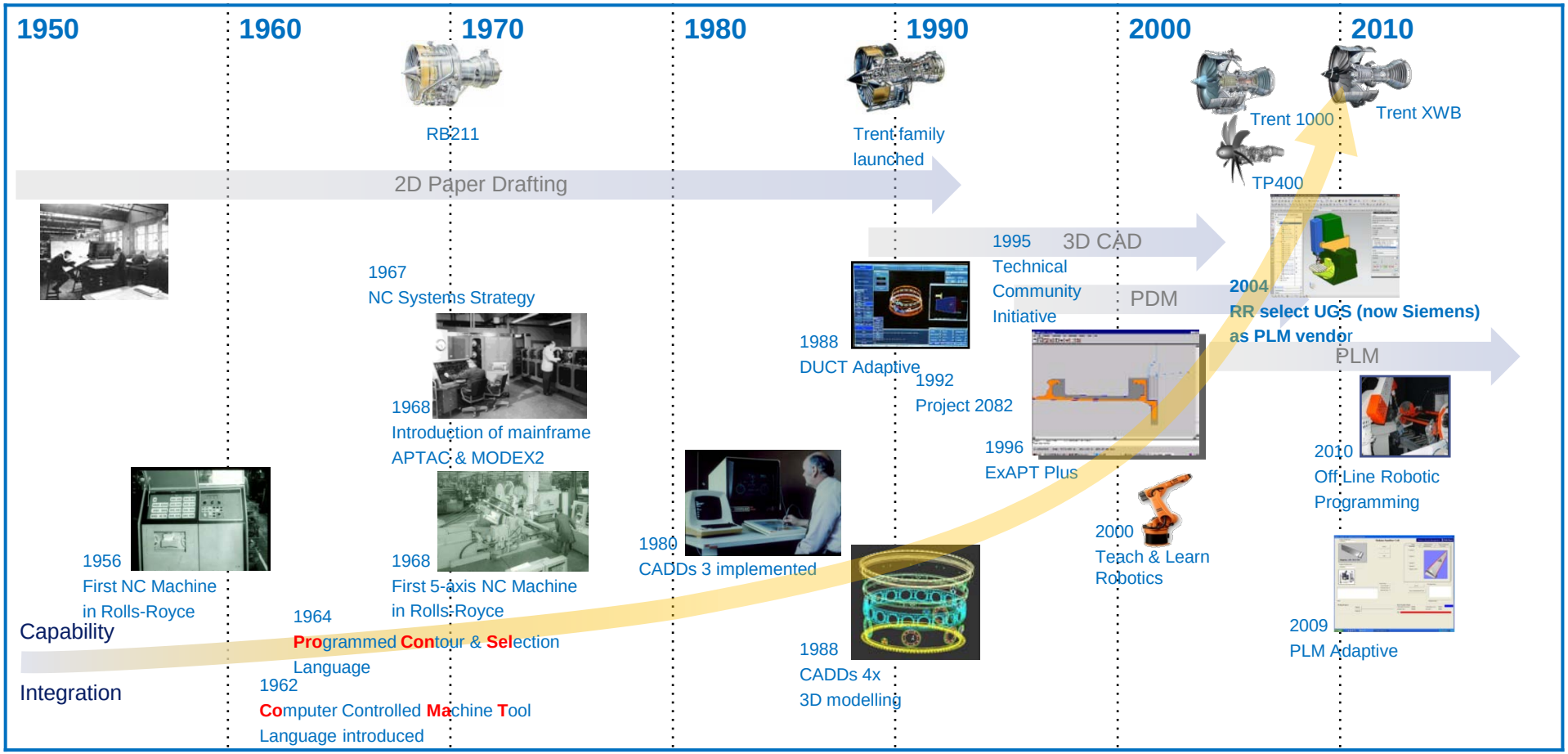
- 50 years STOVL experience
- 20,000 lbs thrust engine
- Development contract $1.5bn – Good progress
- F-35B variant (~ 450 aircraft) is expected to remain in service after 2050

Partnerships with competitors

- Pratt & Whitney – V2500
- GE F136 development
- Honeywell T800

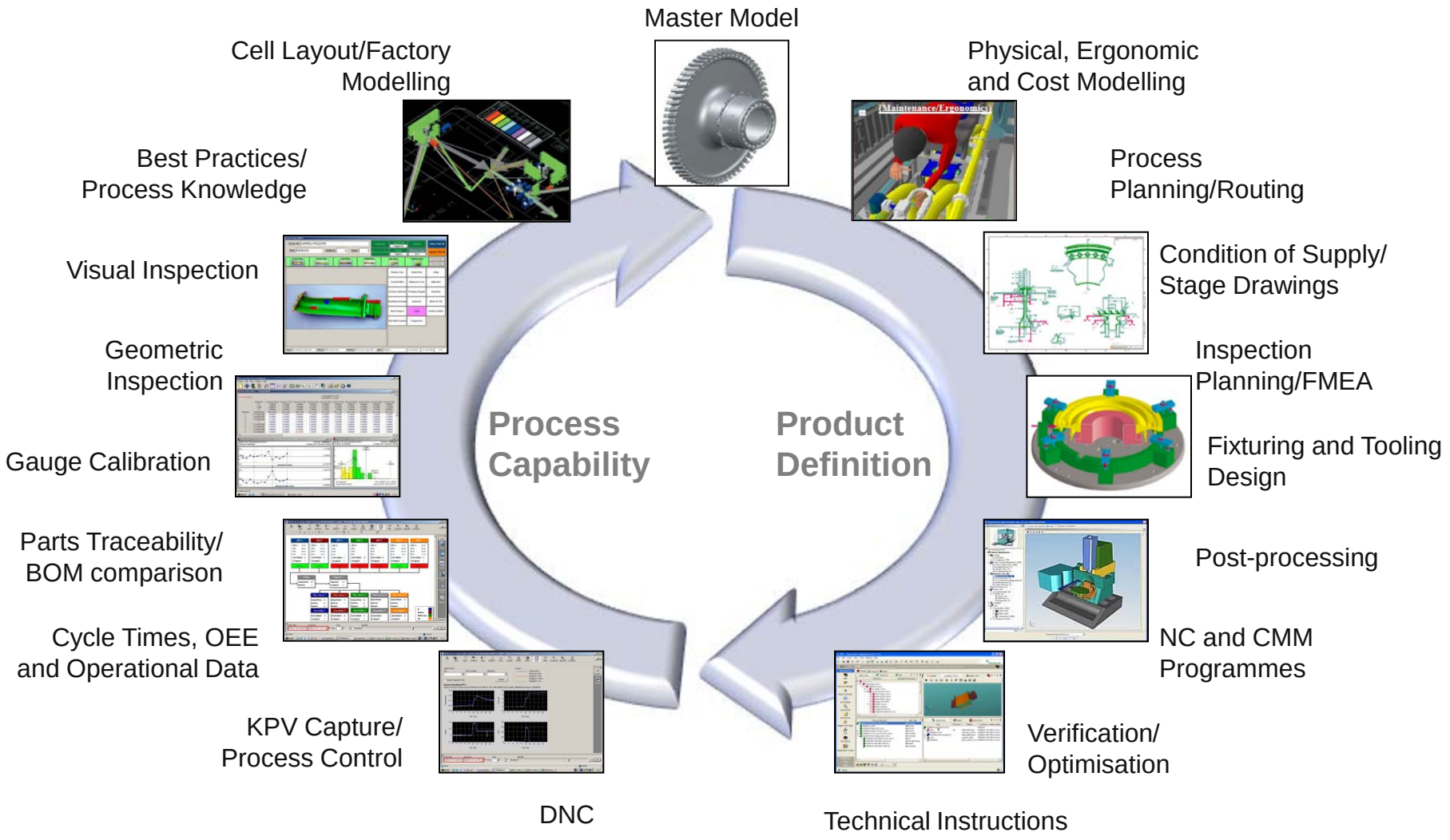
We don’t make cars

A History of CAD/ CAM – Rolls-Royce GTSC

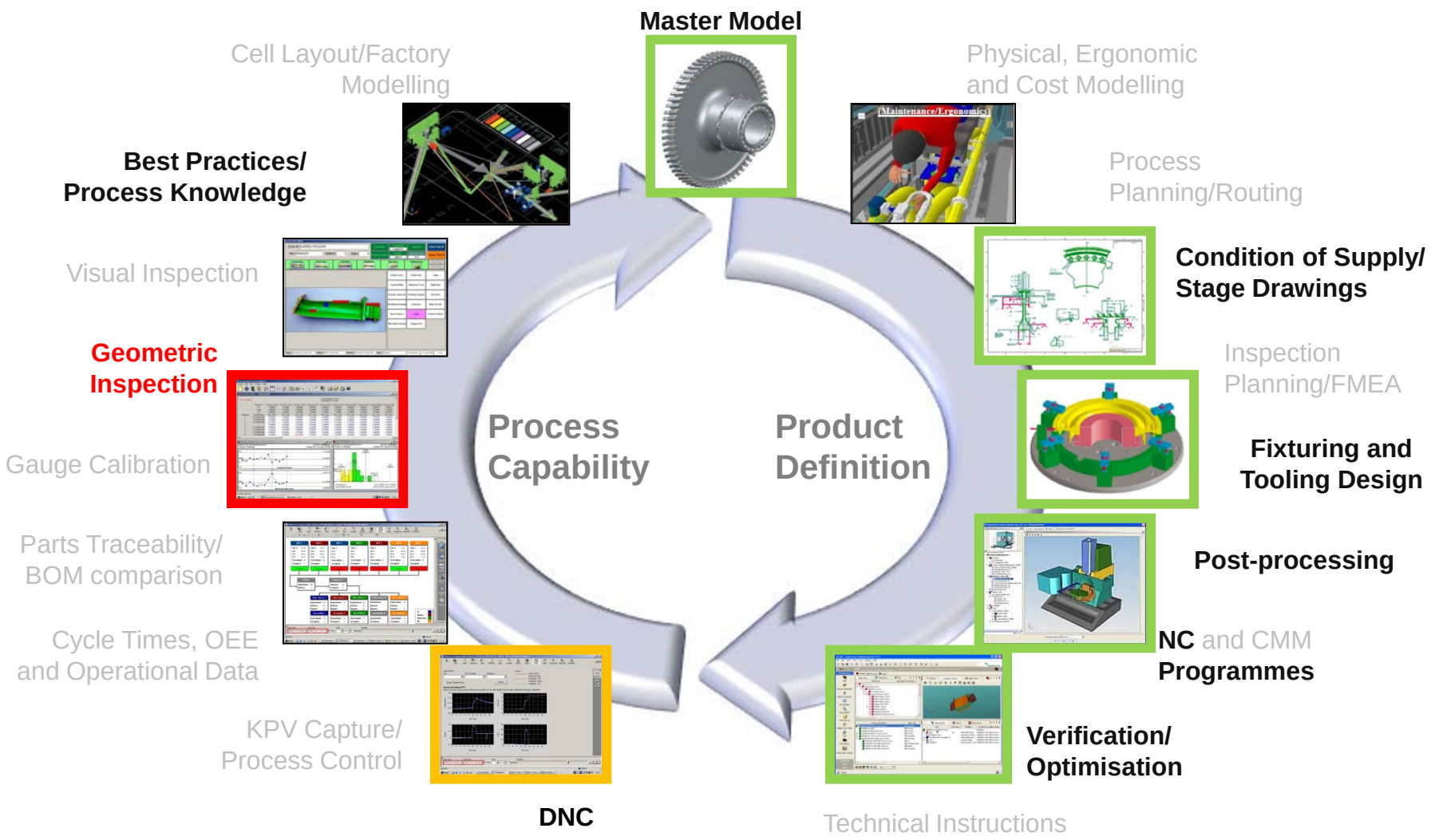


- Migration from ***"Best in breed"*** applications to ***"Fully integrated solutions"***
- Deployed solutions need to support Product Lifecycles **in excess of 25 years**

Sustainable world-class performance though cross-functional process and systems integration



How does CAM deliver the vision?

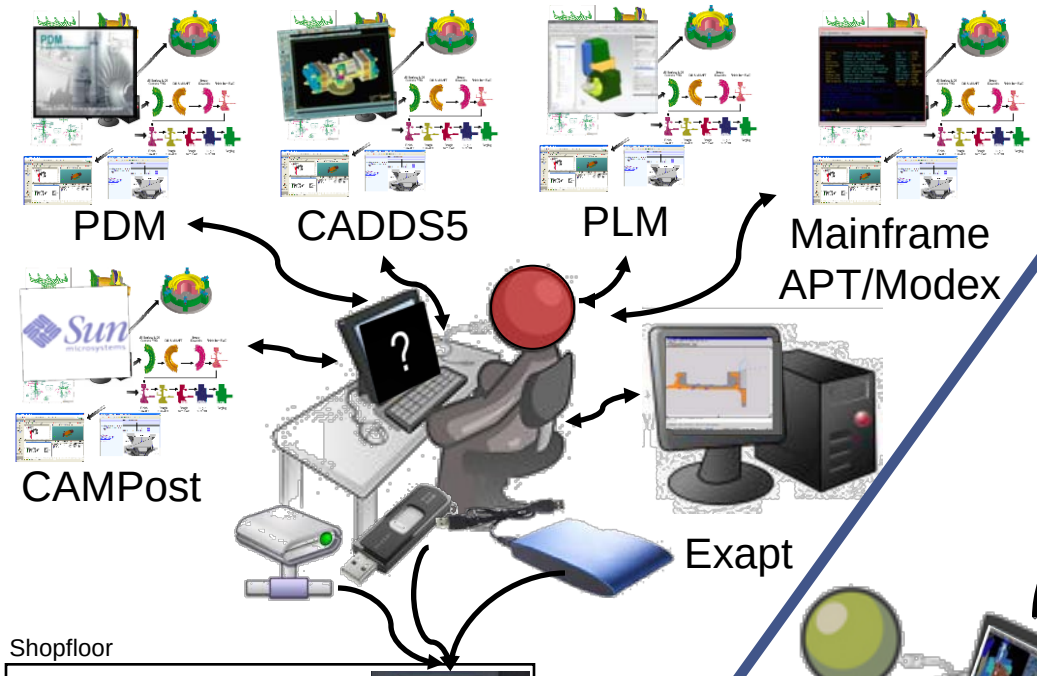


“A Day in the life of an ME”

Traditional CAM

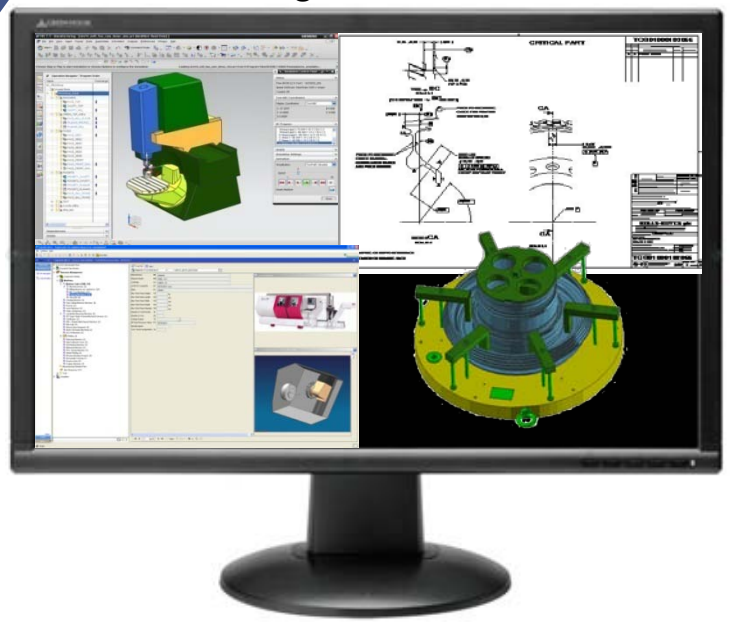
Manufacturing Engineering

Today (Example)



Tomorrow

CAM Single Environment



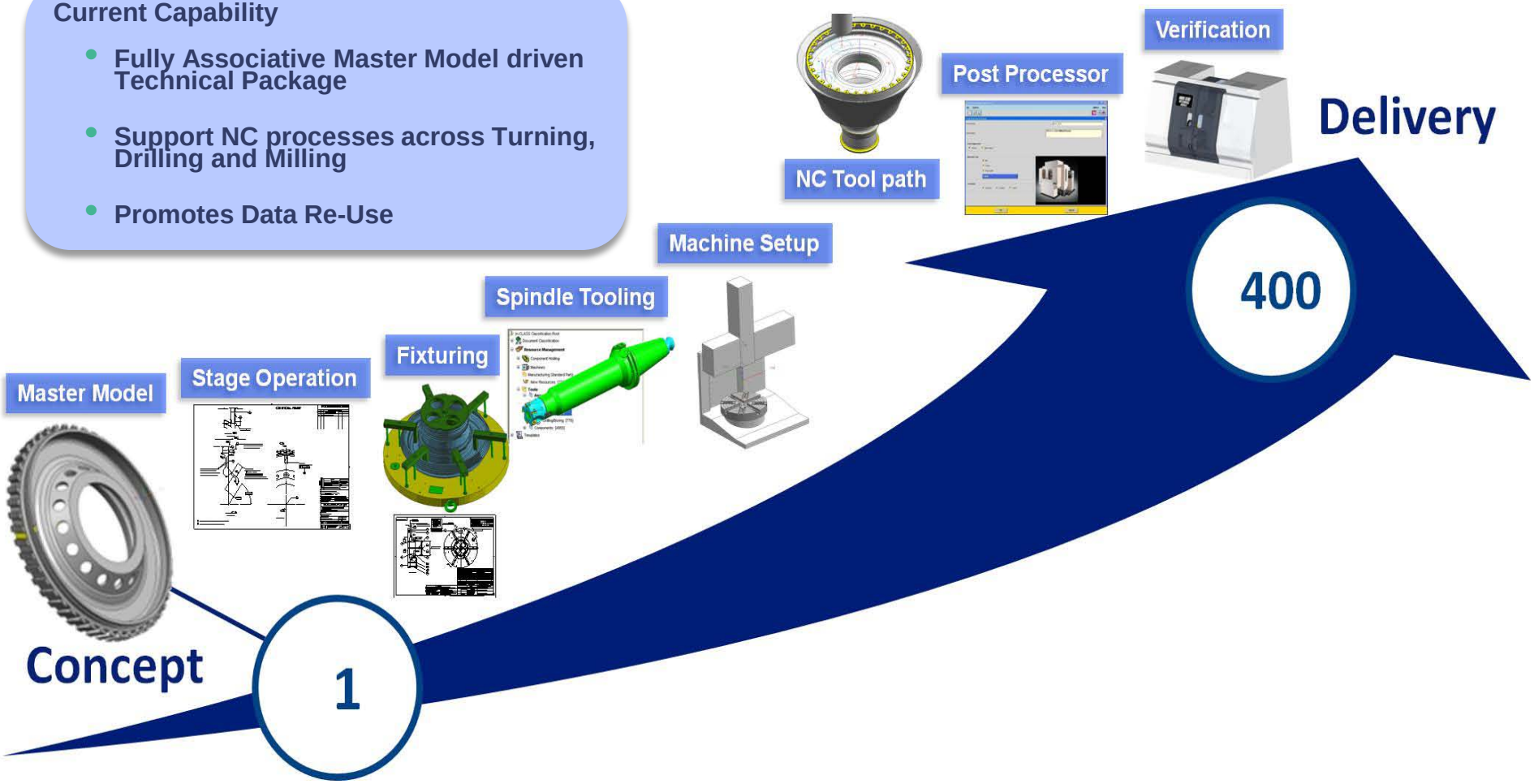
- **PLM Enablement –**
  - **ME Efficiencies**
  - **RFT**
  - **Legacy Retirement**

What is CAM Capability Development in PLM?

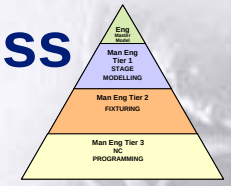
Technical Package Deliverables are authored <u>concurrently</u> and managed within the PLM environment.
This 'approach' enables the delivery of CAM (PLM) components as part of the Concurrent Engineering Process.

Current Capability

- **Fully Associative Master Model driven Technical Package**
- **Support NC processes across Turning, Drilling and Milling**
- **Promotes Data Re-Use**

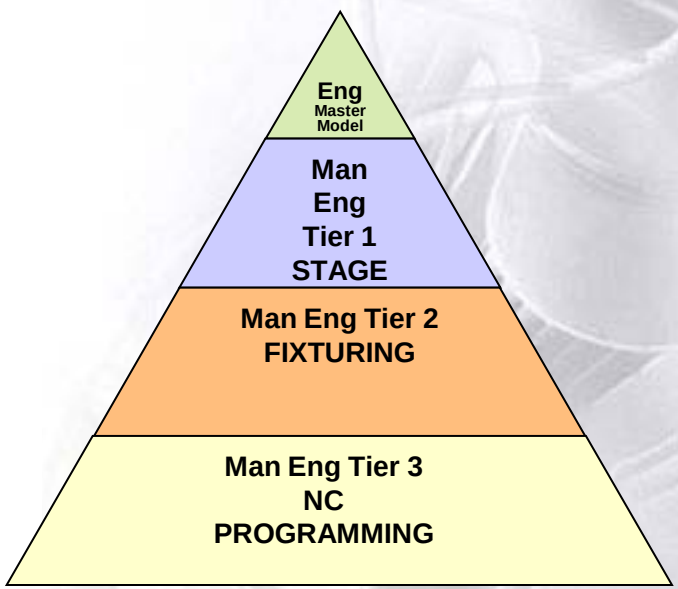


PLM ‘supporting’ R-R’s Concurrent Engineering Process



Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Innovation & Opportunity Selection	Preliminary Concept Definition	Full Concept Definition	Product Realisation	Production & Service Support	Continuing Service Support	End Of Life Disposal

New Product Introduction



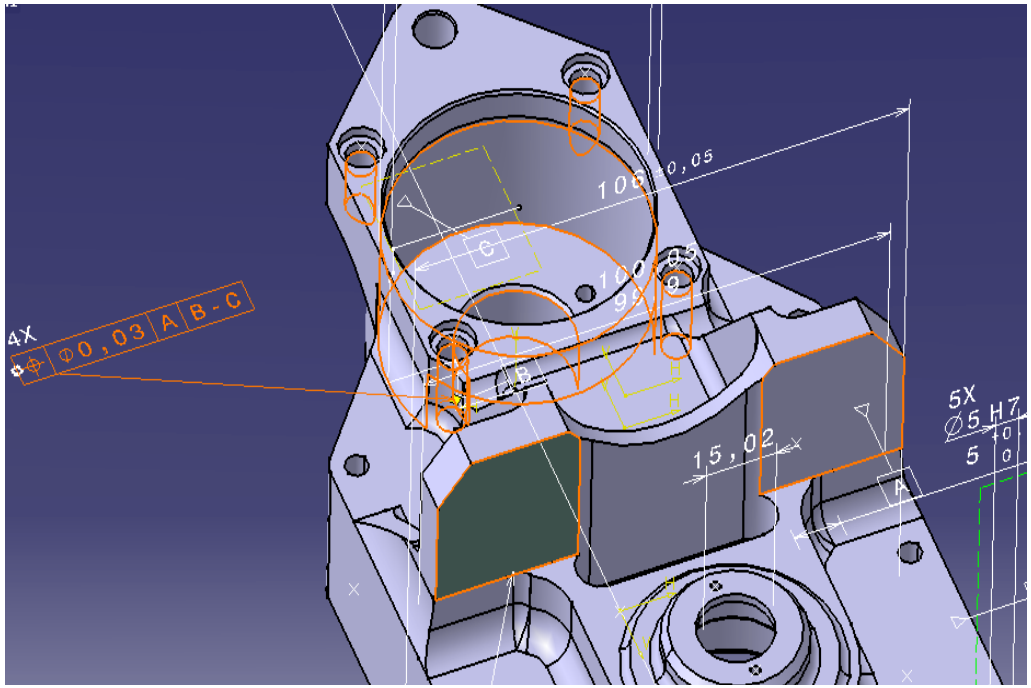
- **Definition evolves over time**
- **Downstream data content increases**

What is PMI?

- Product and Manufacturing Information is a set of annotation tools used to document products in 3D environments

- It allows definition of more useful information than is possible on a 2D drawing
  - For example, each PMI object can have associated geometry, thereby conveying information to downstream applications

- PMI objects include:
  - 3D Dimensions
  - Datums
  - Datum targets
  - Feature control frames
  - 3D annotations
  - Notes
  - Symbols
  - Geometric tolerancing
  - Security markings
  - User defined PMI
  - PMI Section Views



Manufacturing Pull or Engineering Push?

- Stage Inspection
  - Manufacturing Engineering Populate Model
- Machining Knowledge Editor (CAM) utilises PMI to aid feature recognition and recommend cut strategy
- Final Inspection
  - Engineering Populate Final Definitive Engineering Master
  - Manufacturing Engineering extract for:
    - FAIR
    - IPC
    - CMM Program
    - SPC and Process Excellence

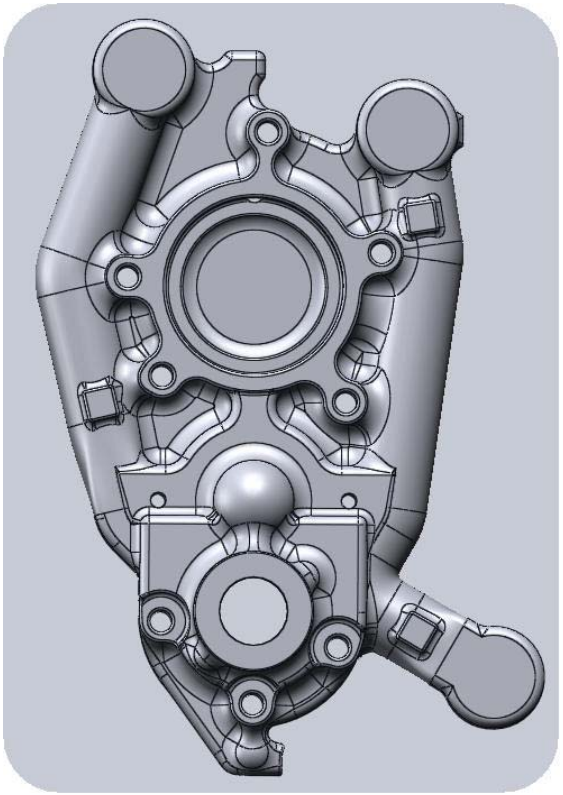
CAD Models - Can one size fit all?

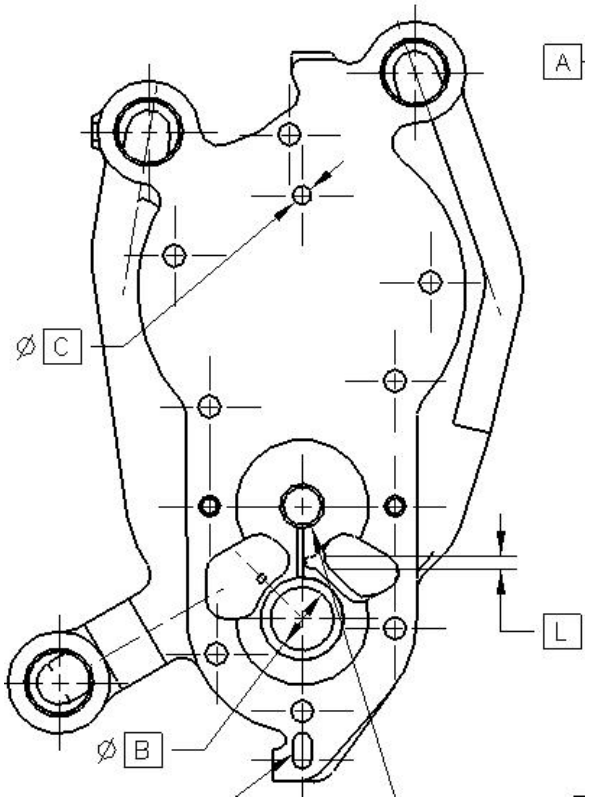
- As built or in-process Manufacturing dimensions don't always match Design Model

- Design models must be built with Stress Analysis and Manufacturing in mind
  - Analysis doesn't like included Blends and Radii in the CAD Model
  - CNC programmers and Quality Engineers do!

Populated CAD Models

- Design Perspective





- Dimensions
- Tolerances
- GD&T
- Datums
- …

Populated CAD Models

- Manufacturing Perspective

- Casting Pads
- Primary Datum
- Secondary Datum
- Tertiary Datum

Populated CAD Models

- 3D Scanning Perspective

- Optical or Scanning CMM
- Point Cloud Data
- Is it valid?
- Density?
- Standards?

Populated CAD Models – Points to Consider

Optical Scanning

- How do we make decisions when using point cloud data?
- How do we define the “right” number of points?
- Qualification of the Optical Based Inspection Standard
- Industry Lack of Optical Based Inspection Standard
- VDI/VDE are still a CMM Based Spec.

Populated CAD Models – Points to Consider

Models

- Complete/Released
  - Design
  - Stages of Manufacture
  - Dimensionally Toleranced
  - Validated for all uses
- Configuration Management
  - Naming Convention
  - Feature Identifications
  - Revision Control
  - Model Ownership
- Knowledge Capture and Management
  - Standard Features
  - Standard Processes

GD&T

- What Level Imbedded
- Stack up and tolerance checks
- Repeated Features