PLM as the Foundation of the Digital Thread

Connecting Data, Processes, and People

With – further discussion on the Model Based Extended Enterprise

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Presented at GPDIS 2024

Parker

Agenda

- Short intro to myself and my company
- Definitions
- Models, Models, Models
- More on the MBEE
- Digital Thread
- Closing the Loop
- Benefits
- Examples
- Challenges
- Emerging Technologies
- Conclusions
- Questions (and maybe some answers)

PARKER HANNIFIN
At a Glance

~ 900,000

Products

$19.1 Billion

In Global Revenue

500,000+

Customers Worldwide

62,000+

Team Members Worldwide

Our ability to work collaboratively around the world sets us apart from the competition. We are a global business with a local focus.

Parker's Operating Groups

AEROSPACE

- Engine Technologies
- Flight Control Actuation
- Fuel And Fuel Tank Inerting
- Hydraulics And Electro-hydraulics
- Airframe And Engine Fluid Conveyance
- Braking Systems

ENGINEERED MATERIALS

- Sealing And Shielding
- Thermal Management
- Adhesives And Coatings
- Vibration Control
- Engineered Composites

MOTION SYSTEMS

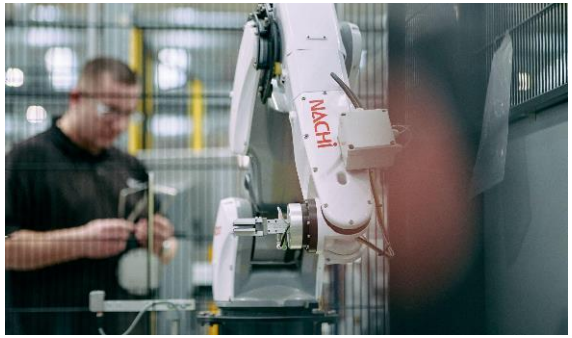
- Hydraulics and electro-hydraulics
- Pneumatic
- Electromechanical
- Components and systems

FILTRATION

- Engine And Mobile
- Hydraulics And Lube
- Industrial Air
- Process And Water Platforms

FLUID CONNECTORS

- Hose And Tubing Assemblies
- Fittings
- Quick Couplings
- Connected Products And Diagnostics
- Process Fittings, Valves And Manifolds
- Refrigeration Flow And Climate Control
- Precision Fluidics Pumps And Valves




PARKER AEROSPACE
BUILDING ON INNOVATION

PARKER AEROSPACE + MEGGITT

$5.47 billion*+
annual sales

12 divisions

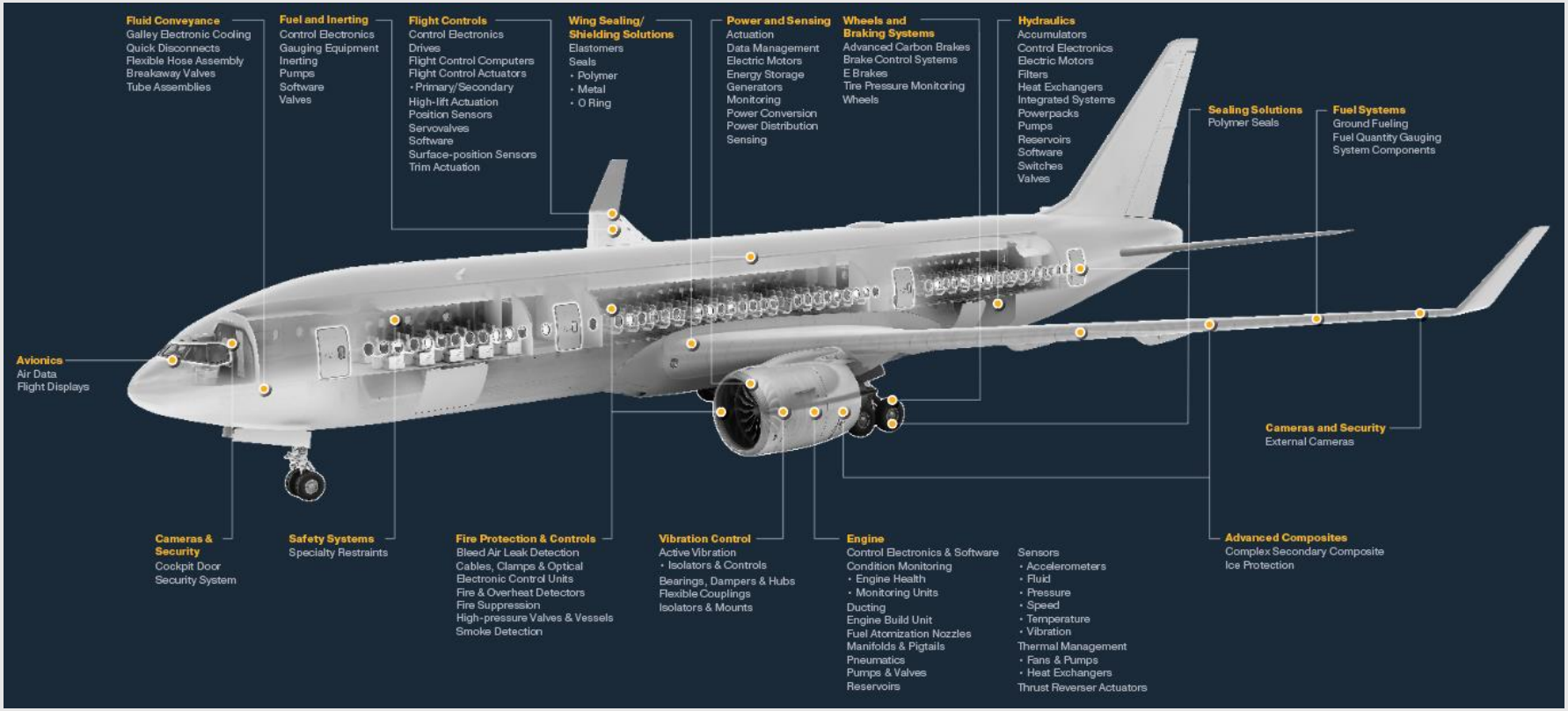
Five
joint ventures

12,200+
employees

Parker

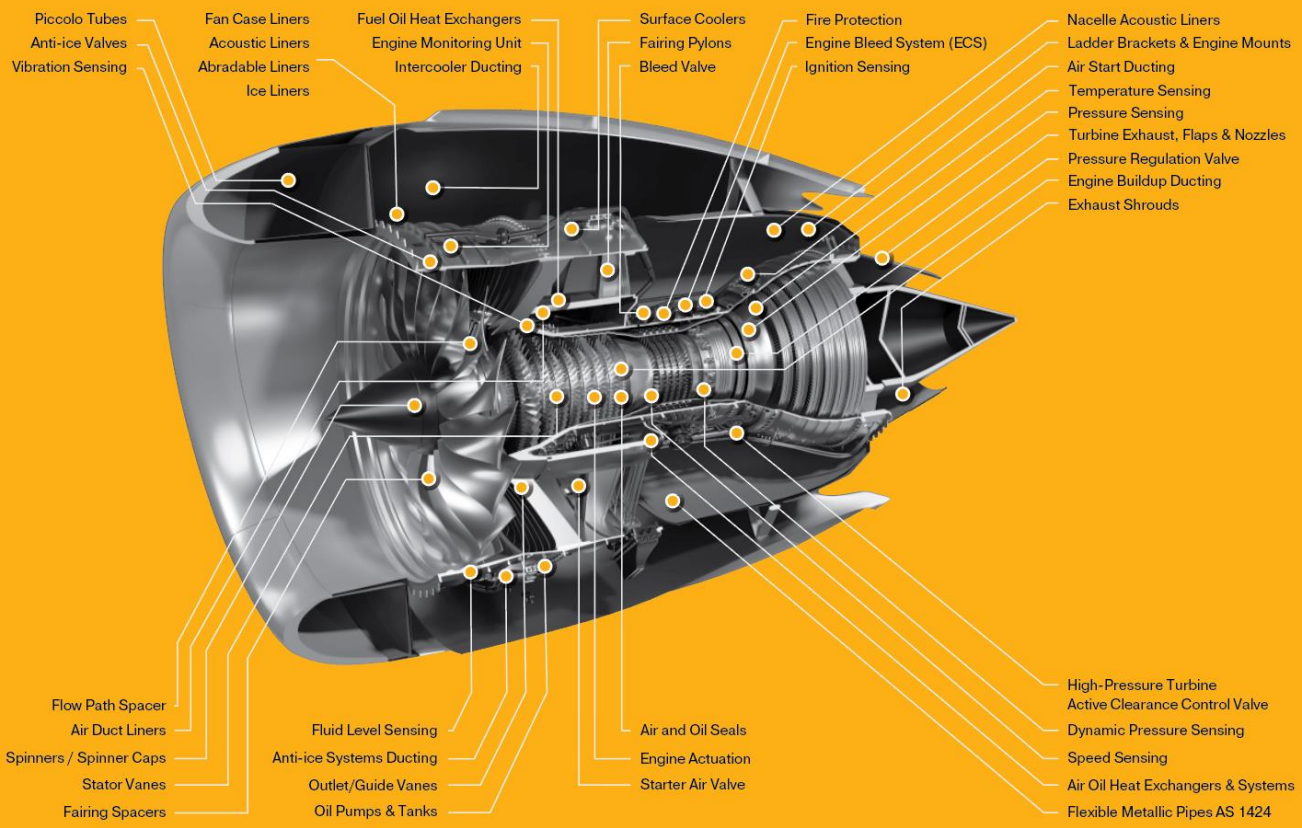
NOSE TO TAIL

An expanded portfolio of products and services



COWL TO CORE

Innovative solutions powering the future of flight



SERVING THE WORLD'S AEROSPACE LEADERS

And, a little about me

- 44 years at Parker
  - All supporting engineering and other functions for IT (fka IS, MIS, DP)
  - Participant at GPDIS since ~2007
  - GPDIS Executive Board since 2011
  - Past president COE
  - First member COE Hall of Fame
  - CAD Society Joe Greco Award Winner
- Most importantly
  - Married 46+ years
  - Two adult children
    - (FO at American and Stem Academy Lang. Arts Dept. Chair)
  - The best two grandchildren ever – there is no debate!
    - Hockey player and equestrian

Definitions – interactive!

- PLM –
  - Product Lifecycle Management from Birth to Retirement
- Digital Thread –
  - Digital framework to connect data, processes, physical across lifecycle
- MBSE –
  - Model Based Systems Engineering
- NIST
  - National Institute of Standards and Technology

Definitions – interactive!

- MBD –
  - Model Based Design
- MBM –
  - Model Based Manufacturing
- MBSS –
  - Model Based Systems and Software
- MBEE
  - Model Based Extended Enterprise
- SaS –
  - Service After Sales

Models, Models, Models

- As per the previous, MY perspective is
  - Without Models, there is no MBEE
  - Without MBEE, there is no Digital Thread
- The “digital twin” is a misnomer to me
  - EVERY Model is a twin (could be dozens – duodecoplets?)
  - MUST relate to the physical
- Therefore – SaS *must* be part of the Digital Thread

More on MBEE

- Collaborative framework
  - Leverages digital models and simulations
  - Enhances communication, coordination, and decision-making
  - Across the entire ecosystem
  - Involving all stakeholders in a product's lifecycle

This includes not only internal teams but also external partners, suppliers, and customers.

Digital Thread

(Again, my opinions throughout)

- Requires Models to be successful
- Requires ‘connection’ to end items
  - Typically serialized end items, not each component
- Requires feedback from Physical to Digital
- Must therefore “close the loop”

Closing the Loop

Shipment of a ‘serialized end item’ cannot be the end of the lifecycle

The digital “as built” model needs updates from the field

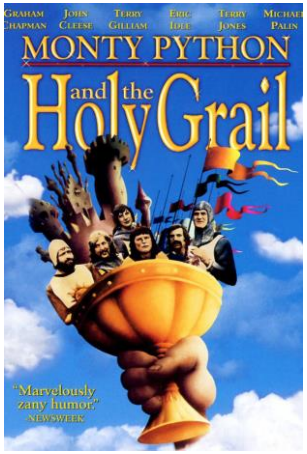
Model-based Service after Sales

The digital “as designed” model needs updates from the field

Reliability, serviceability, upgradeability

Benefits of PLM as the Digital Thread Foundation

- Improved collaboration beyond engineering



- "Single Source of Truth" – the holy grail
  - Bringing together the digital and physical
  - Data integrity is improved
  - Common, streamlined workflows
  - Modern PLM – dynamic collaboration
  - Real-time data – during fabrication and use

- Improves regulatory compliance

Examples

- Automotive industry
  - Leveraging PLM to increase supply chain collaboration
  - Common platform for vehicle and purchased systems development
  - Manufacturing models tied to Manufacturing Execution
  - 20-30% reductions in SC cost reported

Examples

- Aerospace (company must remain nameless)
  - Moved from “first gen PLM” to modern PLM
  - Reduced development cycle on PCBs by 30%
    - Increased design turns by 2x in reduced timeframe
  - Incorporated fabrication supplier into design
    - Able to create Manufacturing Model concurrently with Design model

Challenges

- Legacy of technology
  - Design tools used for 30+ years
- Standards are not mature
  - “Software tools will deliver the standards”
- IP Protection in the Extended Enterprise
  - Who owns the ‘operating data’?
  - Competitors on same ‘system of systems’
- Closing the loop is not so simple
  - Petabytes of data – how does it help?

Emerging Technologies

- Artificial Intelligence
  - Can it safely “close the loop” back to design?
  - Can it improve virtual testing to equal physical?
- Generative Design
  - Faster modeling, but slower manufacturing?
- IoT
  - LOTS of data (orders of magnitude)
  - Can modern PLM handle this?

Conclusions – governance is key

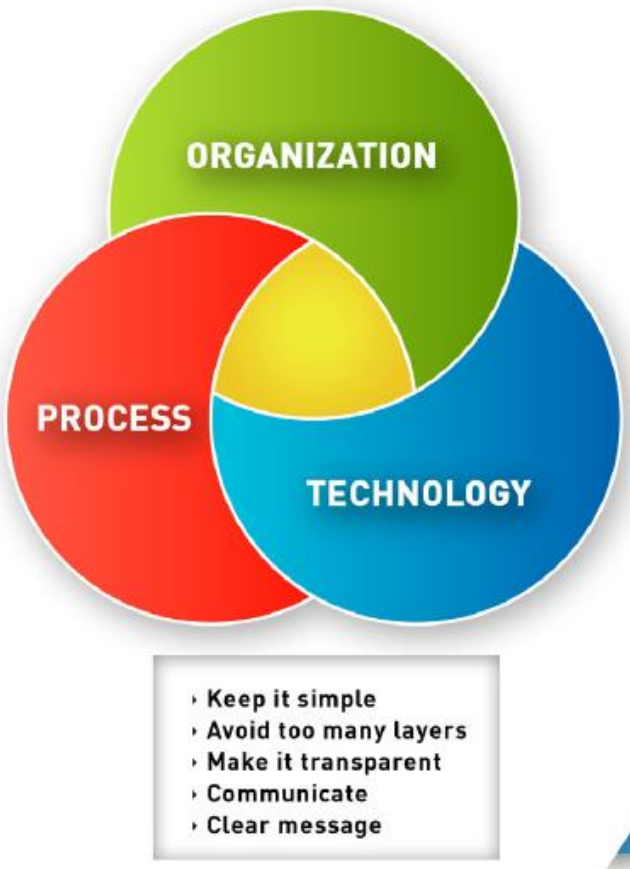
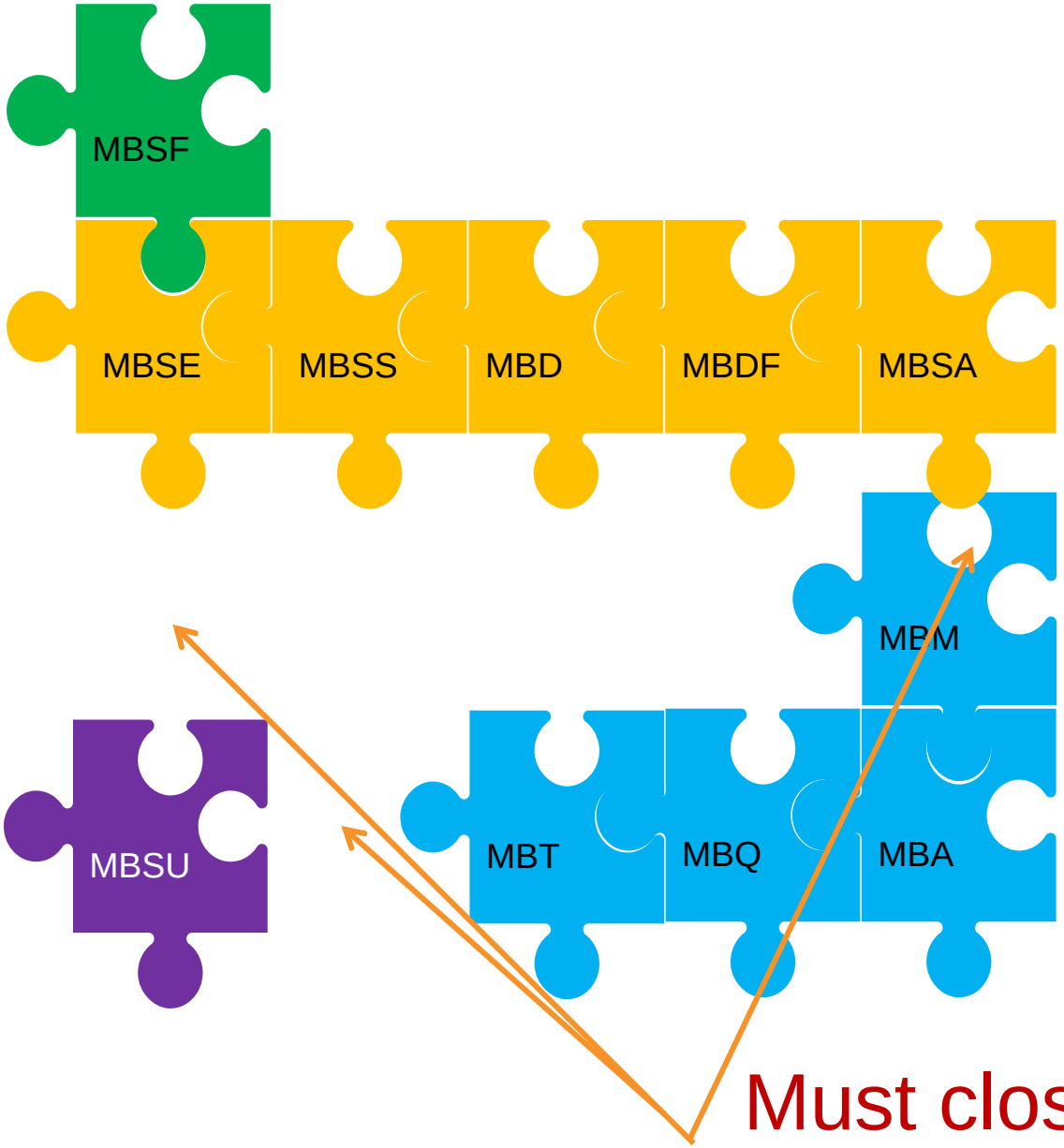


Figure 6: Proper governance is essential

Thanks to SMS Thinktank for this graphic

Conclusions

- PLM, far more than ERP, provides the platform for Digital Thread
- ERP, MES/MOM must participate
- Data ownership as flows through Extended Enterprise must be ‘portable’
- Physical twin state and operations must be used to ‘close the loop’
- **Culture of collaboration to break down the walls**



SF – Safety
SE – Systems Engineering
SS – Systems & Software
D – Design
DF – Definition
SA – Simulation & Analysis
M – Manufacturing
A – Assembly
Q – Quality
T – Test (Physical)
SU - Sustainment

Must close these gaps

Questions & Feedback

No answers promised! (I probably have more questions than you!!!!)


рахмат
danke
謝謝
ngiyabonga
teşekkür ederim
Баярлалаа
mersi
kia ora
barka
welalin
spas
tack
mahalo
tapadh leat
спасибо
faafetai lava
vinaka
спасибі
blagodaram
dank je
misaotra
matondo
paldies
grazzi
gracias
хвала
kiitos
dankie
nanni
nandri
dhanyavad
mauruuru
köszönöm
thank you
asante
manana
obrigada
tenki
bedankt
bayarlalaa
gràcie
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terima kasih
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dhanyavadagalu
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мерси
감사합니다
xièxie
ευχαριστώ
merci


Parker
Aerospace