



DIGITAL TRANSFORMS PHYSICAL

CREO UPDATE AND FUTURE STRATEGY

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PTC CAD CER

September 2022





AGENDA



23. Bayreuther 3D-Konstrukteurstag

- Industry Trends
- Creo Strategy
- Creo Futures, including Creo+

CREO CAPABILITIES THROUGH THE VALUE CHAIN



A comprehensive suite of integrated digital design, manufacturing and simulation solutions supporting the needs of designers, engineers and downstream users throughout the product lifecycle.

- 2D & 3D Concept Design Tools
- Parts & Assembly Modeling
- Automatic 2D Drawing Creation & Update
- Fully Semantic Model Based Definition
- Multi-CAD Collaboration & Data Exchange
- Assembly Management & Performance Tools
- Parametric & Freeform Surface Design
- Sheet Metal Part Design Tools
- Mechanism Design
- Molded/Cast Part Design Tools
- Structural Framework & Weldment Design
- Photorealistic Rendering & Animation
- Direct Modeling with Creo Flexible Modeling
- Design Reuse & Automation
- Volume Production & Mold Machining Capabilities
- Associative Mold & Die Design
- Broad Array of Simulation Technology for Engineers





INDUYSTRY TRENDS

INDUSTRY TRENDS DRIVING INDUSTRIAL DISRUPTION

Worker Shortage



Ten million manufacturing jobs cannot be filled today due to a growing skills gap, and flexible work models create new complexity.

Risk And Cost Pressure

J.P.Morgan

Global Manufacturing PMI at lowest level since 2009 due to a global disruption of demand, supply chain, and production from COVID-19.

Digital Disruption

STANDARD
&POOR'S

At the current churn rate, about half of today's S&P 500 firms will be replaced over the next 10 years.

HOW MARKET TRENDS AFFECT ENGINEERING



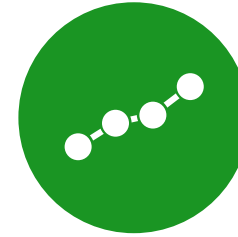
DRIVE INNOVATION

- ◇ Products require differentiation to be relevant and competitive



CLOSE SKILL GAP

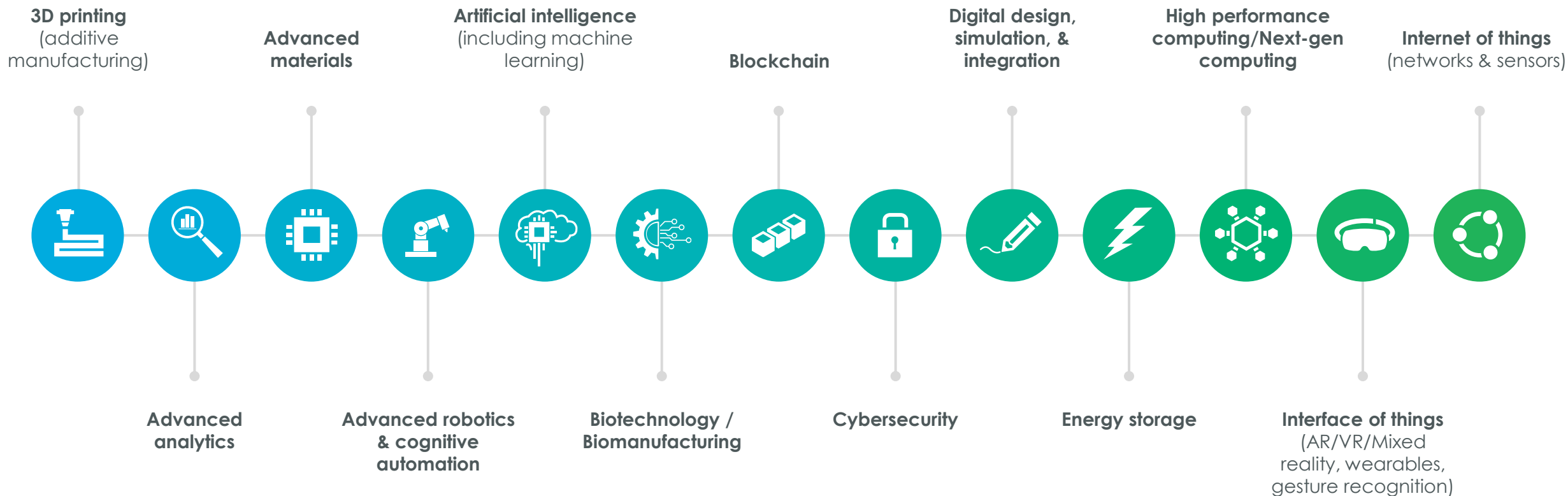
- ◇ Subject matter expertise needs to be broadly democratized across the organization to close skill gaps



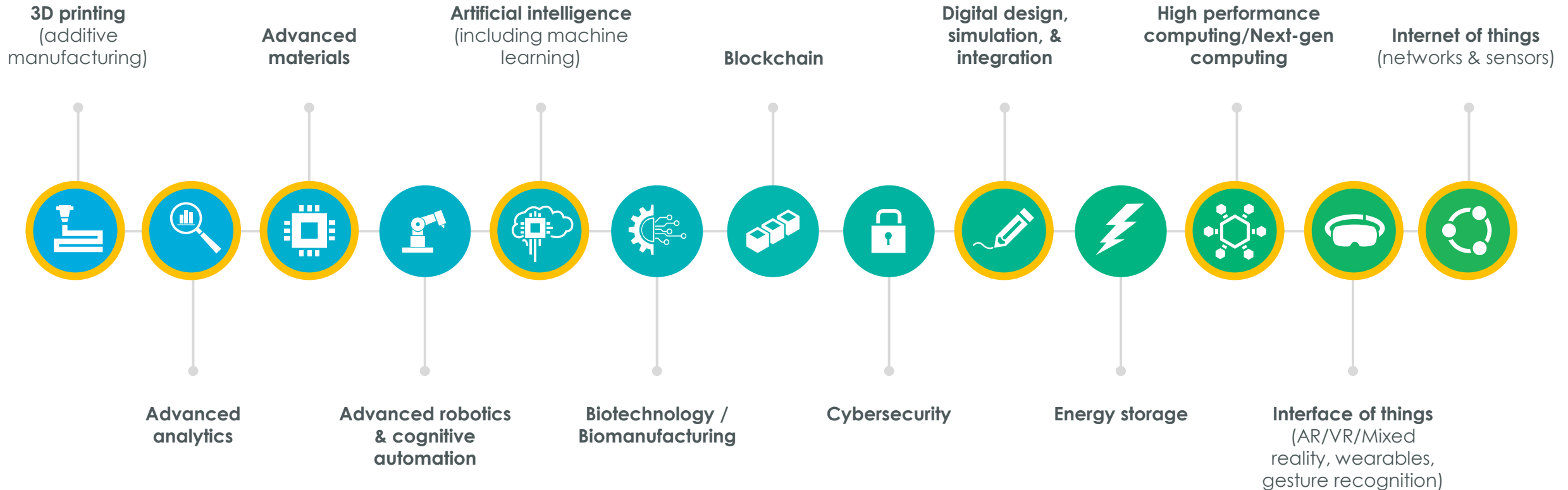
ACCELERATE TO MARKET

- ◇ Demands continue to increase and time to market remains accelerated

EMERGING TECHNOLOGIES



EMERGING TECHNOLOGIES



EMERGING TECHNOLOGIES ARE CHANGING DESIGN AND MANUFACTURING



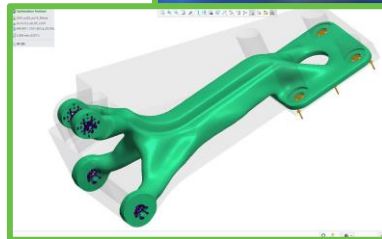
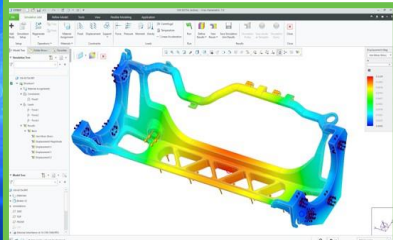
Only Creo delivers these technologies deeply integrating into the design environment...

...while delivering integral design, manufacturing & simulation capabilities supporting the entire digital and physical product lifecycle.

Augmented Reality Collaboration



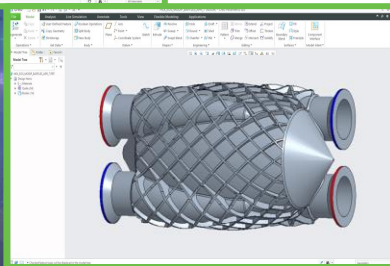
Real-Time Simulation



AI-Driven Generative Design



IoT-Driven Design



Design for Additive Manufacturing



ENGINEERING EXCELLENCE DRIVERS

Operational Impact

5-10%

Annual improvement in cost
of poor quality

20-30%

Reduction in time to industrialization

25-40%

Design cycle time

30-70%

Faster time to implement change orders

Top Use Cases

Model-Based Product
Development

Concurrent Engineering

Configuration Management

Design Innovation

Enterprise Change and
Quality Management

Simulation-Driven Design

Design for Manufacturing

Customer Success Stories

MITSUBISHI
HEAVY INDUSTRIES, LTD.

eGO

GRUPE BENETEAU



VAILLANT GROUP

Hewlett Packard
Enterprise

ROYAL
ENFIELD

DAKTRONICS



JABIL



Nidec

rexroth
A Bosch Company

Kinloskar

Medtronic

Shark | NINJA

Jacobs

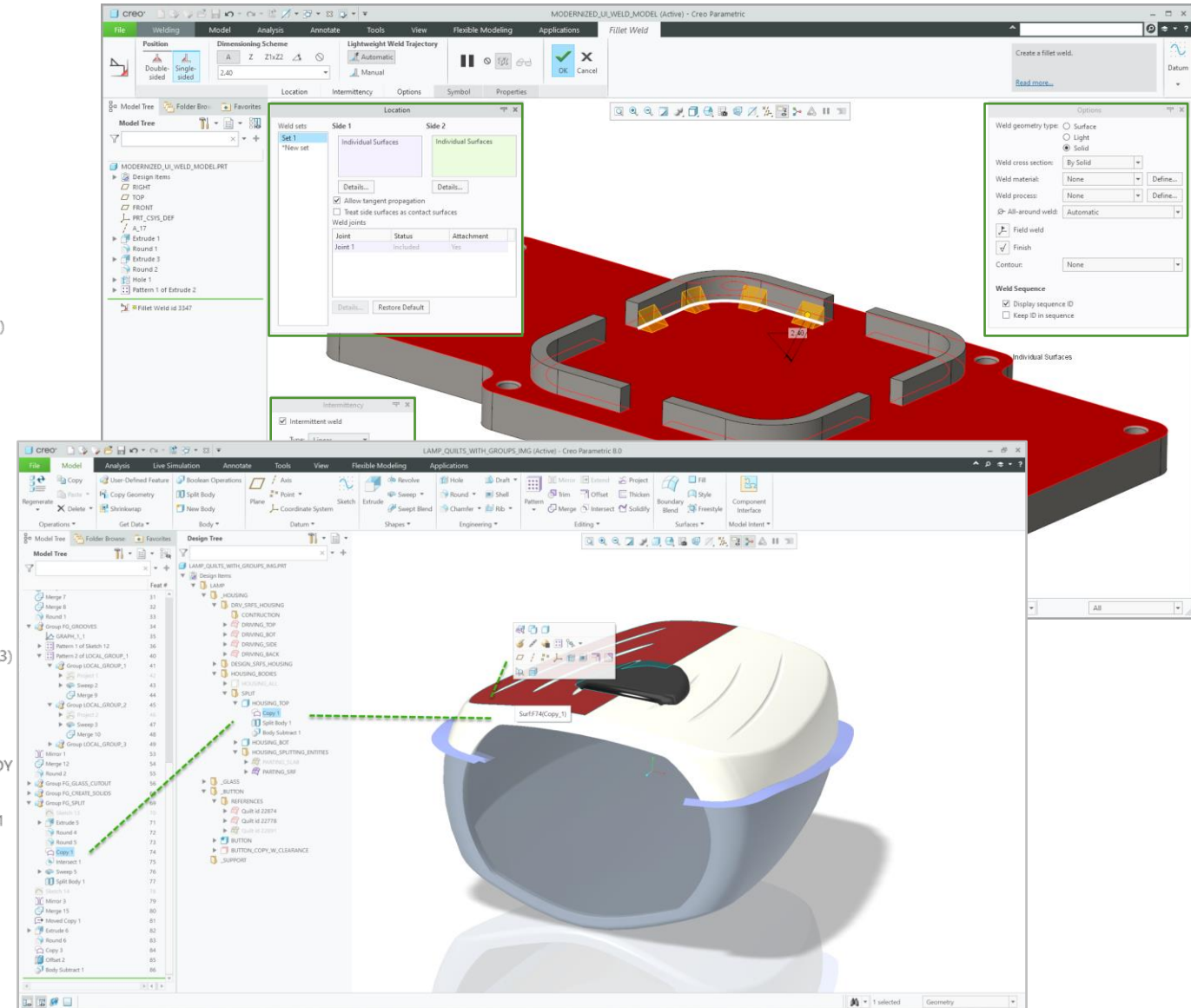
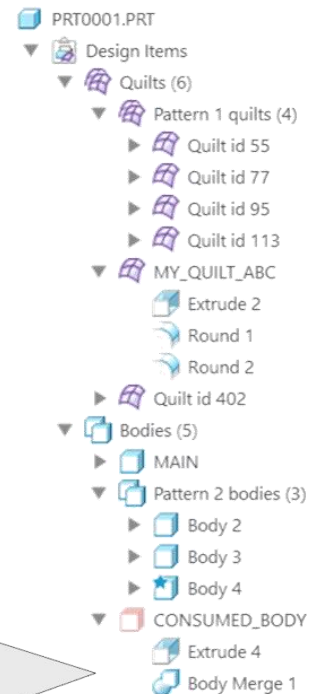
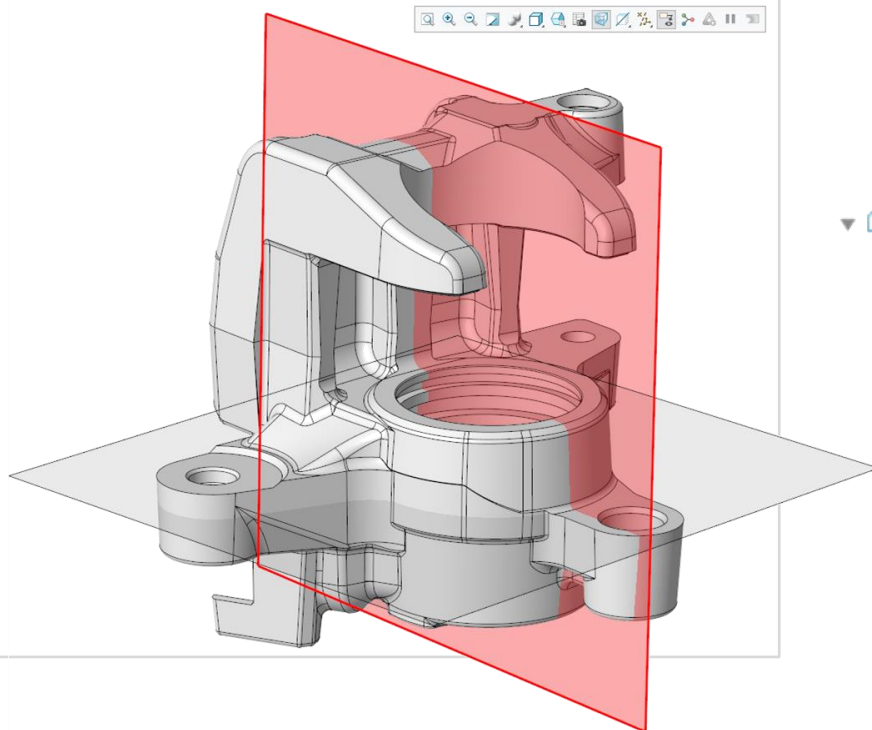
*Based on World Economic Forum, McKinsey, industry analysts reports and PTC customers' experience **Cost savings based on a 128B Euro manufacturer with approximately 7,500 employees and around 200 model variants



PRODUCTIVITY

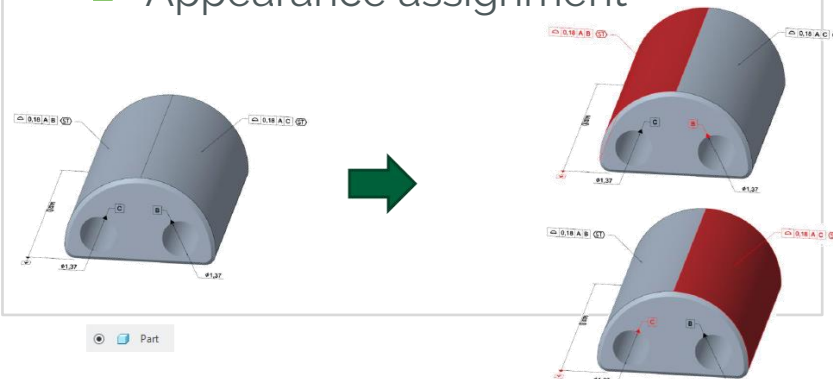
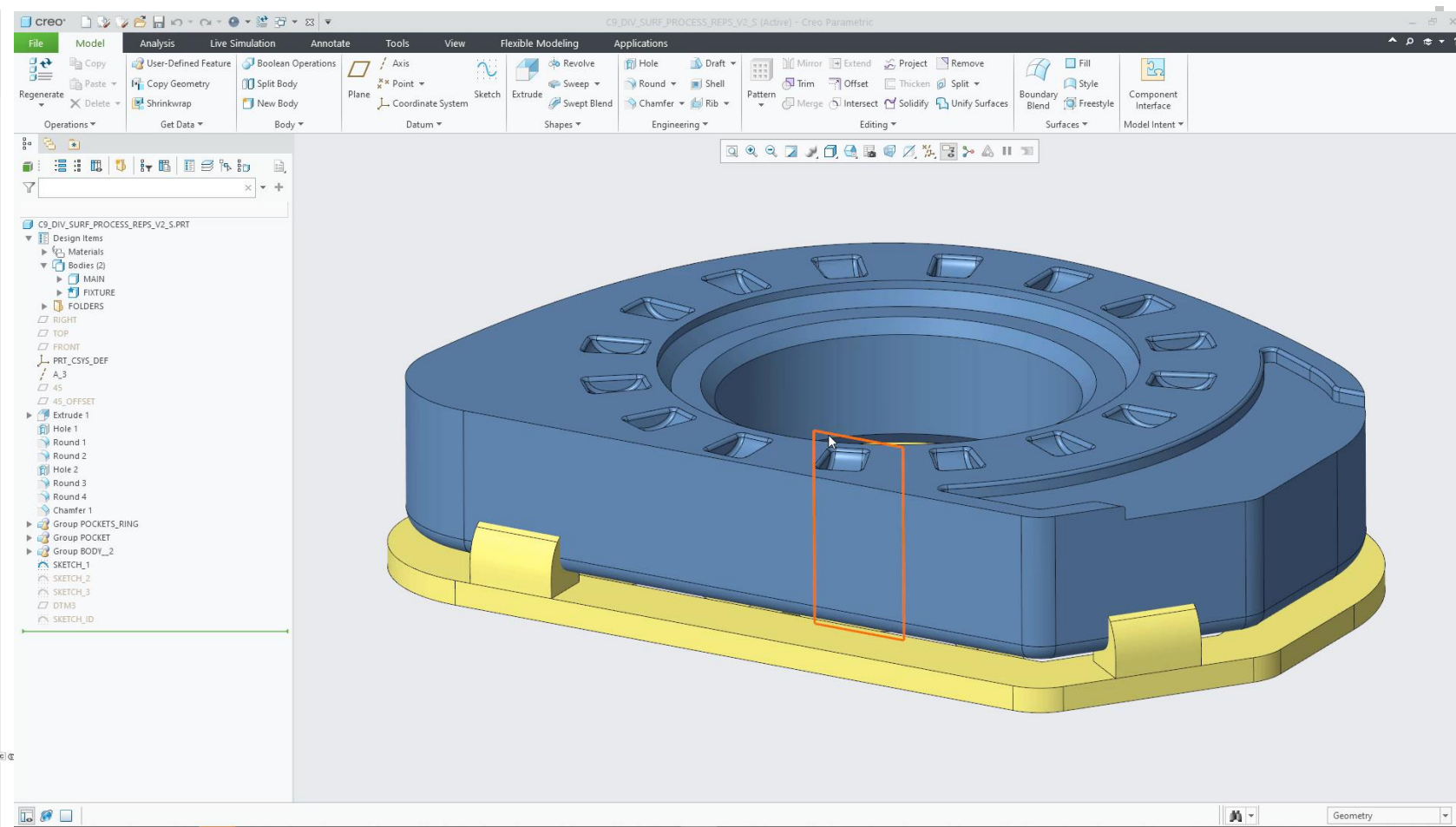
Modernized U/I

- Dashboards and Skins
- New Design Tree
- Shaded 3D Datum Plane Display



Divide Surfaces

- New **Divide Surfaces, Unify Surfaces**
- Use Surfaces as semantic references for PMI
- Leverage divide surface for following use cases
 - Simulation
 - Generative design
 - MBD
 - Geometry modification/creation
 - Appearance assignment



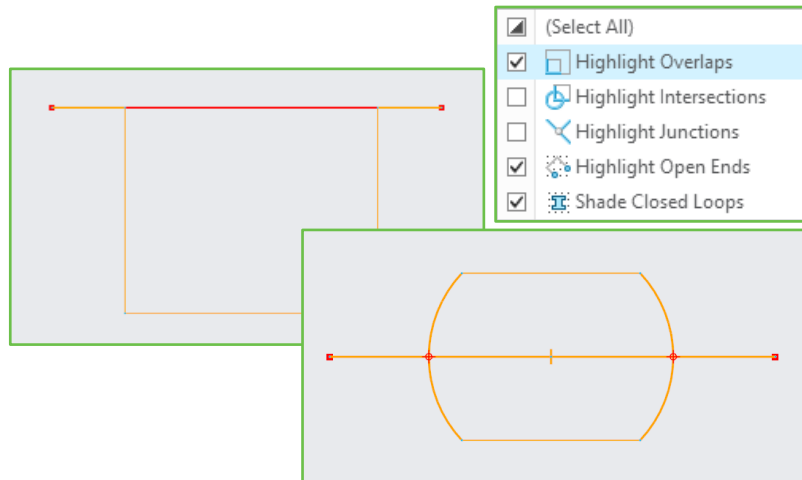
Divide surfaces to create new regions

Isolate constraints and loads to specific locations on the model

Greater control of PMI references

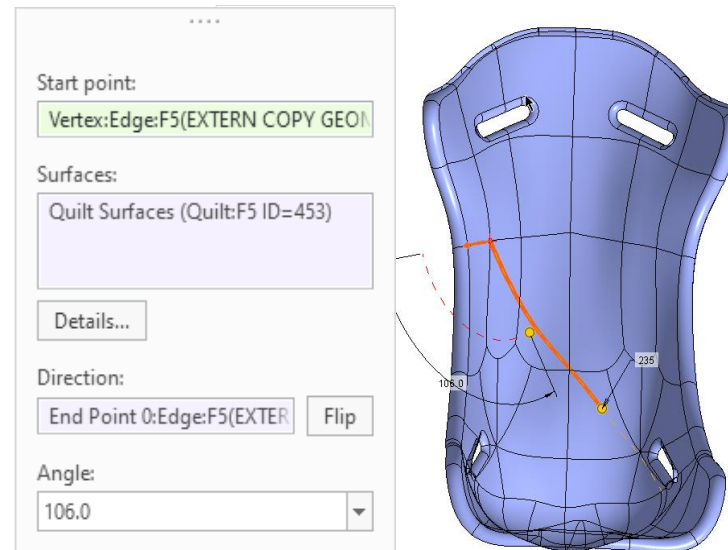
Sketcher

- Auto-scale FIRST Sketch
 - Scale sketch based upon initial modification
- Modernized project tool
- Enhanced & Enriched Inspection tools
 - Highlight intersections & junctions



Curve from point

- New functionality to define a geodesic curve on surface starting from a point and an angular direction



Patterns

- Increased Flexibility in Pattern feature
 - Dimension Pattern supports re-definition of the hole type
 - Adjustment of pattern regeneration options when required

Idea Site



Example: Geometry Fill-
Pattern of a group of features

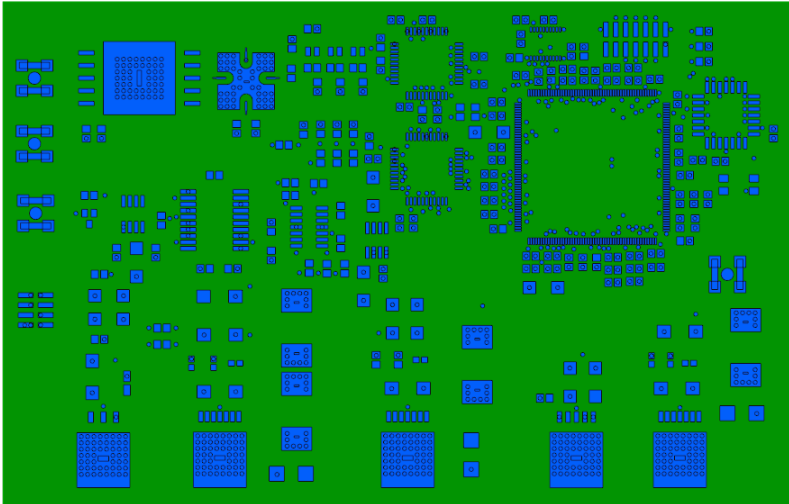
~38 sec → ~2 sec

Regeneration
Option: **General**

Regeneration
Option: **Identical**

ECAD support

- Import Silk Screen layer as ECAD context data from EDA files.
- Import Solder Masks layers as ECAD context data from EDA files.



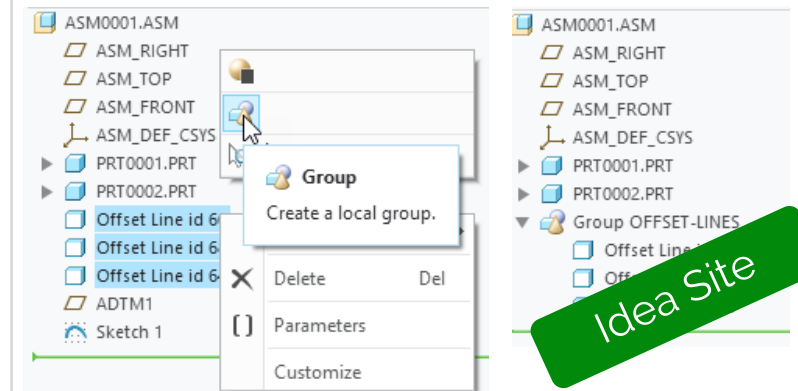
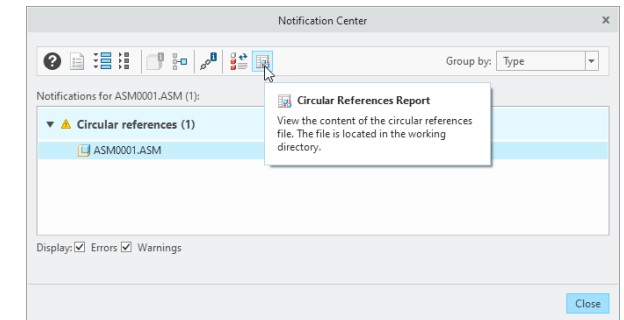
Assembly Enhancements

- Replace component with assembly
- Retrieve missing component enhancement
- Show component session IDs in model tree

Idea Site

Assembly Enhancements

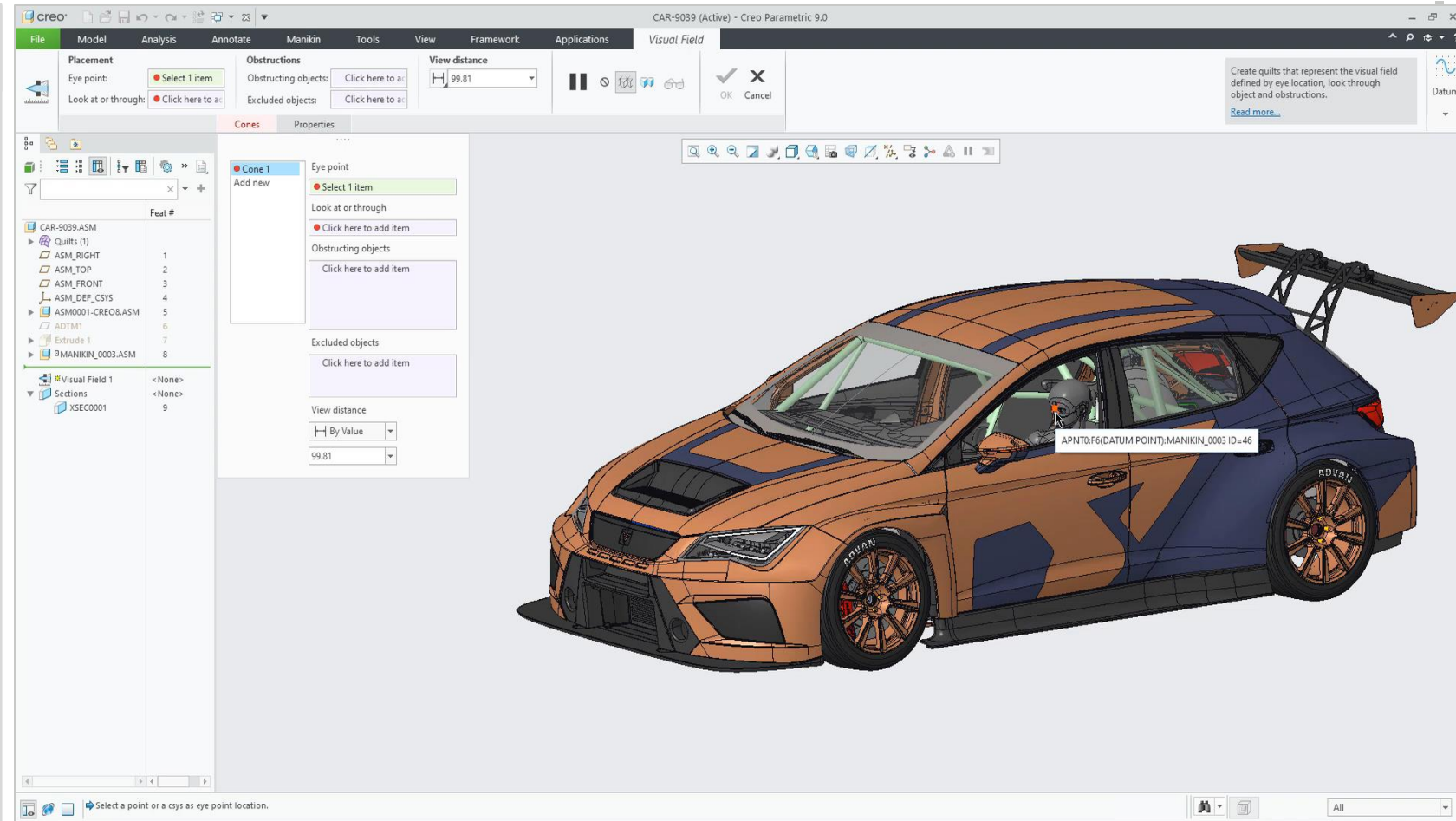
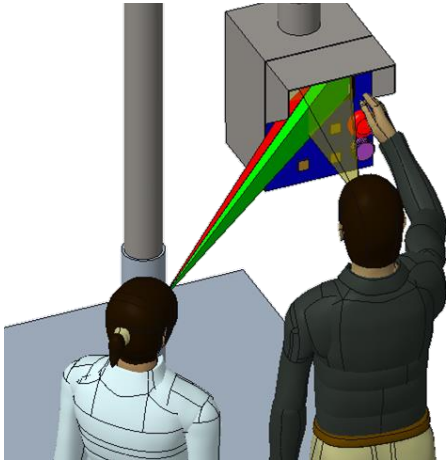
- Group exploded view offset lines
- Easier access to Circular references report



Idea Site

Safety

- **New Visual Field** feature
- Visibility cone constructed, representing the field of view trimmed by all obstructing object's
- Associative update based on the involved obstructing objects and selection



Multiple visibility cone sets
in a single feature

Better insight into resulting
field of view

Analyze model to conform
to visibility standards

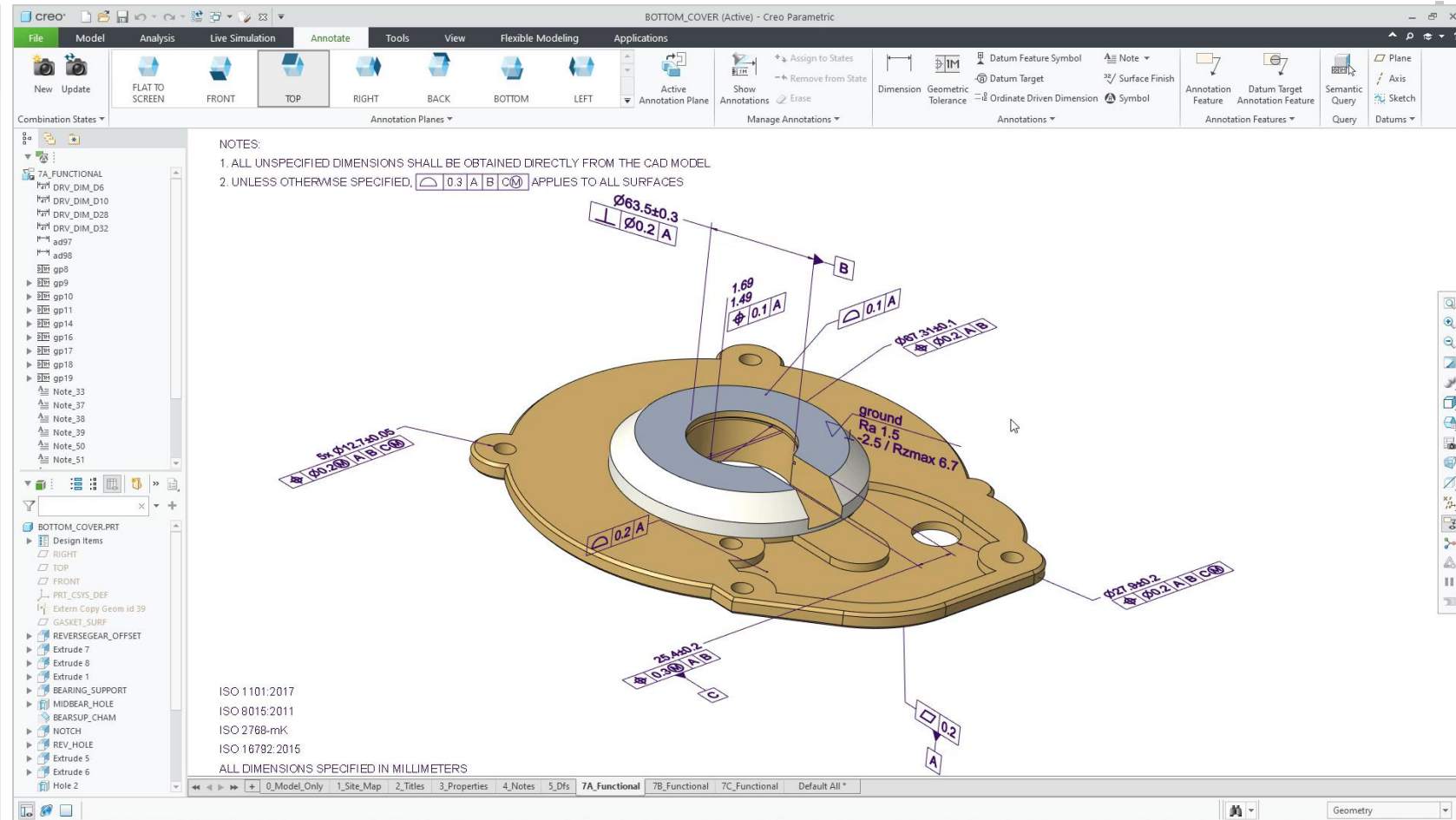
Surface Finish

- Streamlined placement & editing workflows for Surface Finish
- New gallery for surface finish symbols
- Improved surface finish customization
- Semantic support for Surface finish

Ground and honed X
S-L 0.008-2.5 / Sq 0.7
S-F 0.008-RG2.5 / Sa 0.5

Ground
-0.8 / Ra 3.1
U -0.8 / Rz 18
L -2.5 / Rz 6.5

Milling
0.0025 - 0.8 / Ra 0.2 - 0.43 / n=5
0.0025(G) - 0.8(G) / Rpk 5 / 0.37 / n=5
0.0025 - 0.8 / Rpm 0.5 / n=5
0.0025 - 0.8 / Rpm 0.14 / n=5
0.0025 - 0.8 / Rmr (5.0%, 2.0) / 70% min / n=5



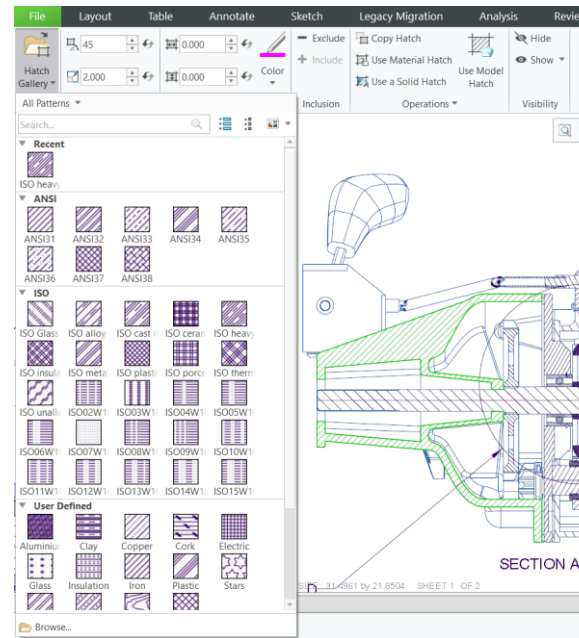
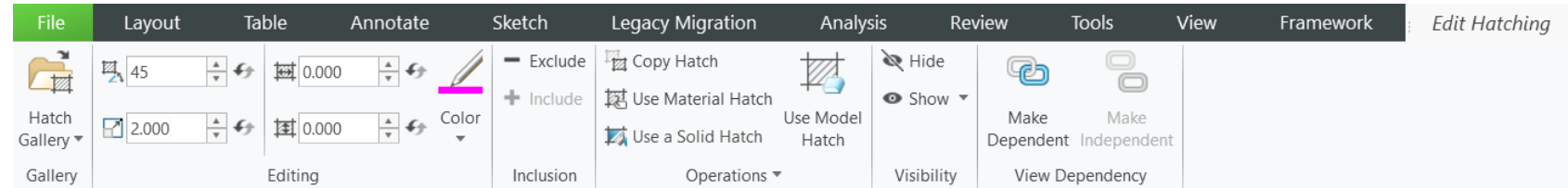
Intuitive creation,
placement and editing
workflows for surface finish

On-screen transformation
of surface finish using
modern draggers

Convey semantic definition
of surface finish annotations
to downstream consumers

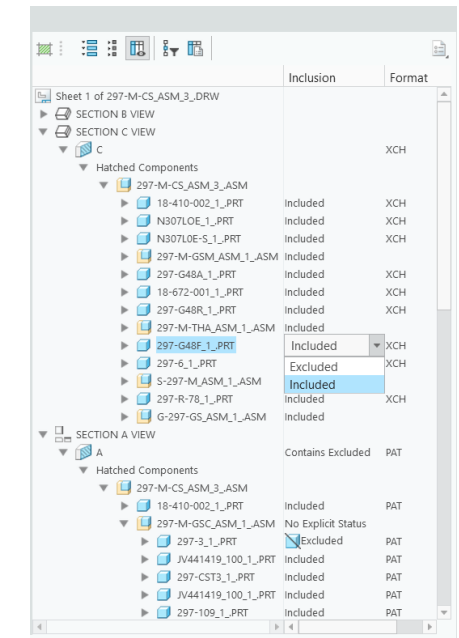
Hatching in Drawings

- Streamlined workflows for creating and editing hatch patterns
- Hatch gallery** contains numerous ANSI/ISO and user defined patterns of hatching
- Quick review of all the hatched items of a drawing sheet in a **tree view**
- Hatch Designer** for creation & editing of custom hatch patterns with multiple lines



Hatched areas, components or bodies are much easier identified in the drawing

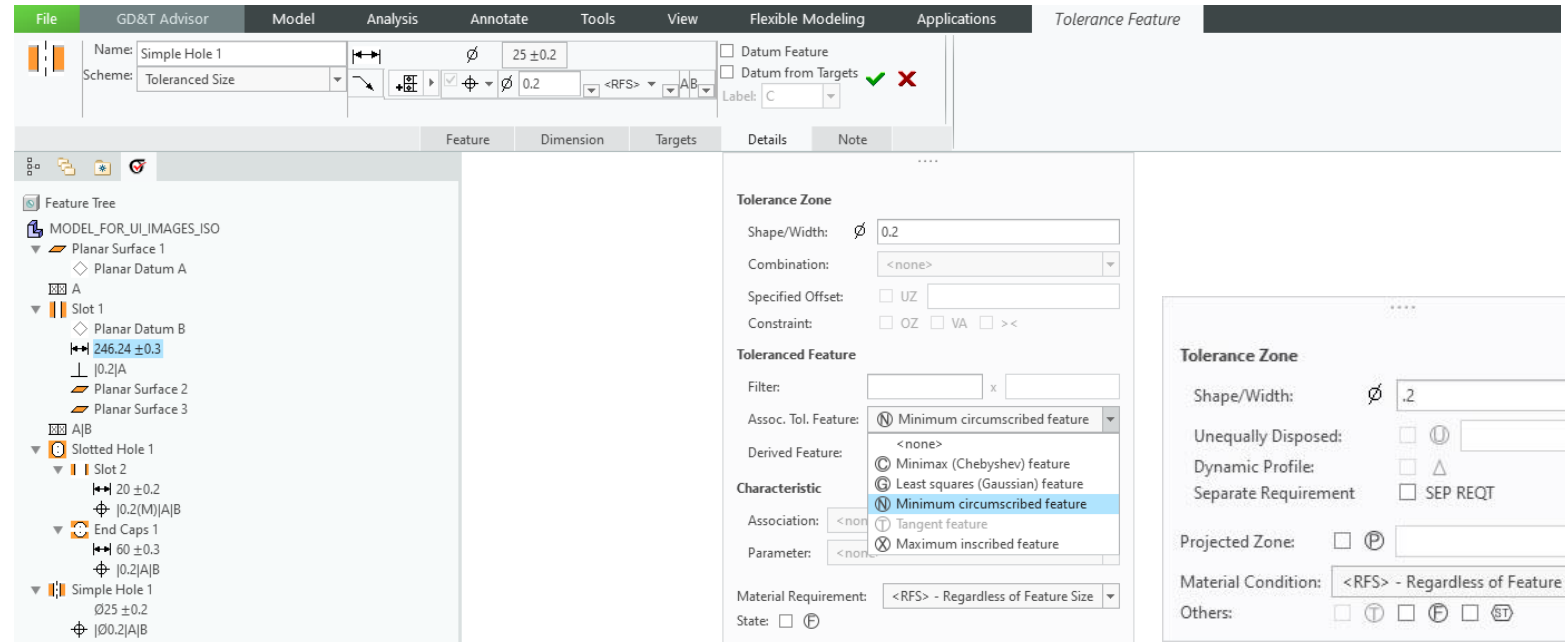
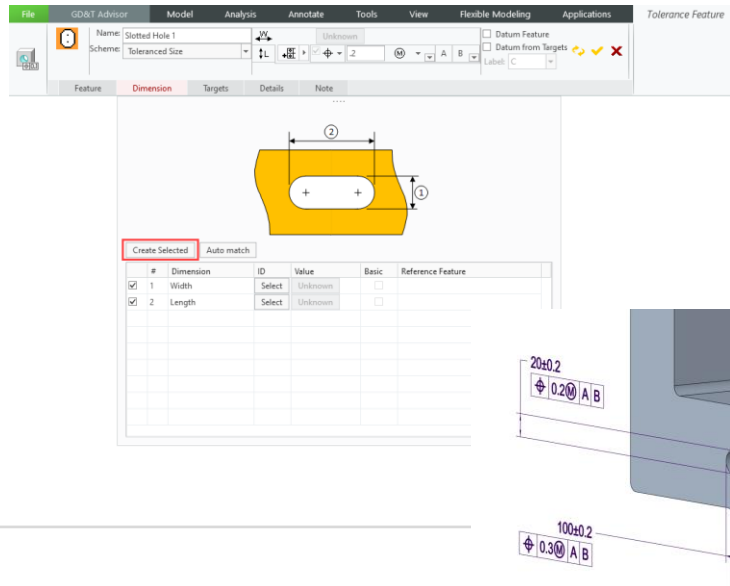
Less time spent on hatching related tasks in drawings



Quick access to favorite hatch patterns

GD&T Advisor

- New “Details” tab is added to the tolerance feature definition
- Creation of missing dimensions that are required for tolerance feature definition
- Cross highlighting of annotations between graphics areas and GD&T Advisor tree



Details tab for ISO 1101:2017

Details tab for ASME Y14.5-2018:

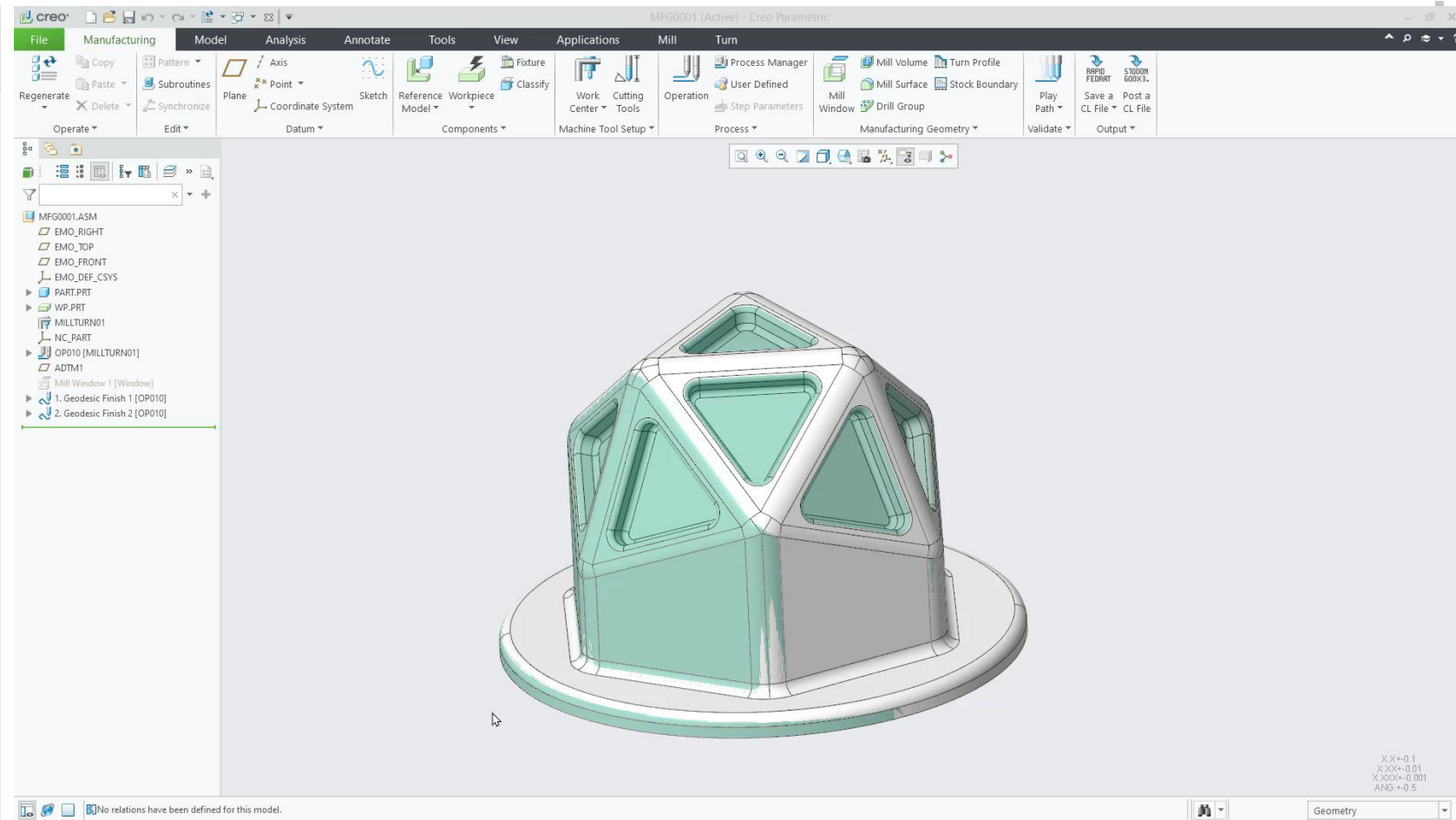
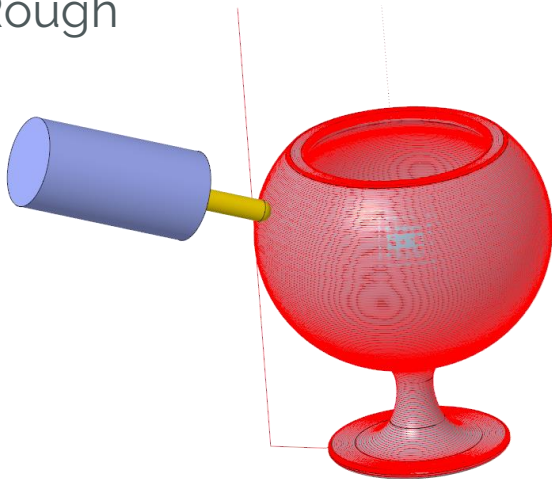
Improved support of detailing standards

Automatic creation of dimensions that are required for tolerance feature definition

Improved productivity when working with annotations in GD&T Advisor

High Speed Machining

- Geodesic 5 axis finish toolpath
- Tool motions tab in all HSM sequences
- Adaptive feed for HSM Rough and Rest-Rough
- Cutter compensation support for 3 Axis HSM Rough and Rest-Rough



Better surface finish and additional flexibility for 5 Axis Finishing

Increase in tool life, avoid chatter and faster overall machining

Fully associative in-process stock models, now on the model tree

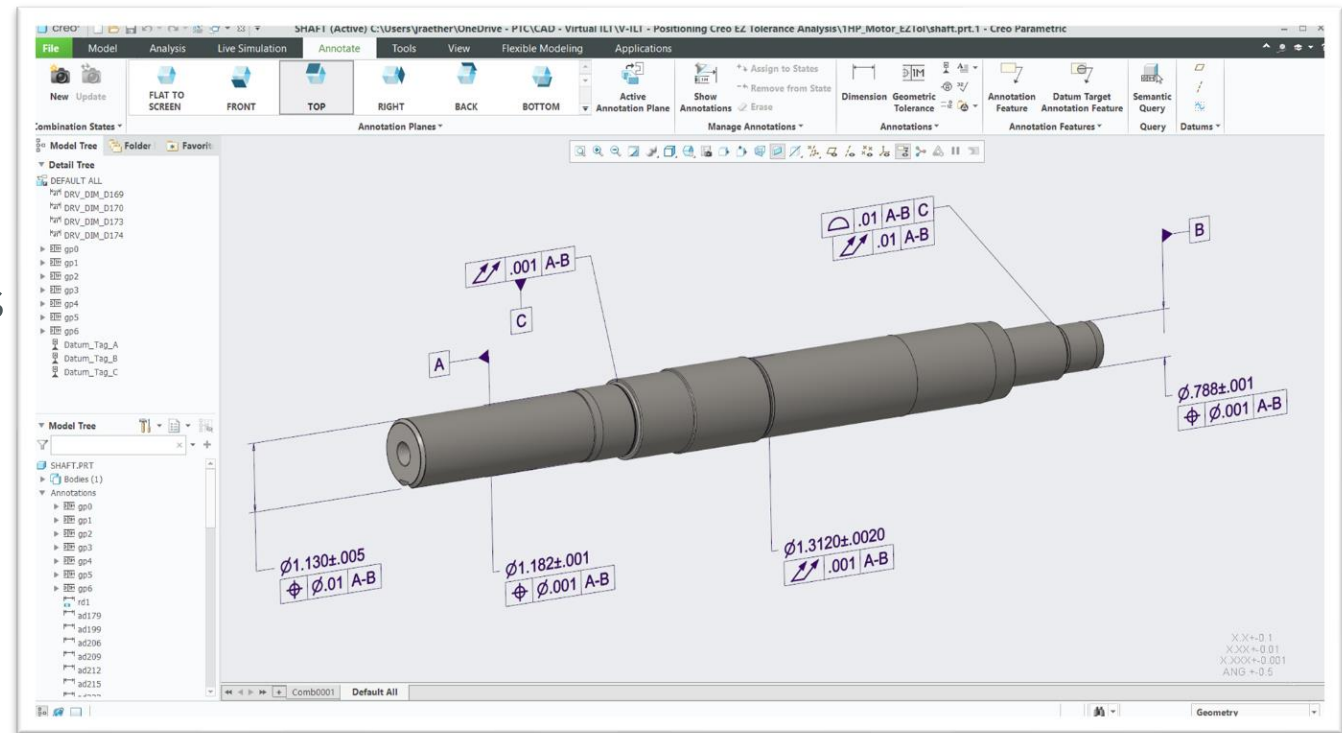


MODEL BASED DEFINITION

WHAT IS MODEL BASED DEFINITION?

3D Model Becomes the Single Source of Truth

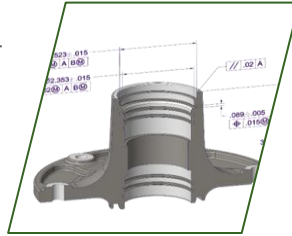
- MBD defines the source of Product and Manufacturing Information (PMI) as the 3D model (Model-Based)
- The goal of MBD is to provide a “single source of truth” for downstream partners
 - Manufacturing, Quality, Inspection & Suppliers
- MBD is a process that starts with an annotated 3D model.
- Using MBD, the 3D model replaces the 2D drawing as the source of PMI
 - Can continue to support 2D processes.



MODEL BASED BUSINESS VALUE

3D Annotated Model

Fully semantic,
correctly applied GD&T



Faster Product Development

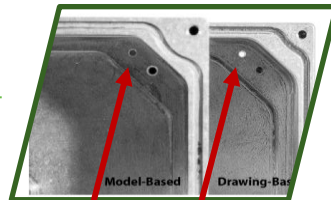
Simplify complexity

Faster Manufacturing and Inspection

Save time ,especially downstream

Reduced Errors and Non-conformances

Simplify complexity



Model-Based **Drawing-Based**
(as intended) **(with errant thru hole)**

Feedback Provided by PTC Customers*



40% faster
documentation
creation



60% reduction
in First article
inspection time

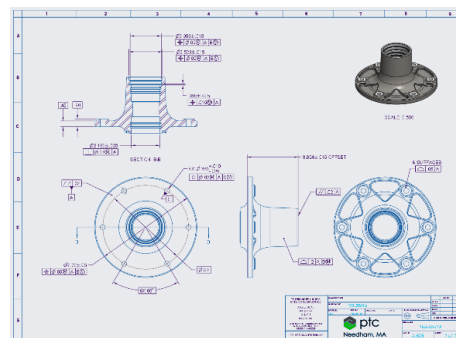


90% less
product non-
conformances

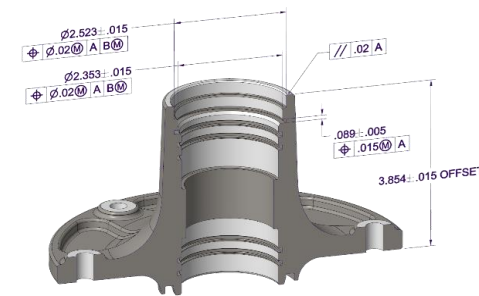
*Selected feedback from pilots and
real-world use by PTC customers

MODEL BASED CAPABILITIES DRIVE THE DIGITAL THREAD

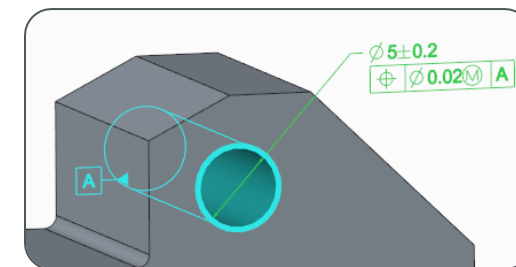
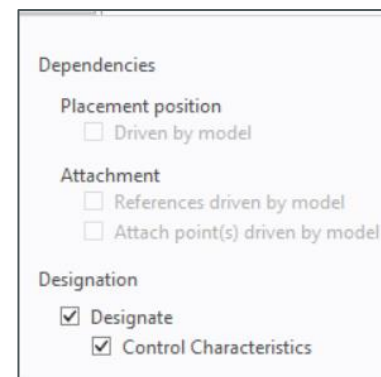
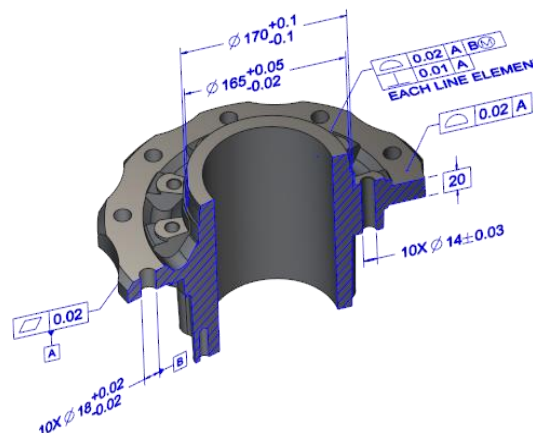
- Author
 - Intelligent, guided GD&T application
 - ASME & ISO standards
- Validate
 - Semantic Search
 - Standards compliance assurance
 - Completion validation
 - Integrated variation analysis
- Share
 - Key control characteristics
 - Semantic content available downstream



Fully detailed drawing



Optimally annotated model



Semantic PMI

BENEFITS*

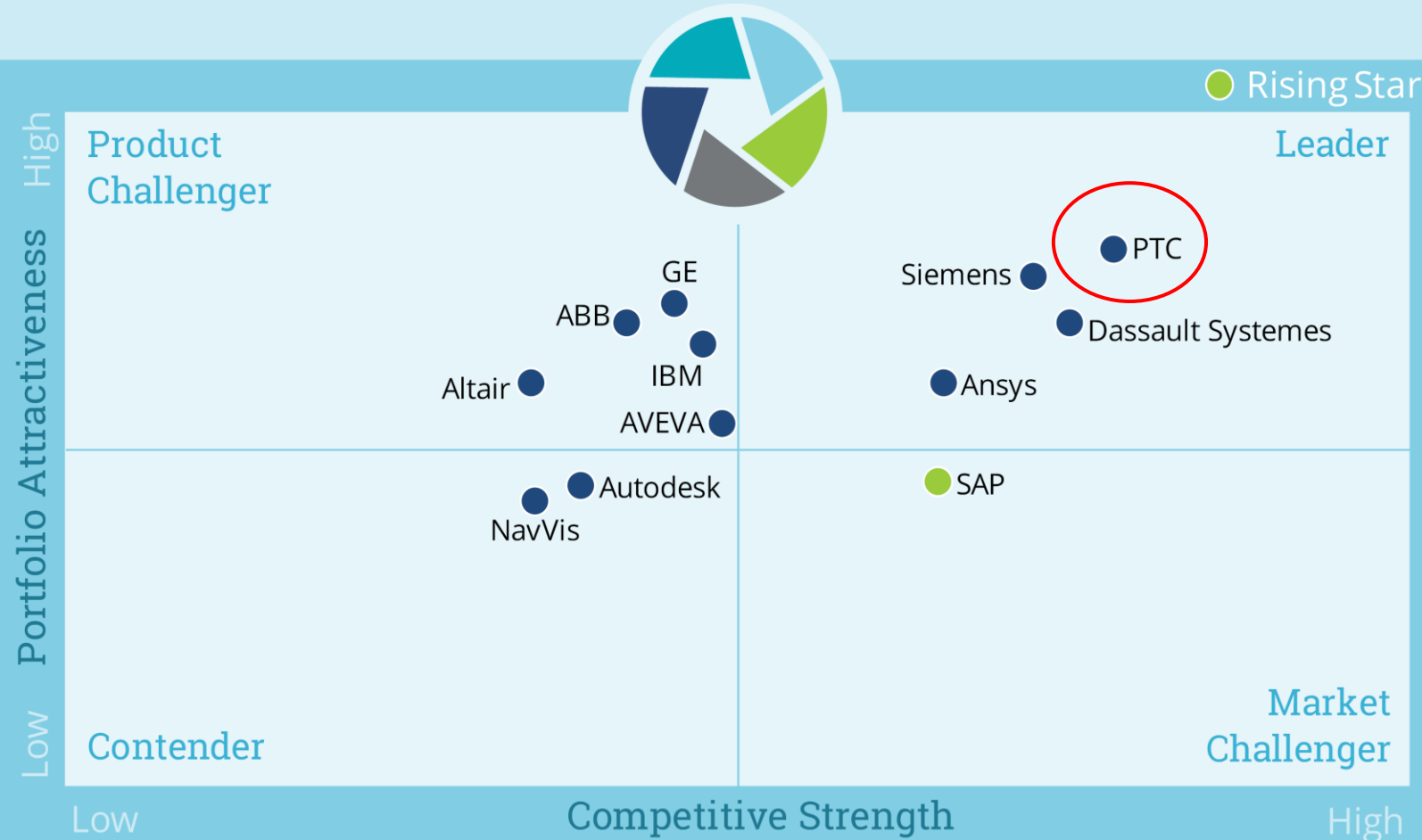
40% Faster Documentation Creation with Less Missing or Misinterpreted Information

60% Reduction in First Article Inspection

90% Fewer Product Non-Conformances

Manufacturing Industry Services Manufacturing Virtualization Solutions

2020
U.S.



"PTC is well-suited to accelerate the customers' shift to MBD and provide the necessary flexibility to convert designs to 3D, as well as leverage the benefits of digital thread in its product development process."

-ISG 2021 Quadrant Report

ISG Provider Lens™

Source: ISG Research 2020

PTC's CAD Portfolio Leading the Way in Independent Analyst Studies

V O L V O

“Using one PLM and CAD platform will act as a key enabler in our digital engineering transformation. Leveraging this foundation, we see great possibilities in connecting PTC’s IoT and AR Solutions into our digital thread strategy.”



Lars Stenqvist
CTO Volvo Group

EXAMPLE DASSAULT CONSOLIDATIONS TO CREO

V O L V O

Product Platforms
Digital Thread
Engineering Capacity Flexibility

Schneider
Electric

Creo Roadmap/Vision
Engineering Capacity Flexibility

RAFAEL
ADVANCED DEFENSE SYSTEMS LTD.

Creo Robustness & Scalability
Creo Additive & Generative
Engineering Capacity Flexibility

britax

15% Improvement in Concept Development
Industrial and Mechanical Concurrency
Engineering Capacity Flexibility

GENERAL DYNAMICS
Land Systems

Creo Robustness & Scalability
Creo Model Based Definition

k'nex

50% Improvement in Concept Development
Creo Robustness and Scalability

LIGHTNING
e MOTORS

Creo Robustness and Scalability
Creo Top-Down/Distributed Design Methodology

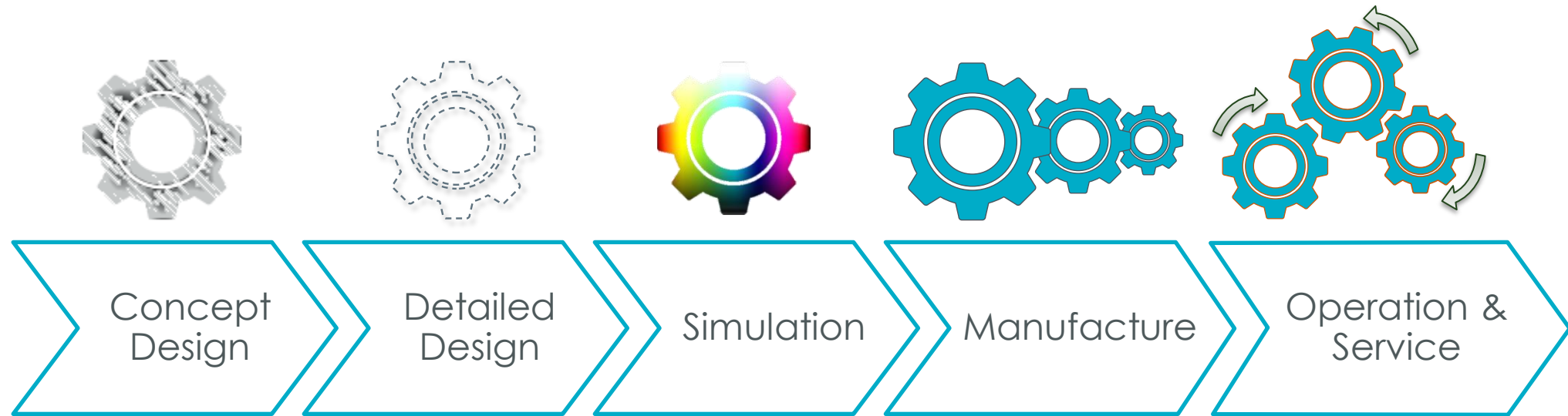
volta

Creo Advanced Surfacing Capabilities
Creo Robustness and Scalability



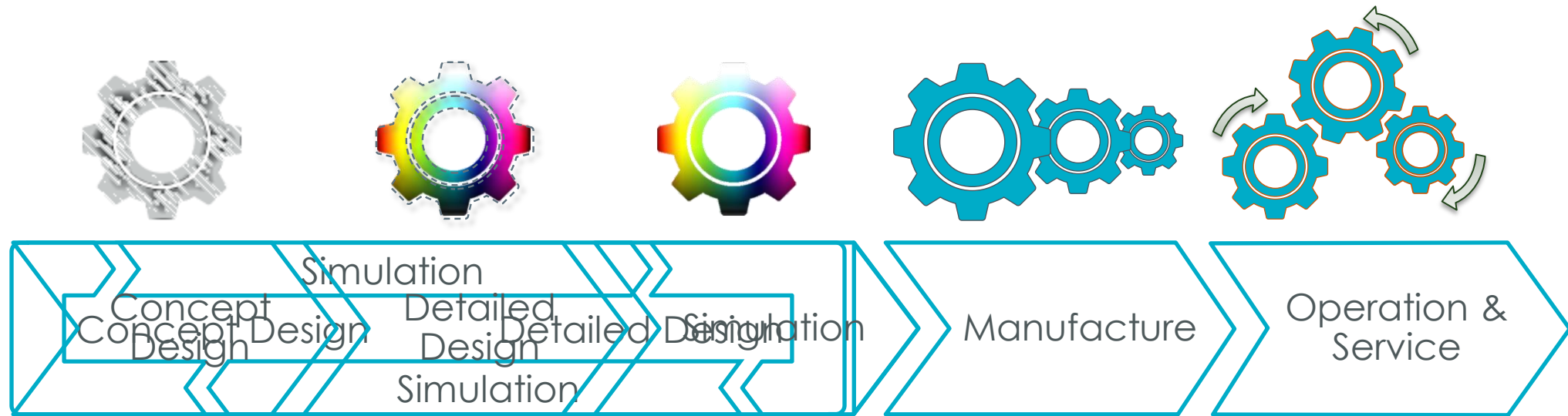
SIMULATION DRIVEN DESIGN

SIMULATION DRIVEN DESIGN

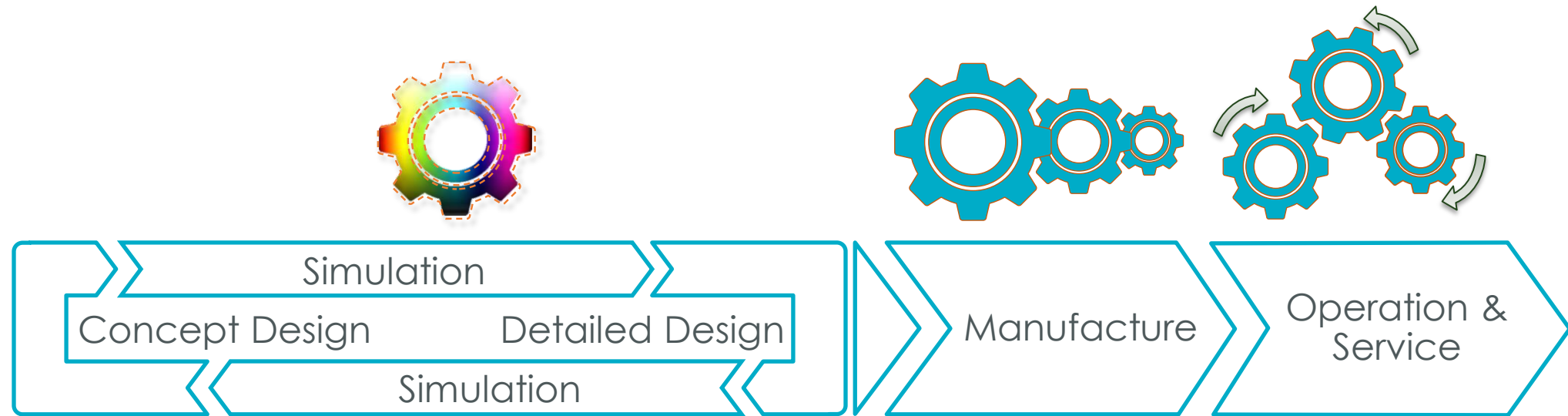


- Need to consult an expert
- Can't use the actual design model – need a simplified copy
- Design is an iterative process

SIMULATION DRIVEN DESIGN



SIMULATION DRIVEN DESIGN



creo® simulation live

Real-time design guidance
from the earliest concepts



creo® ansys simulation

High fidelity Ansys simulation
tailored to the Creo User

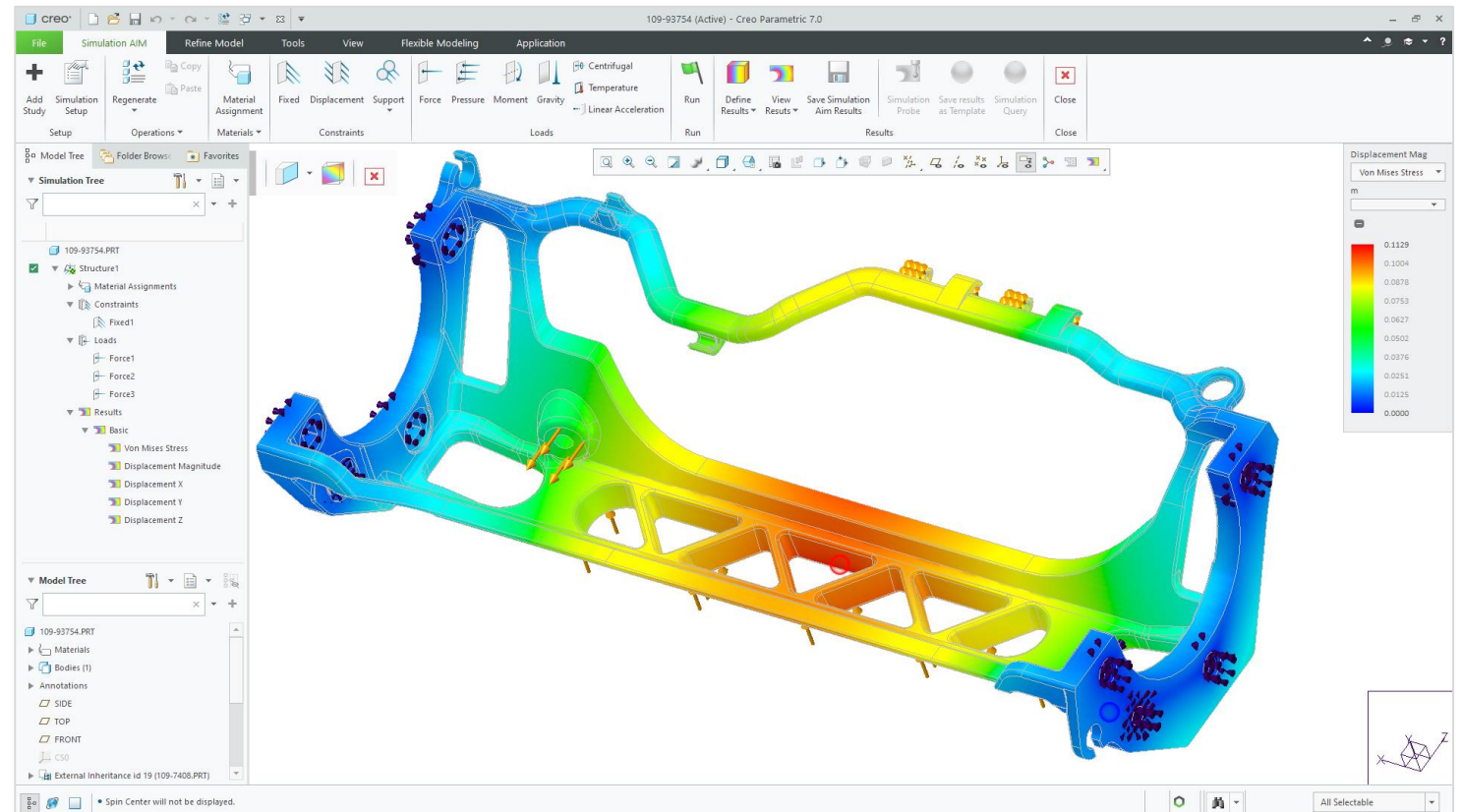


Ansys / MECHANICAL

Broadly and deeply capable
world-class simulation

SIMULATION DRIVEN DESIGN POWERED BY ANSYS

- Integrated Ansys real time simulation for in process design guidance
- Full fidelity Ansys Solvers deliver simulation to aid in production readiness testing
- Supports:
 - Thermal
 - Structural
 - Modal
 - Fluids



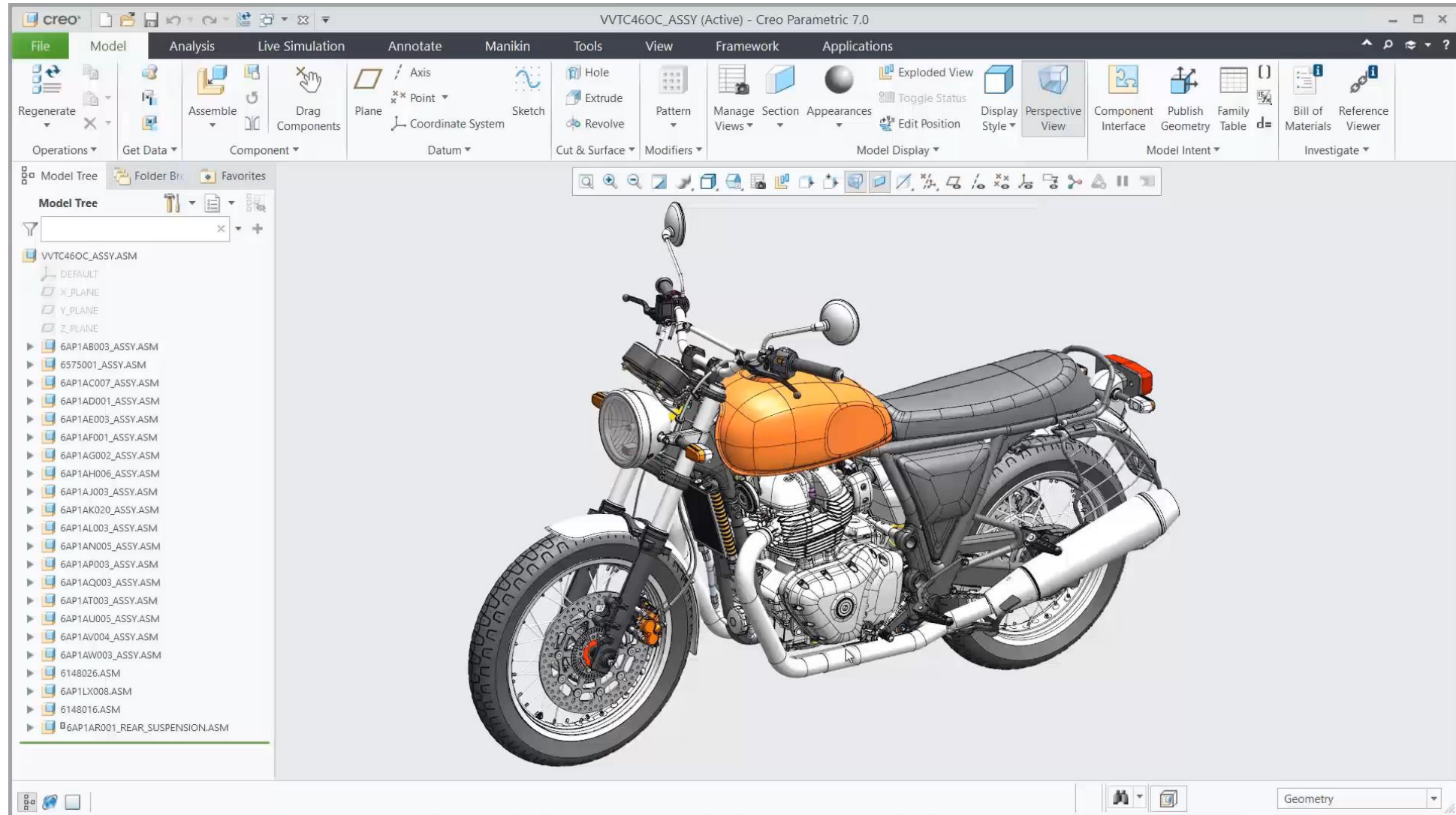
BENEFITS

Improve R&D Efficiency
Reduce Labor & Prototype Costs by 26%

Reduce Cost of Quality
Save 20% on product testing

Drive Innovation
Broaden Design Exploration by 40%

SIMULATION DRIVEN DESIGN IN CREO





HPE COXA is a flexible, agile and innovative provider of engineering solutions, technology projects and products, for automotive, motorsport, off-highway, automation solution, and defense sectors. .

HPECOXA

HPE COXA

The Challenge

Inefficiencies due to a multi-step, multi-software approach to design were causing problems with communications, production times, quality and customer satisfaction.

The Solution

- Harmonize processes, and standardize on Creo
- Fully integrate emerging technologies in a linear, fluid process
- Reduce design time by 30%
- Reduce time from concept to delivery by 50%

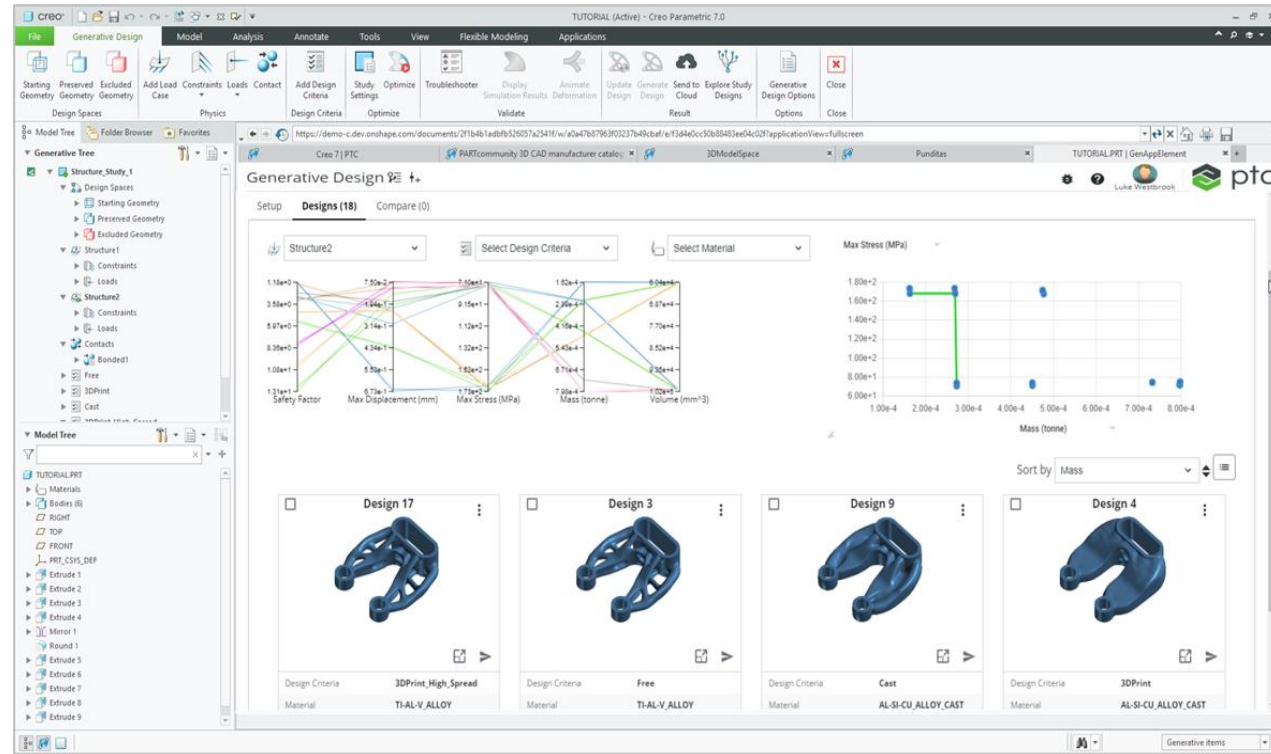


GENERATIVE DESIGN

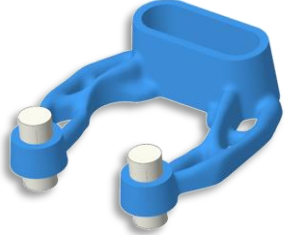
GENERATIVE DESIGN

Autonomously Create Optimal Designs with AI

- Explore an array of design requirements
 - Loads/constraints/physics
 - Materials
 - Manufacturing Processes
- Seamlessly utilize Azure elastic compute
- Automatically integrate full geometric results into Creo
- Automate updates as design criteria change



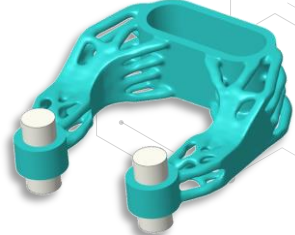
Machining



Casting



Additive



Benefits

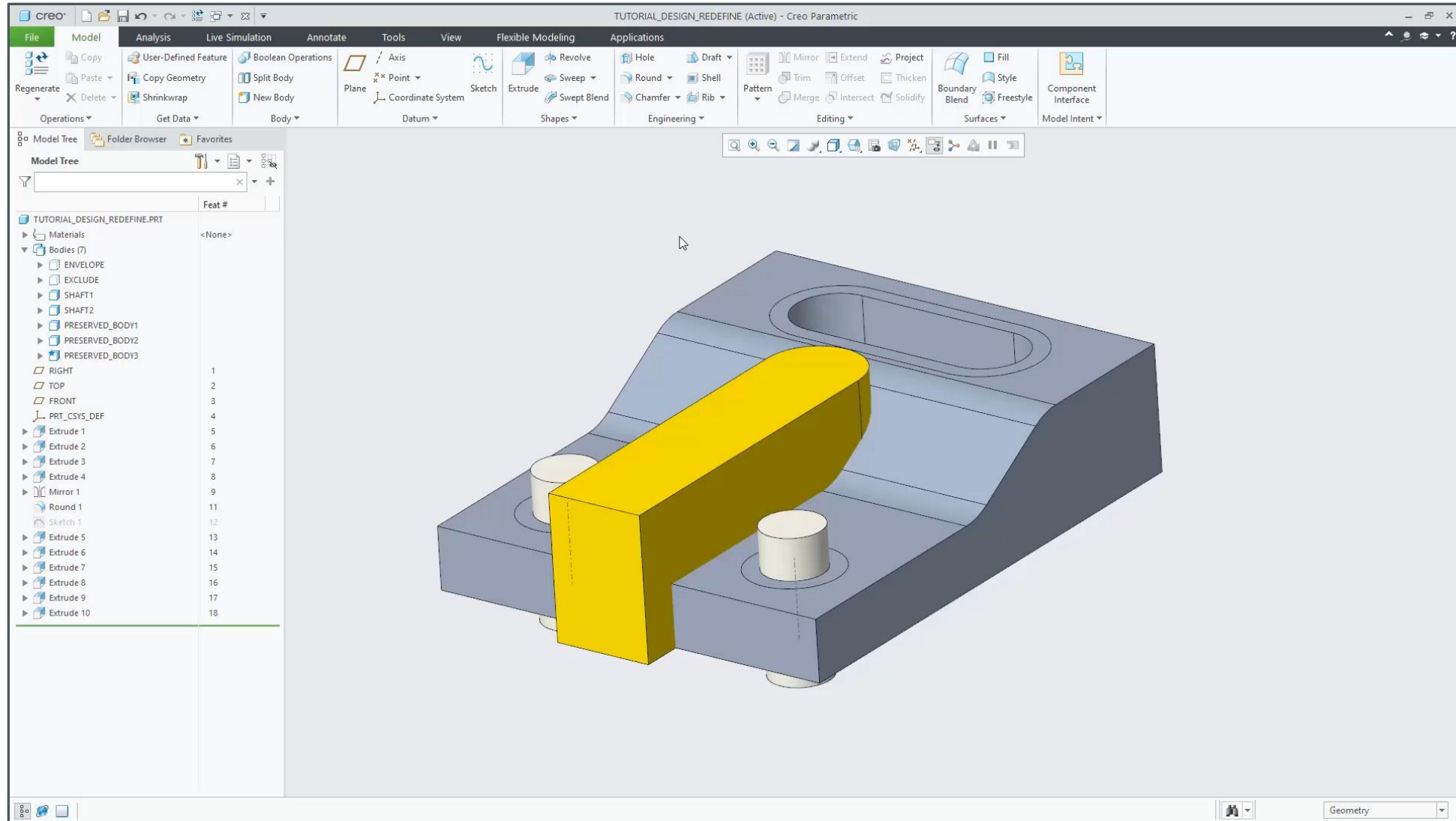
Accelerate Innovation
Design Differentiated
Products

Reduce Time to Market
20% Shorter Design Cycles*

Reduce Product Cost
Optimize Material Usage



CREO GENERATIVE DESIGN VIDEO





Cummins is the world's largest independent diesel and gas engine designer and manufacturer and a leading supplier of electrification systems, including fuel cells and battery systems.




CUMMINS

The Challenge

Cummins is committed to doing their part to create a more sustainable, prosperous world. PLANET 2050, a novel environmental sustainability strategy, sets quantifiable goals for the entire company for 2030 and longer-term aspirations out to 2050.

The Solution

- Adopt Simulation Driven Design
- Integrate generative design into their design process
- Invest in training to improve the skills of every design engineer
- Reduce existing part material usage by up to 15%

A photograph of an astronaut in a white space suit floating in space, with the Earth's horizon visible in the background. A large green diagonal graphic element is overlaid on the left side of the image.

Jacobs Engineering is designing the next-generation spacesuit for NASA using PTC's Generative Design solution

“Jacobs expects that using Generative Design will shorten design time by 20% and produce parts which are incredibly lightweight, resulting in significant fuel savings.”

Jesse Craft
Senior Engineer
Jacobs Engineering

JACOBS[®]

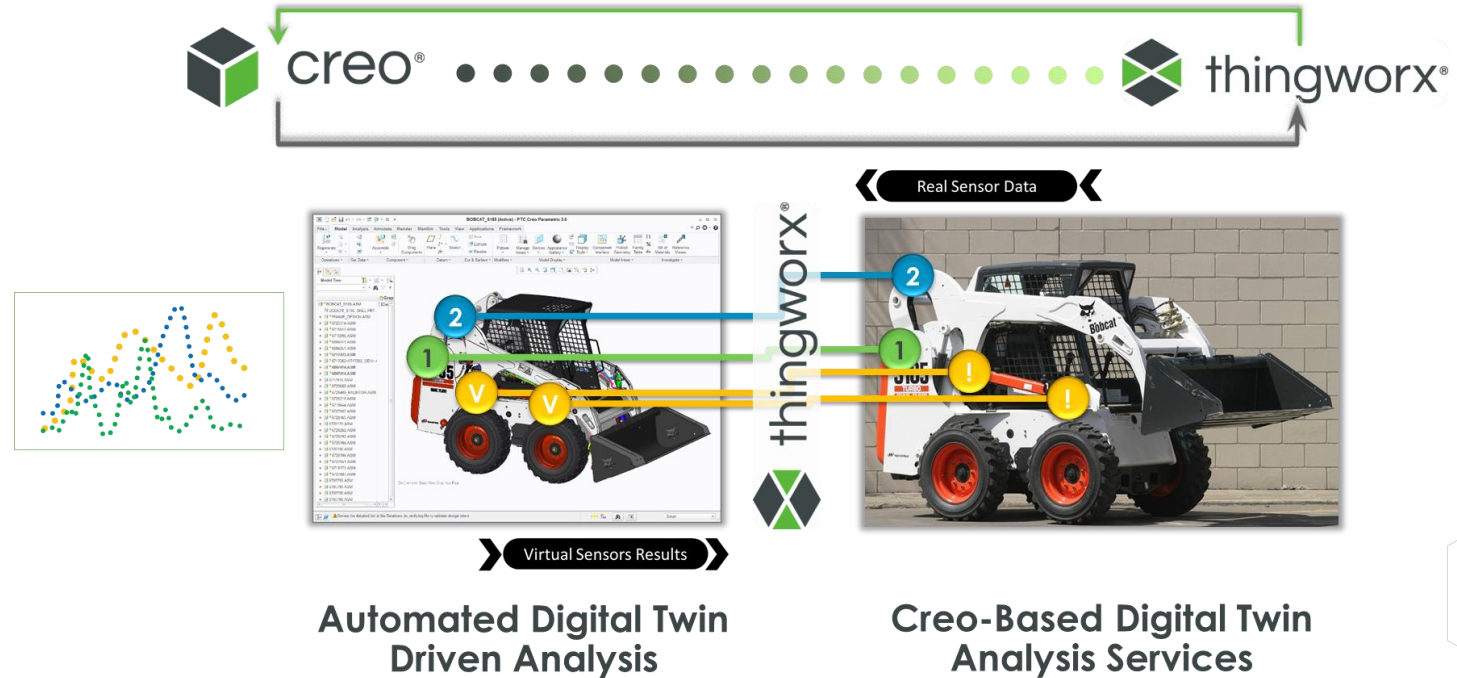


DESIGN FOR CONNECTIVITY & DIGITAL TWIN

DESIGN FOR CONNECTIVITY

Replace Assumptions with Facts

- Optimize products to real world conditions
- Create Virtual Sensors
- Build out correct data streams
- Automate digital twin simulation



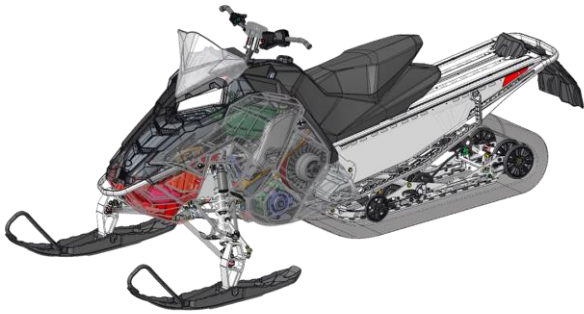
Benefits

Test & Optimize
Sensor Strategies

Understand
Real World Usage

Create
Digital Twins

POLARIS



“We’re using connected data from our factories...from our dealers and from the field to understand how our riders are using our vehicles.”

Matt Emmerich
VP and Chief Innovation Officer
Polaris Industries

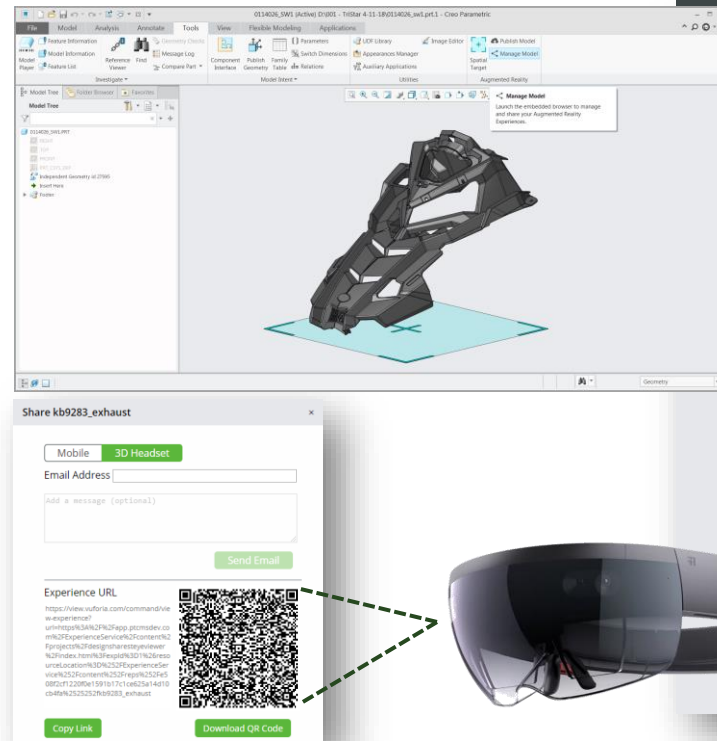


CREO-BASED AR COLLABORATION

SHARE DESIGNS FROM CREO IN AUGMENTED REALITY

Instant Design Reviews in AR from Creo

- Share Creo designs in AR including
 - View states
 - Part hide/unhide
 - Scaling/spin/pan/zoom
- Collaborate with team members via web portal



Personal

Model Dashboard

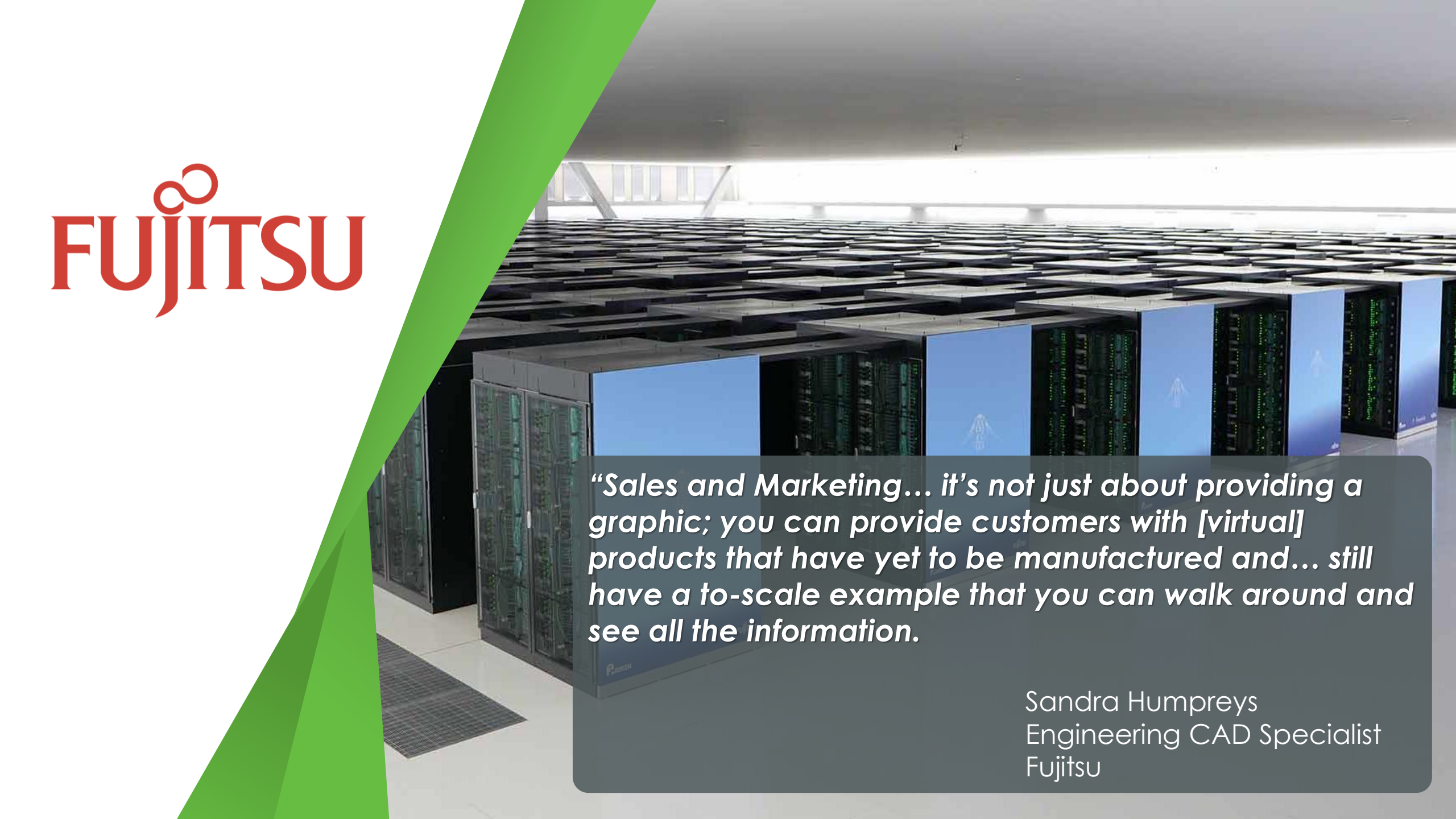
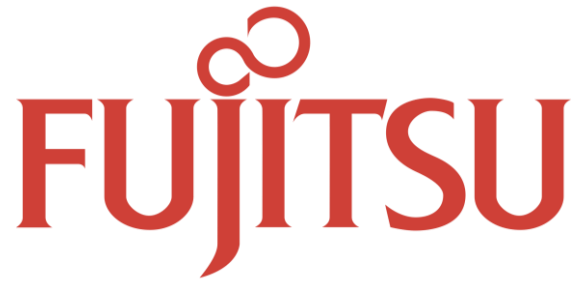
Model Name	Target	Date	Access	Share	Delete
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blade_48921		2/25/2019	Public		
turbine_asm_98370		2/25/2019	Restricted		
fan_blades		2/22/2019	Public		
26485_af0_asm_126_low		2/22/2019	Public		
26485_af0_asm_126_med		2/22/2019	Public		
fan_blades_med		2/22/2019	Public		
26485_af0_asm_126		2/22/2019	Public		
vof3_5_8_1		2/22/2019	Public		

Benefits

Secure
No CAD Data is
Distributed

Clear
Designs Shared at Natural
Scale in Context

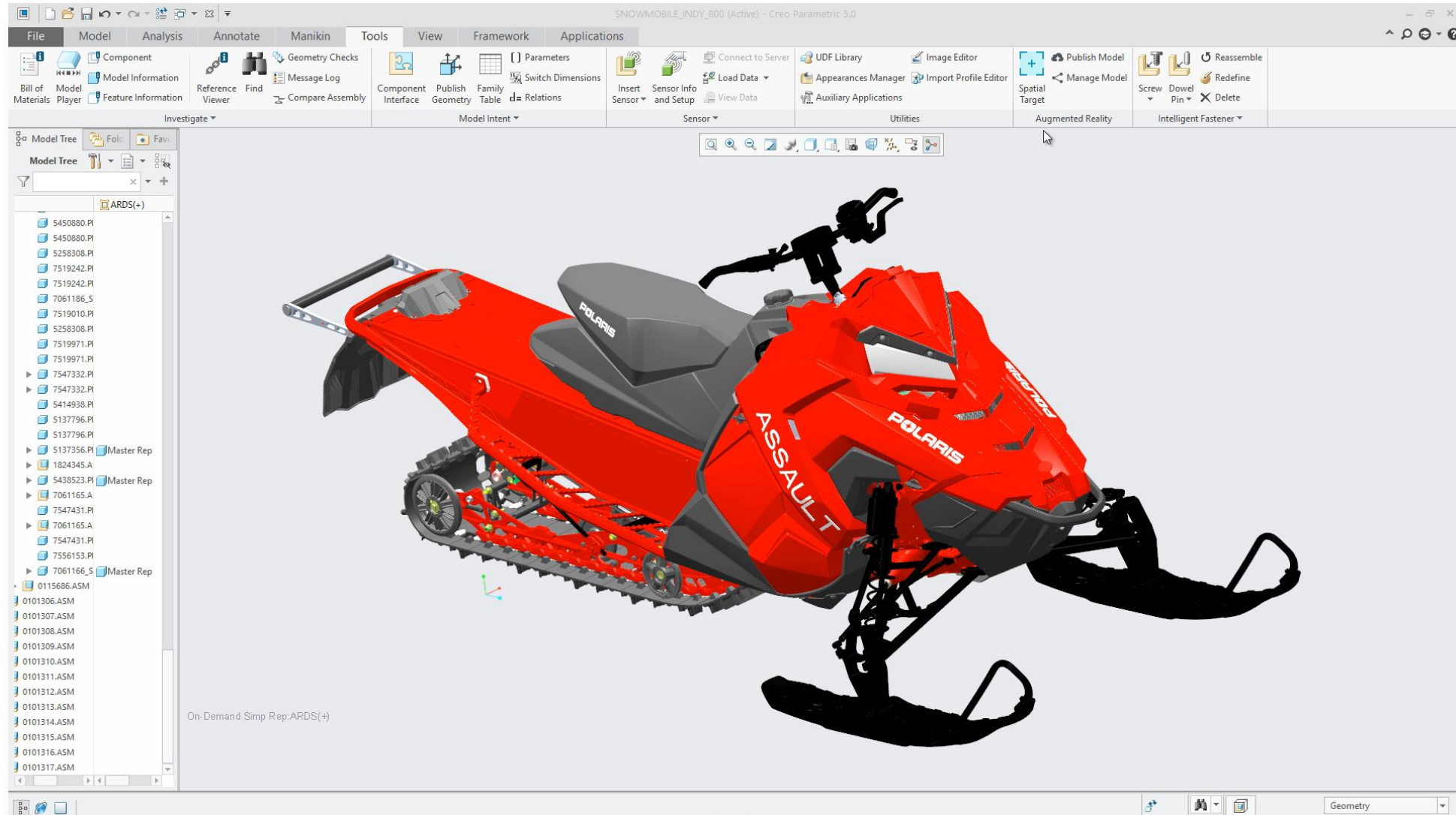
Seamless
No Data Preparation
Required

The background of the slide is a photograph of a server room. Rows of server racks are visible, with some racks having blue doors. The room has a high ceiling with exposed ductwork and lighting fixtures. A green diagonal graphic element is overlaid on the left side of the image.

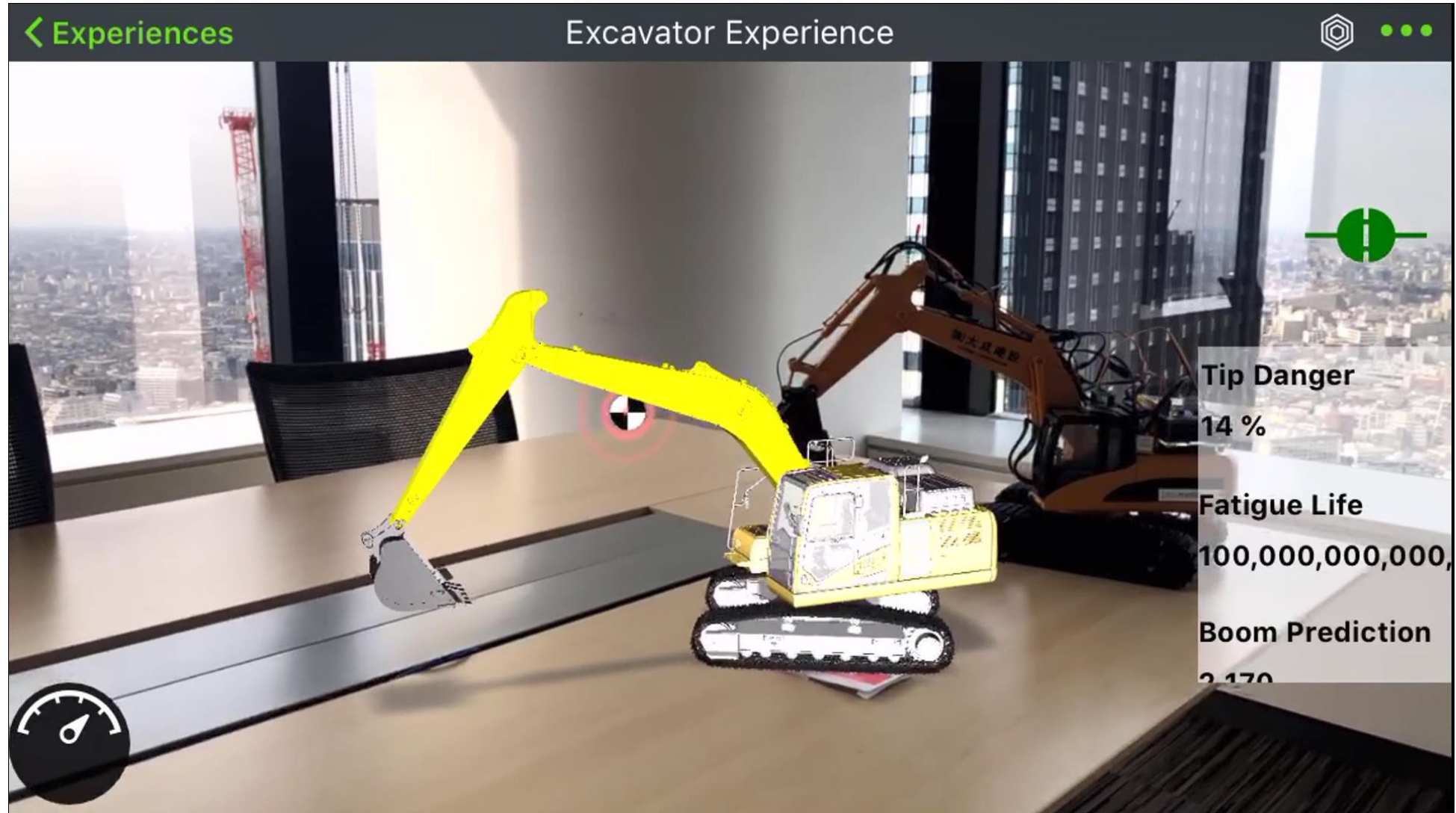
“Sales and Marketing... it’s not just about providing a graphic; you can provide customers with [virtual] products that have yet to be manufactured and... still have a to-scale example that you can walk around and see all the information.”

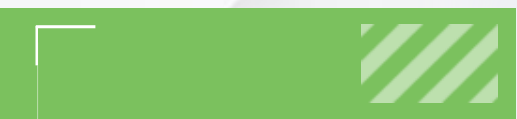
Sandra Humpreys
Engineering CAD Specialist
Fujitsu

AD-HOC COLLABORATION WITH CREO AR DESIGN SHARE



CAD BASED DIGITAL TWIN DEMONSTRATION



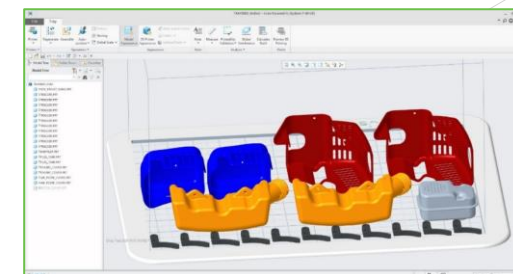
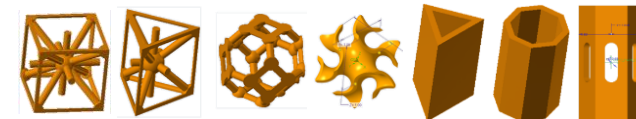
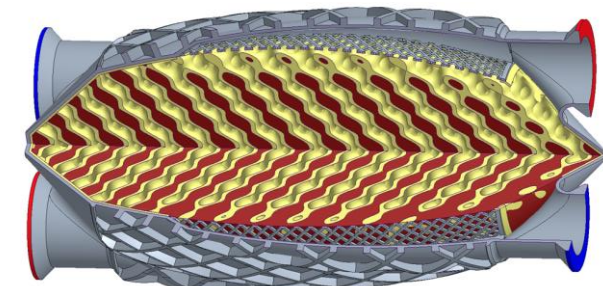
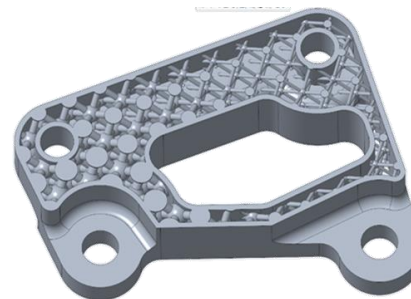


DESIGN FOR ADDITIVE

DESIGN FOR ADDITIVE MANUFACTURING

Additive manufacturing capabilities seamlessly integrated into Creo

- Create, analyze and optimize lattices
 - Parametrically and numerically controlled lattices
 - 2.5D, 3D, User Defined, Formula Driven & Stochastic Lattices
 - Simulation driven lattice structures optimization
- Check, manage and optimize designs for printability



Benefits

Reduce
Errors & Waste

Reduce
Production Time

Preserve the
Digital Thread

Optimize
Designs



DESIGN FOR ADDITIVE & SUBTRACTIVE MANUFACTURING

- Select best suitable manufacturing method



Additive



Subtractive

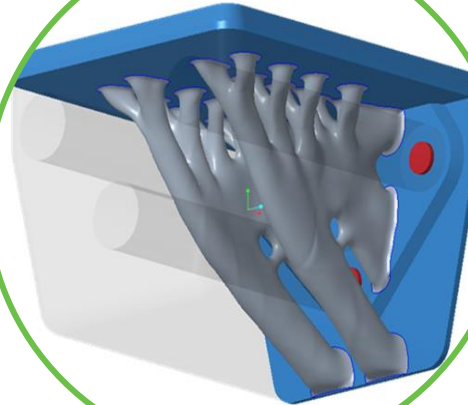


Hybrid

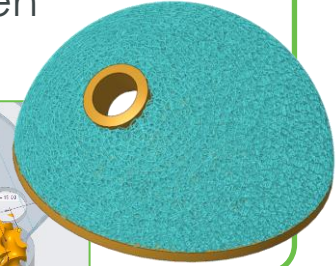
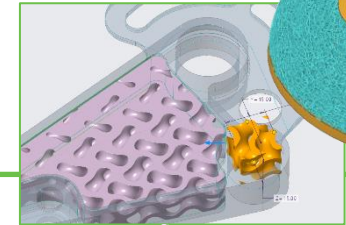
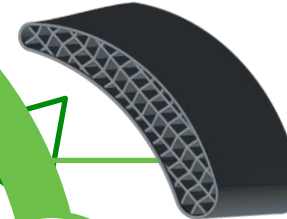
Manufacturing



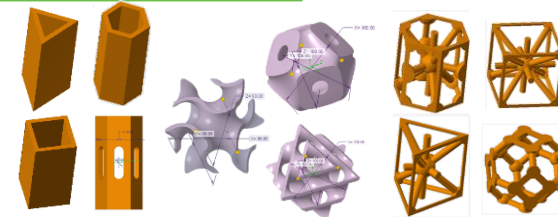
DESIGN



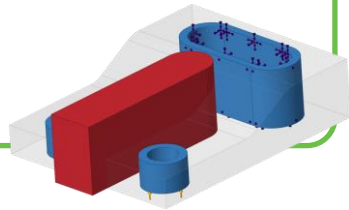
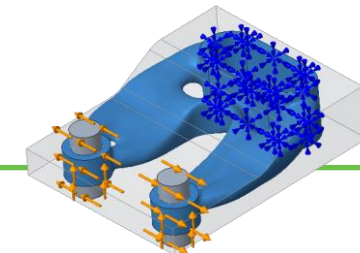
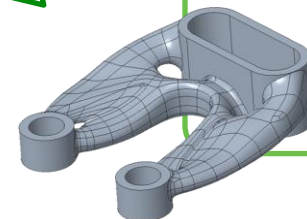
- Lattice Creation & Optimization
 - 2.5D, beam based, stochastic and Formula driven
- Build Direction analysis



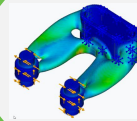
OPTIMIZE



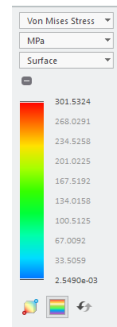
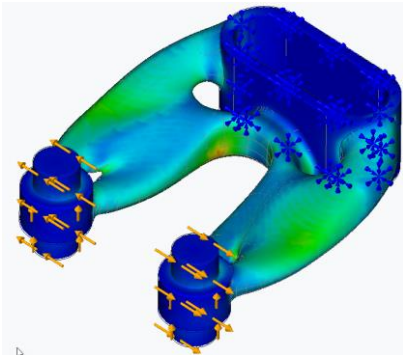
- Generative Topology Optimization
- Generates optimal designs from a set of system design requirements.
- Geometry reconstruction



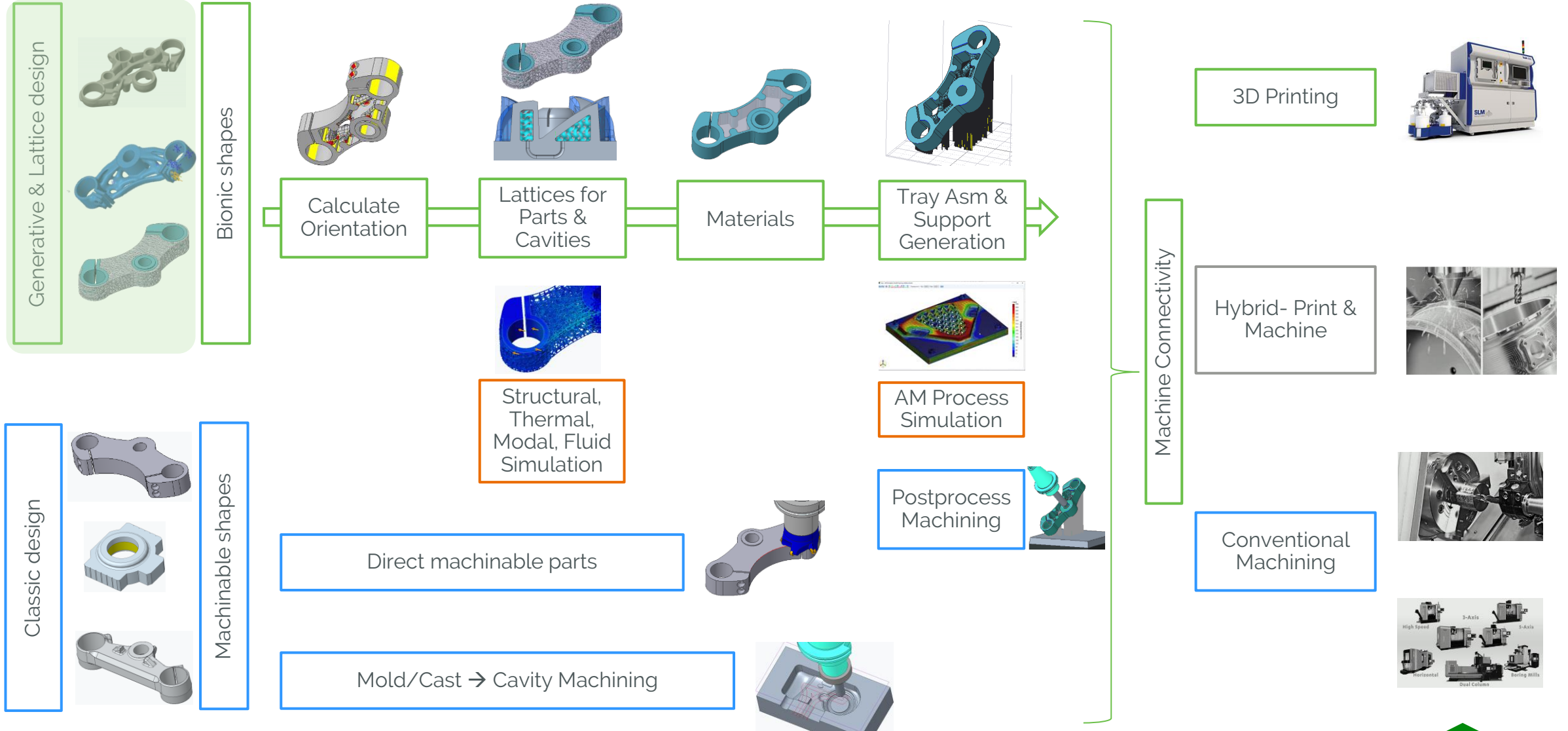
VALIDATE



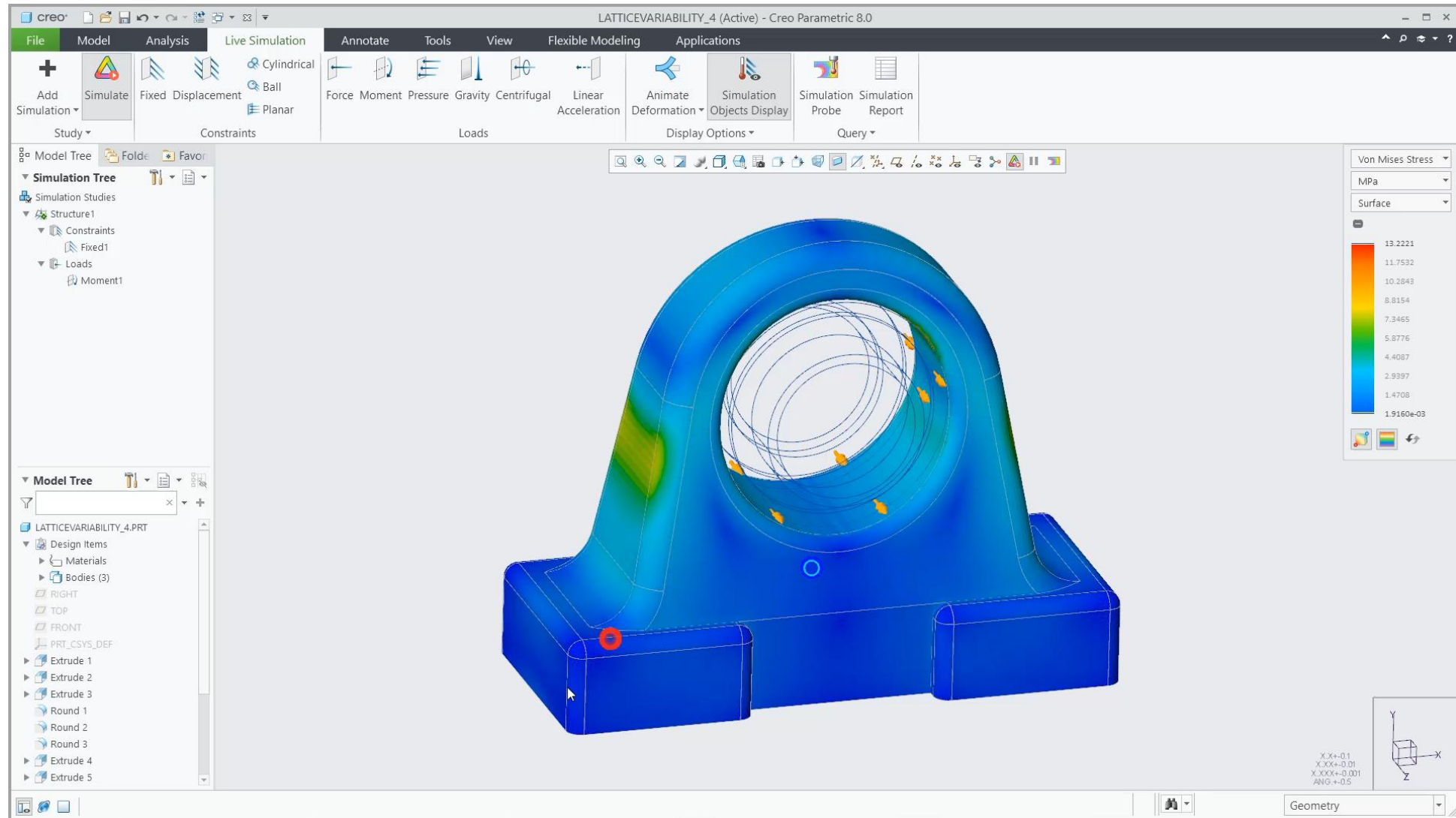
- Validate Geometry in real time using Creo Simulation Live



INNOVATIVE DESIGN → ENHANCED PRODUCTIONS PROCESSES



DESIGN FOR ADDITIVE MANUFACTURING VIDEO

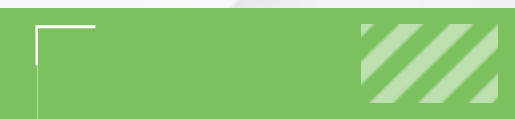


Advanced Engineering Solutions designed this award-winning Avionics Heat Exchanger in partnership with  ptc & 



“With Creo Additive Manufacturing Extension, we now have the capability to build gyroid structures. Not only that, but we can also simulate them in real-time.”

Dr. Andreas Vlahinos
CTO Advanced Engineering Solutions



FUTURES



creo+™

FUTURE CAD INVESTMENT AREAS

CAD

creo[®] +

User
Productivity



Design with
Composites



Model Based
Definition



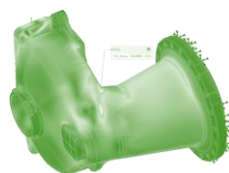
Control Center*

Core Functionality

Emerging Technologies



Generative
Design



Simulation
Driven Design



Design for
Additive



Real Time
Collaboration*

PTC UNIFIED SaaS PORTFOLIO ON PTC Atlas

TODAY

FUTURE

windchill®

creo®

onshape®



ptc® atlas

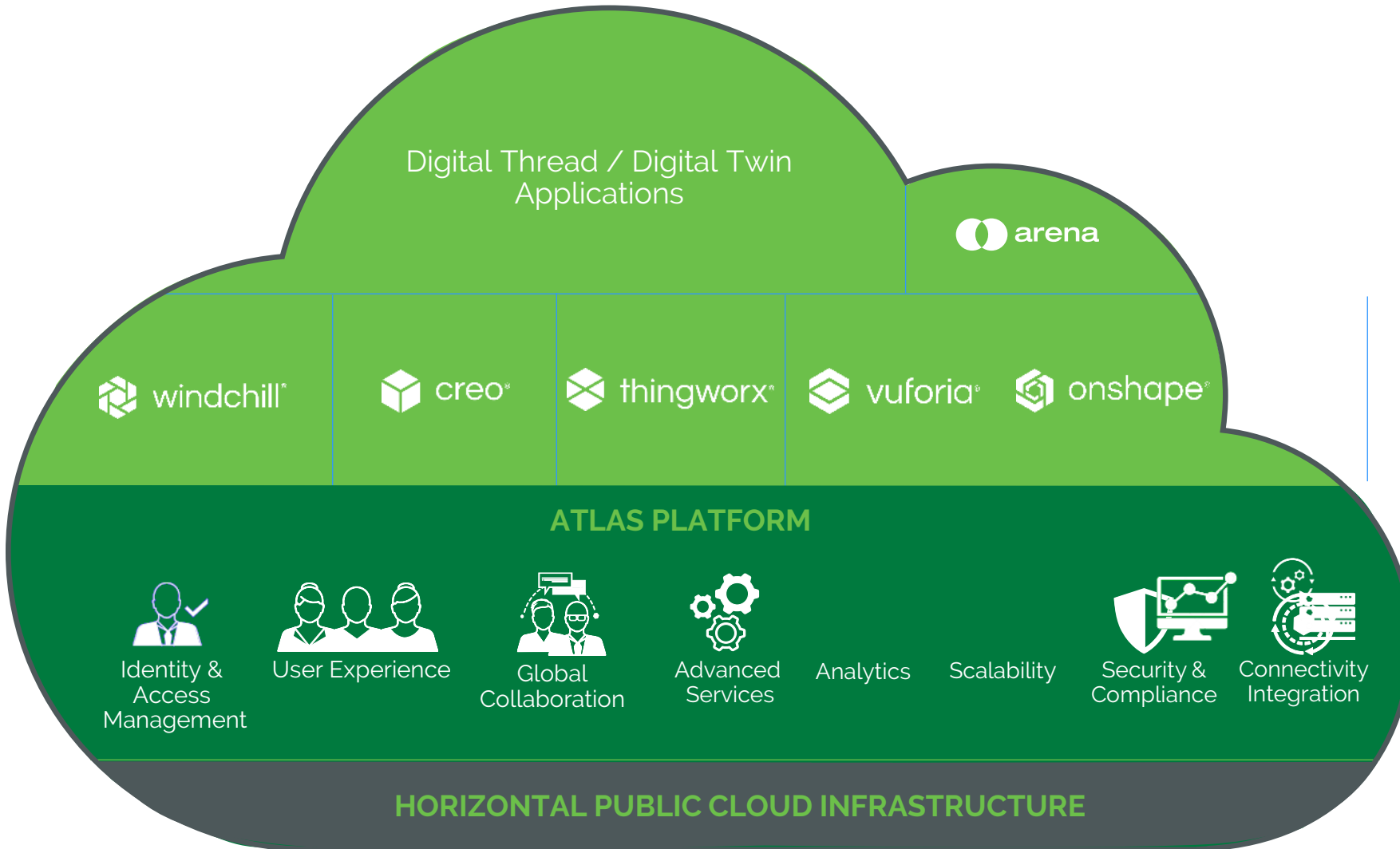
Unified
SaaS
Portfolio

vuforia®

arena®

thingworx®

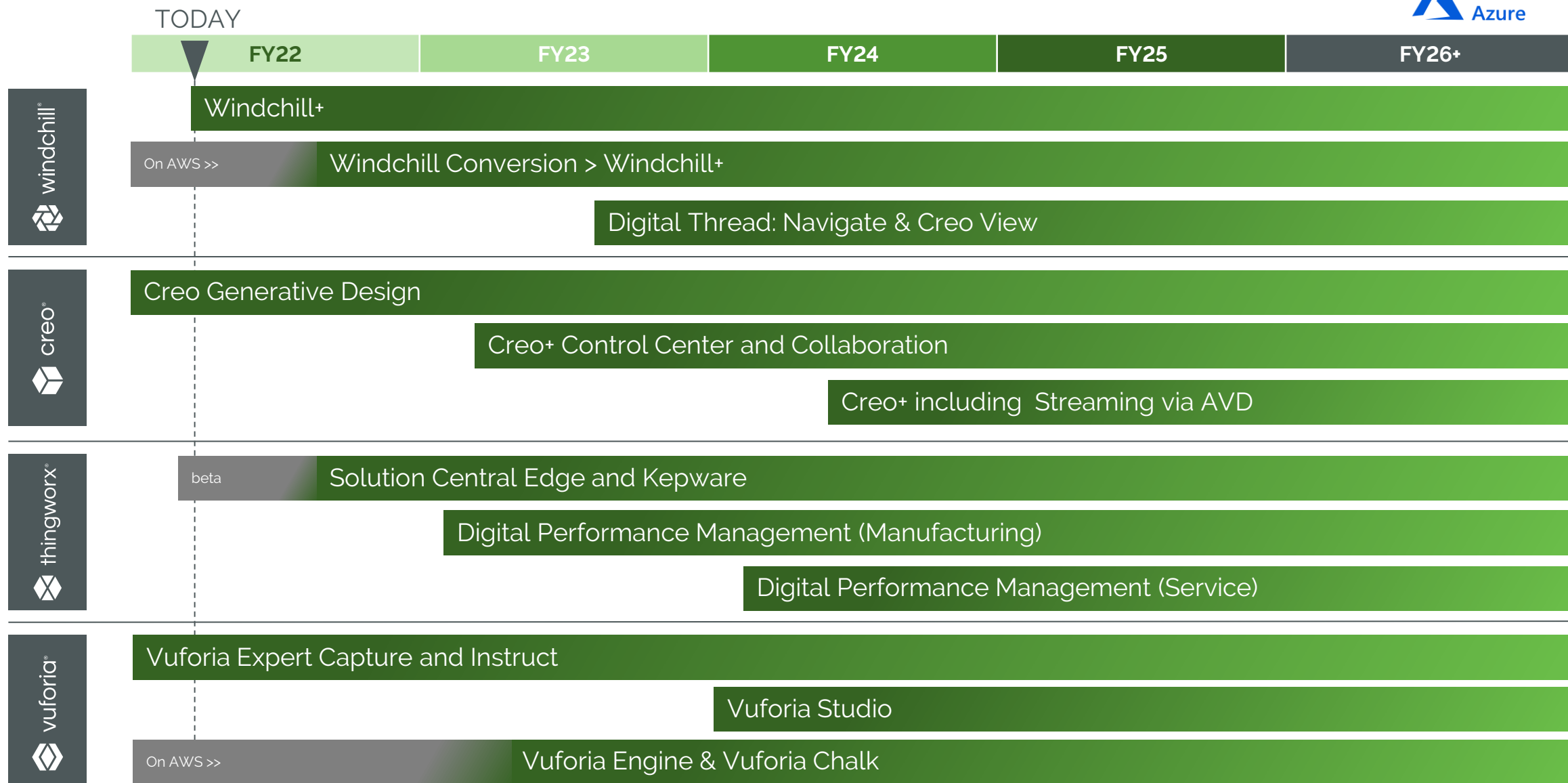
PTC UNIFIED SaaS PORTFOLIO ON PTC Atlas



PTC Atlas PLATFORM



SaaS ON PTC Atlas OFFERING ROADMAP





creo+™

WHAT DOES IT MEAN FOR CREO

Streamlined Deployment

- Simple user access and entitlement control
- Push button or automatic enterprise updates

Enhanced Collaboration

- Multi-user, real time concurrent design
- Design branching & merging

Scalable PDM/PLM

- Simple, integrated PDM
- Integrated with Windchill+ for PLM



creo+™

The power and proven functionality of Creo with new tools to enhance collaboration, create greater accessibility for designers and easier administration for IT, tightly integrated with Windchill+ or with PDM on PTC Atlas.

- No data translation
- Fully upwards compatible with on-premise Creo
- Identical core CAD capabilities with on-premise Creo



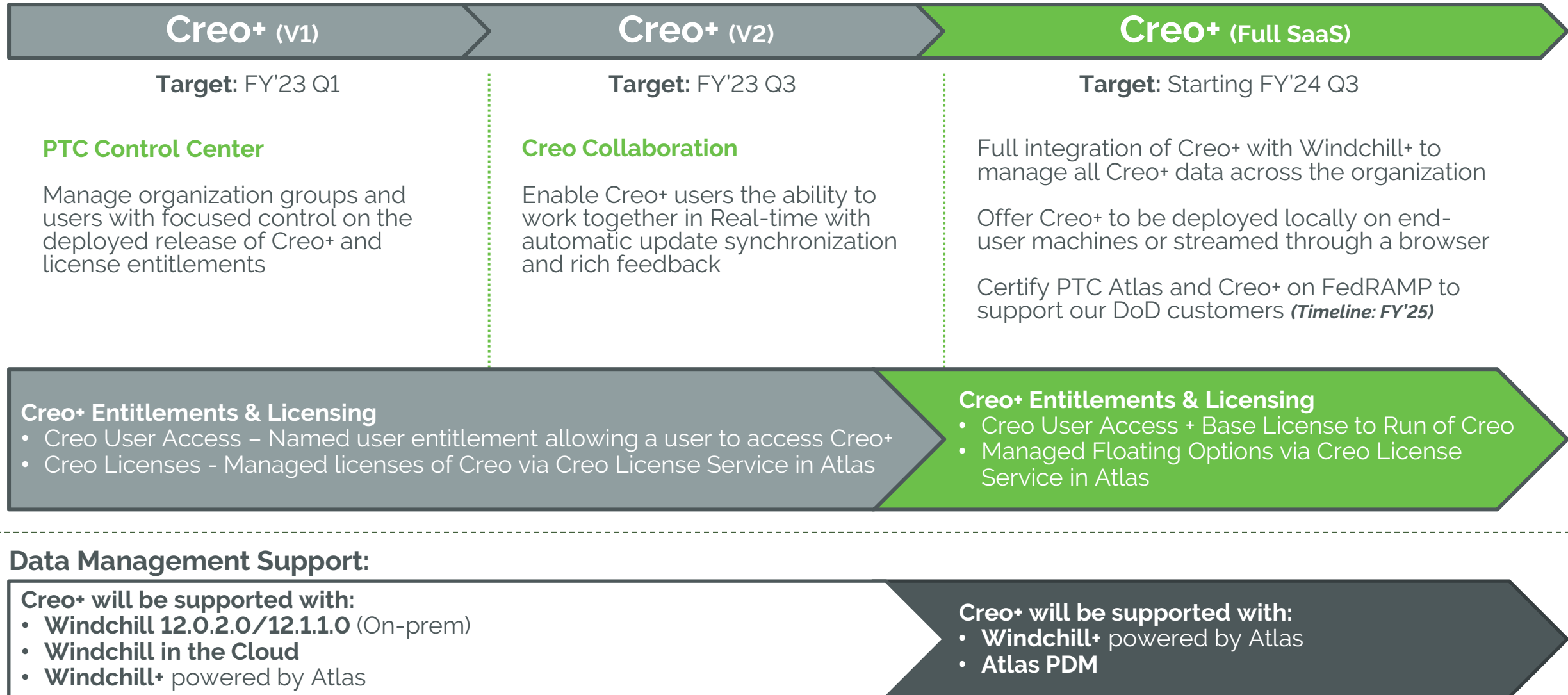
creo®

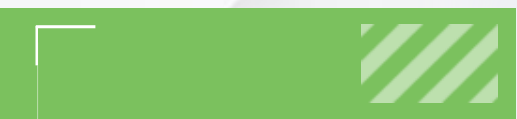
ptc® atlas



• **easy** to use • **easy** to configure • **easy** to deploy • **always** up to date •

CREO+ STRATEGY ROADMAP

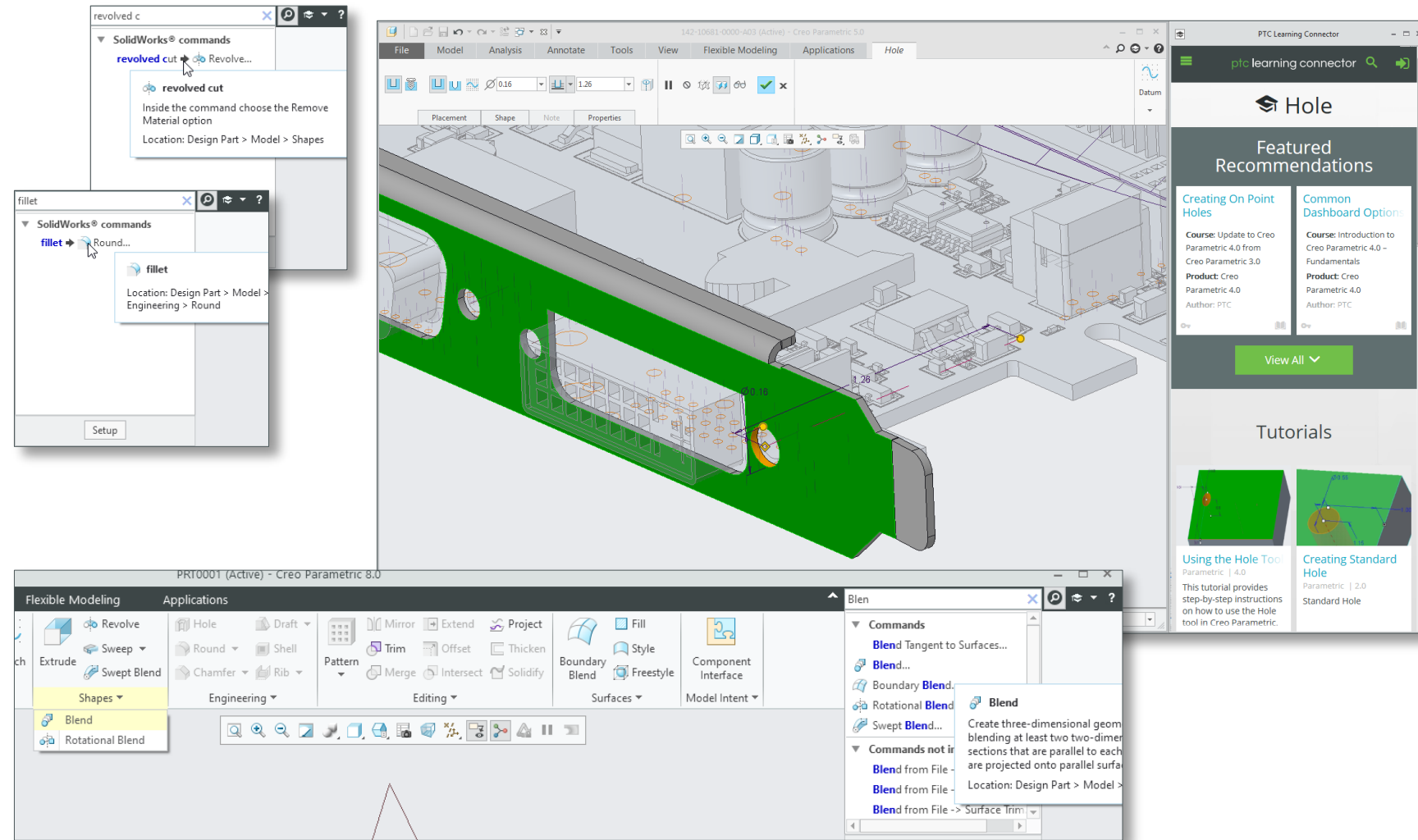




LEARNING CREO

USER GUIDANCE IN CREO

- Learning Connector
 - Consolidated, context sensitive recommendations
 - E-learning
 - Help Center
 - Knowledge base
- Command Search
 - Searching for any command in the current mode
 - Locate and activate the command



USER TRAINING WITH CREO LEARN

■ Comprehensive In-Person Training

- Case Studies
- Hands-on exercises
- Instructor demonstrations
- Knowledge Checks
- Discussion Questions
- Certifications

■ Online Training Subscription

- Unlimited course enrollment
- No hardware or software requirements – only internet access required
- Regularly updated content



Live Instructors



Flexible Class Schedule



Getting Started with LEARN



Virtual Software Environments



Certifications



Digital Student Guide



DIGITAL TRANSFORMS PHYSICAL

THANK YOU

ptc.com

