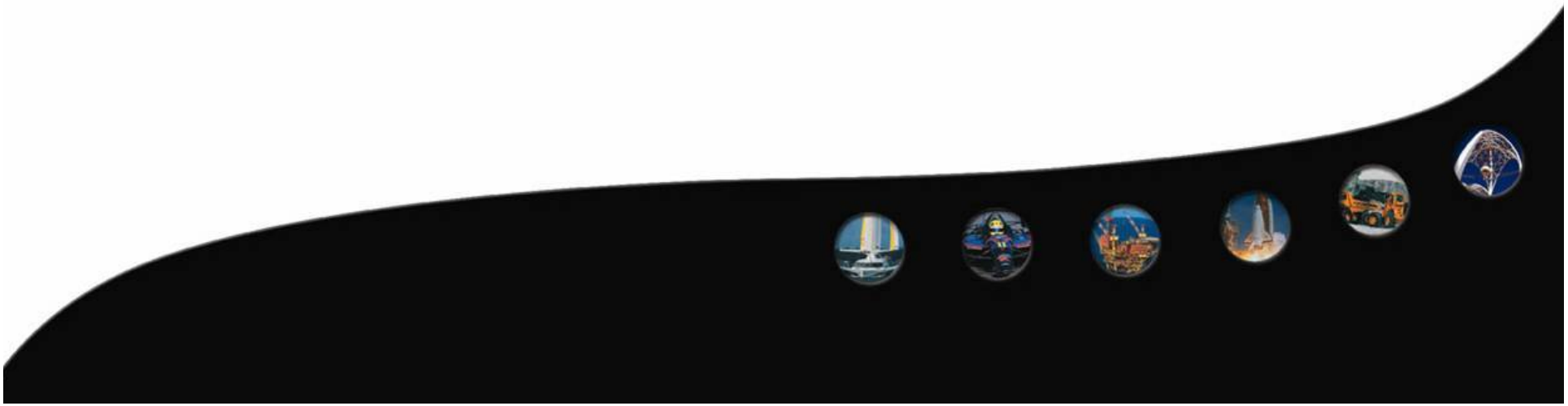
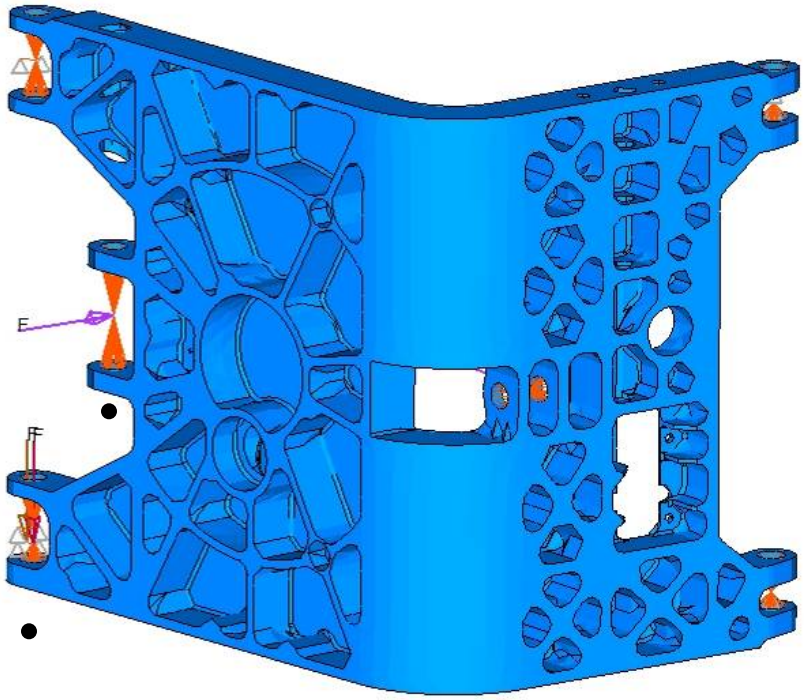
NA Regional Summit 2008 NAFEMS
2020 Vision of Engineering Analysis and Simulation
October 29 - 31, 2008 | Hampton, Virginia

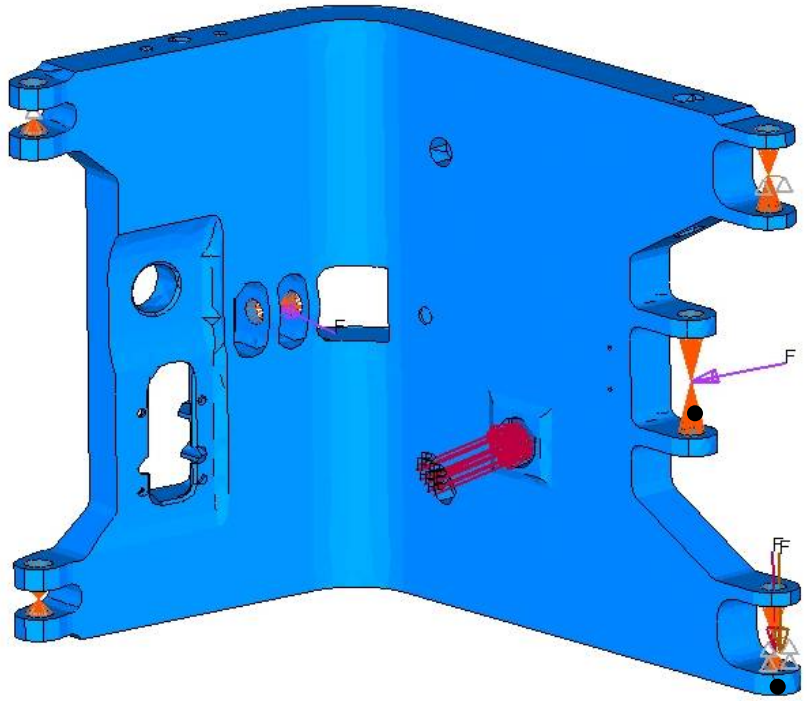
SIMULATION AND THE CREATIVE PROCESS – A NEW PARADIGM

Uwe Schramm
Altair



Door Hinge Element





- Total of three static load cases (Blocking of door mechanism, emergency opening, hit of damper mechanism on door)
- Stiffness given by nodal displacements in two places of original design
- Integrated part with given rib direction

Redesign - General Approach

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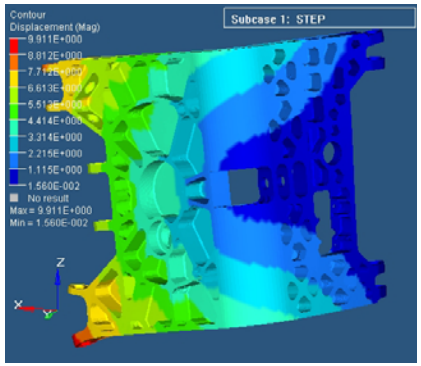
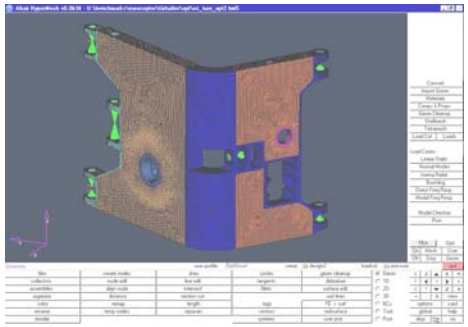
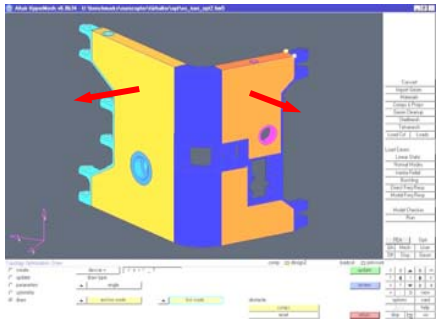
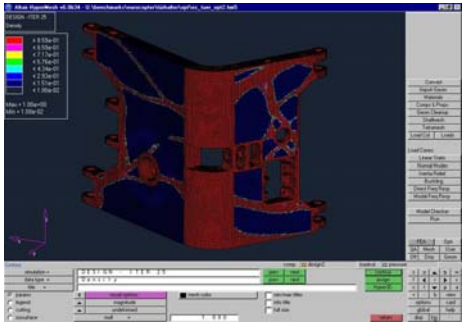
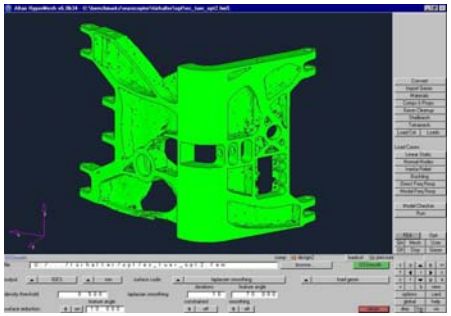
- Analysis of Original Design
- Meshing of Design Space
- Topology Optimization
- Export of Geometry with OSSmooth



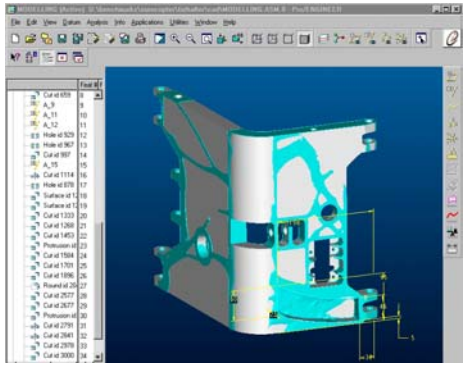


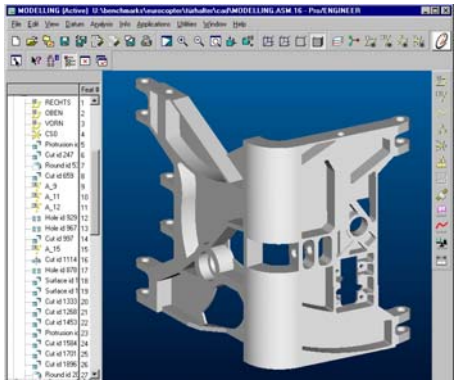


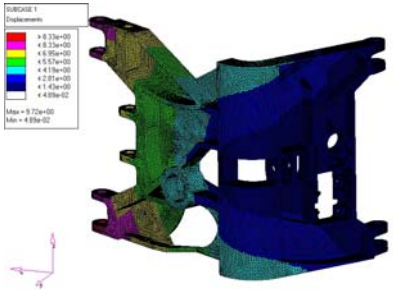


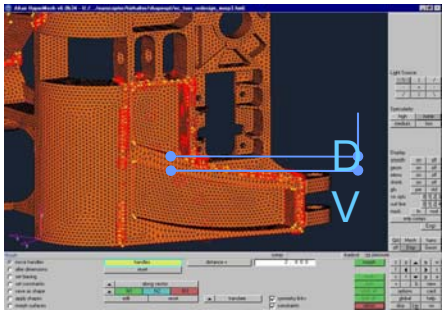


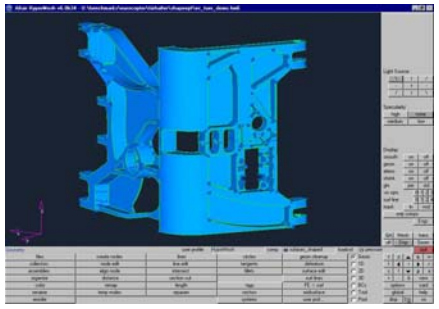
Redesign - General Approach





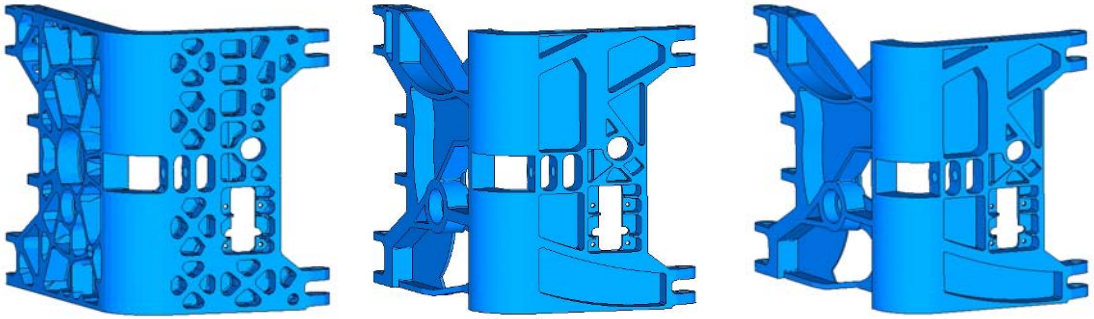


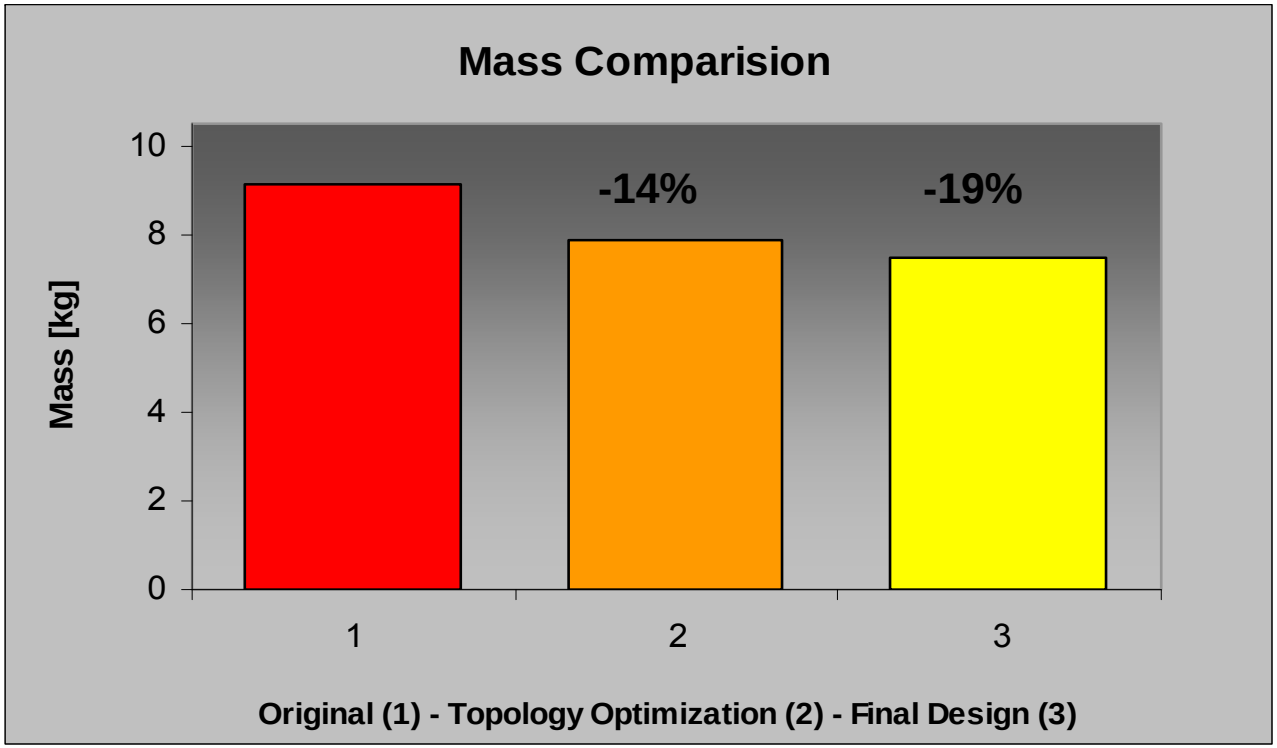




- Drafting of Design Proposal
- Analysis of Design Proposal
- Shape Optimization
- Export of final Geometry from HyperMesh

Results




Mass Comparision
Mass [kg]
10
8
6
4
2
0
-14%
-19%
1
2
3
Original (1) - Topology Optimization (2) - Final Design (3)

Development Time

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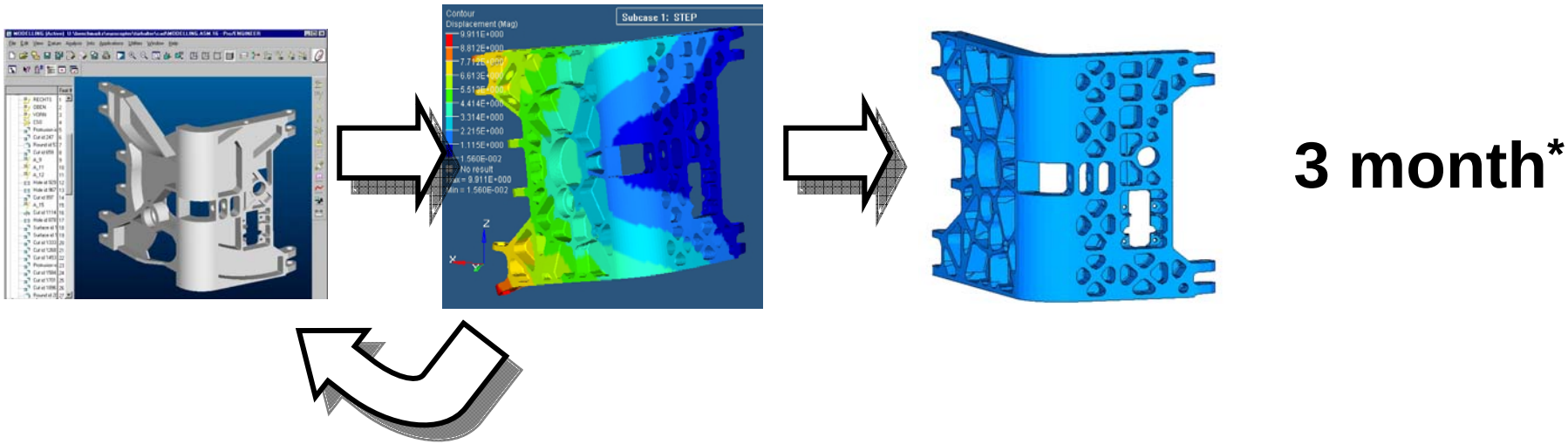
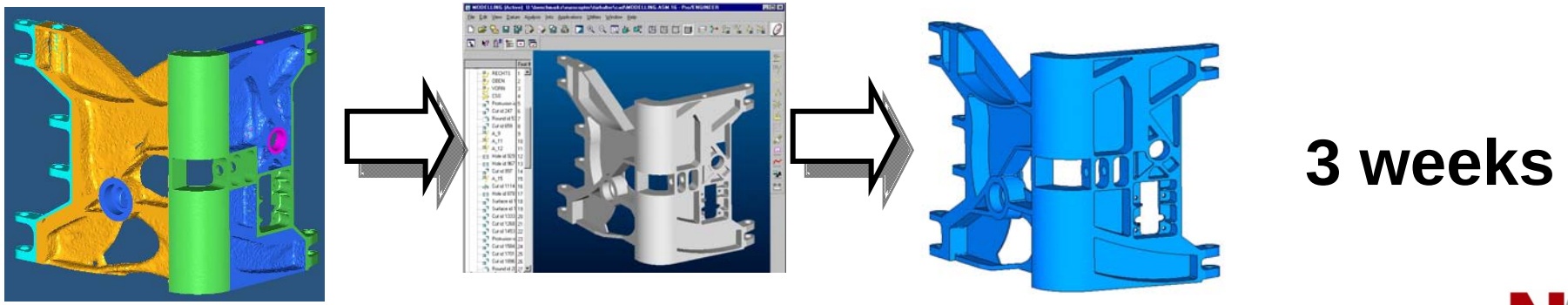
Design by Intuition vs. Design by Simulation



3 month*



3 weeks

*statement from customer

Business Equation

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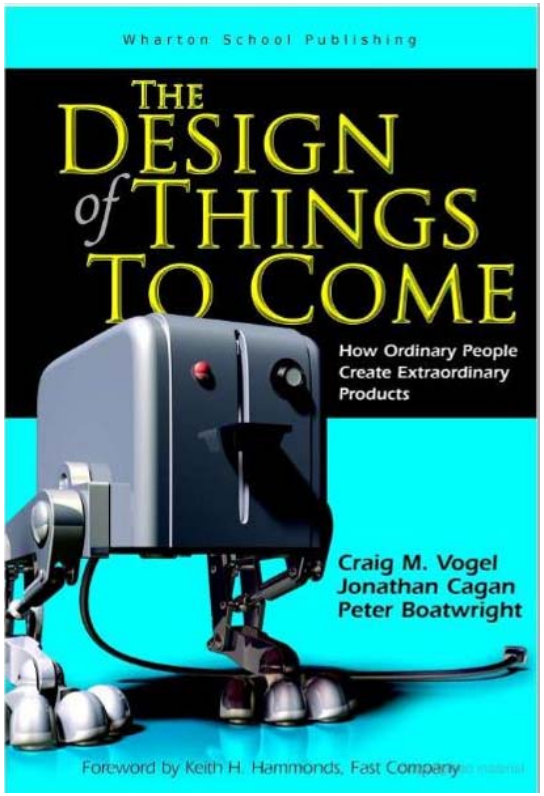
- Making a business successful is an optimization problem
  - max *profit* = max (*price* – *cost*) subject to available capital
- Reduce cost
  - Innovation – be more creative
  - Time to market – shorter development cycle
  - Performance – get out the last reserve
- Increase price
  - Innovation – never seen before
  - Time to market – be first
  - Performance – the best

Innovation

- Separates market leaders from the pack
- Disruptive innovation introduces new products
- Sustained innovation to existing products
- Key to survival of a company

Innovation



"Differentiation now must happen through innovation; that is the strategic weapon that drives profit in the new global economy."

Innovation

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"The stock market tends to punish [business that cut spending on research and development] and reward those with a commitment to R&D - often years before long term projects reap benefits"

To Make a Stock Pop, Innovate,
The New York Times,
Sunday, August 31, 2008


The New York Time

STRATEGES

To Make a Stock Pop, Innovate

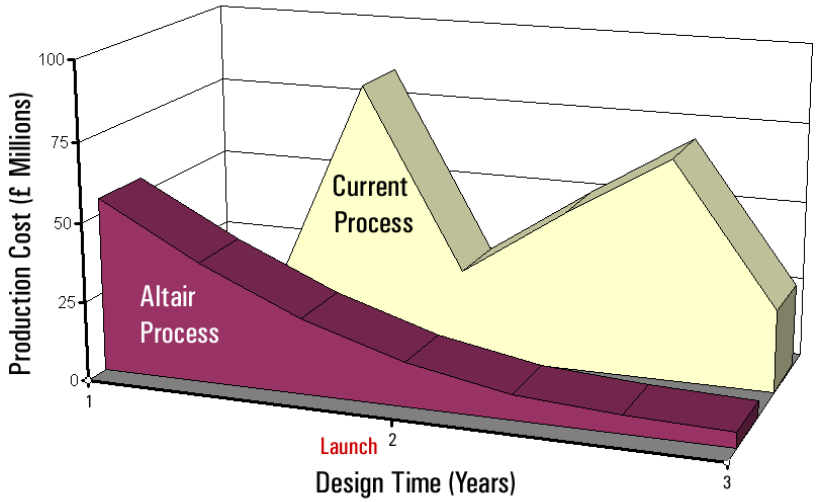
By MARK HULBERT

ESPECIALLY when times are tough, beware of companies that
their spending on research and development. The stock market
to punish such businesses and reward those with a commitme
R.& D. — often years before long-term projects reap benefits.

Those conclusions come from a study, "Do Innovations Re
Off? Total Stock Market Returns to Innovation,"

Time to Market

- Cost escalates, sales are lost due to launch date slippage
- Design changes late in the process can cost three orders of magnitude more than at concept stage
- Often engineers' effort diverted from concept stage because of post launch problems
- Design Process should provide a framework to produce a controlled design expenditure



Product Performance

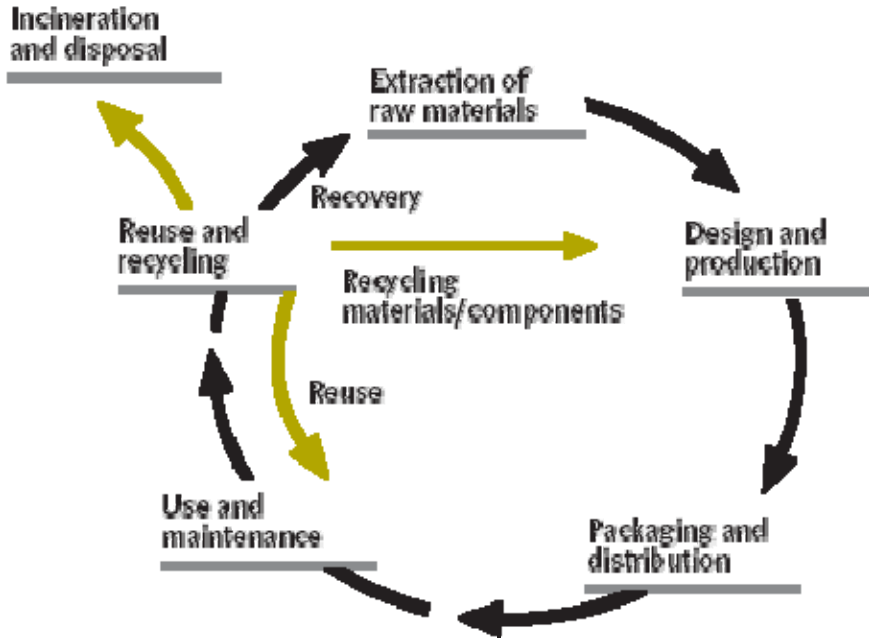
- Features
- Cost of ownership
  - Quality
  - Energy consumption
- Environmental footprint
- Social impact

Product Life Cycle

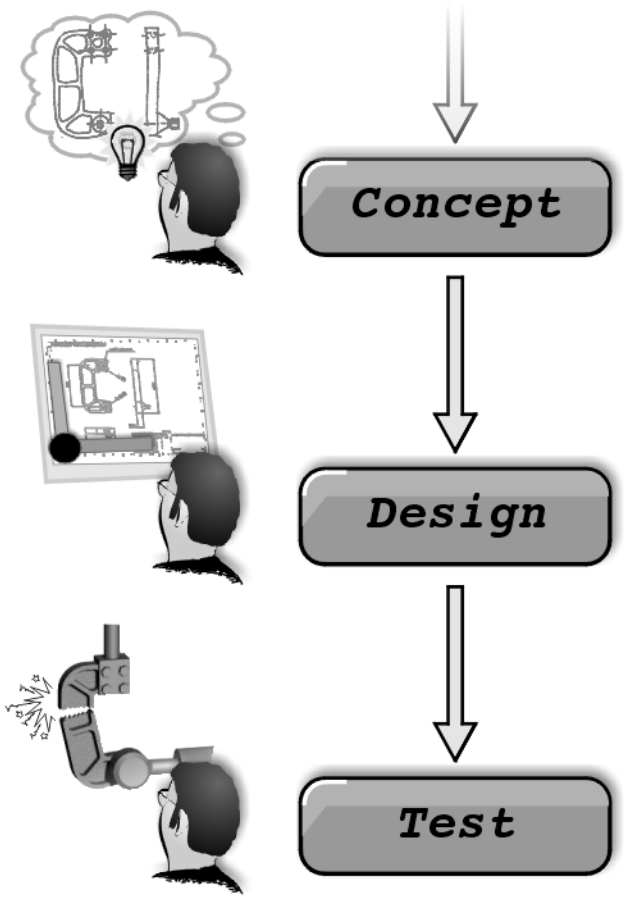
- Market analysis
- Ideation
- Creation
- Validation

} Design

- Manufacturing
- Rollout
- Product life
- Disposal/Recycle



Phases of Design Development

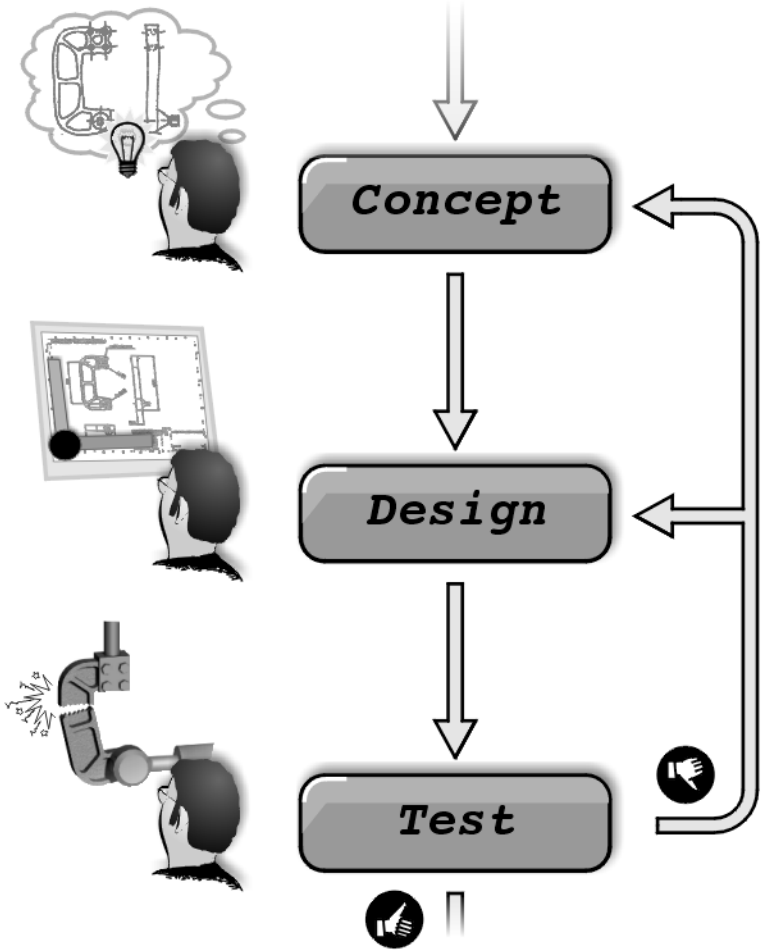


... corresponding to a number of requirements a design concept is developed ...

... detailed design following the concept ...

... design is tested to the requirements ...

Phases of Design Development

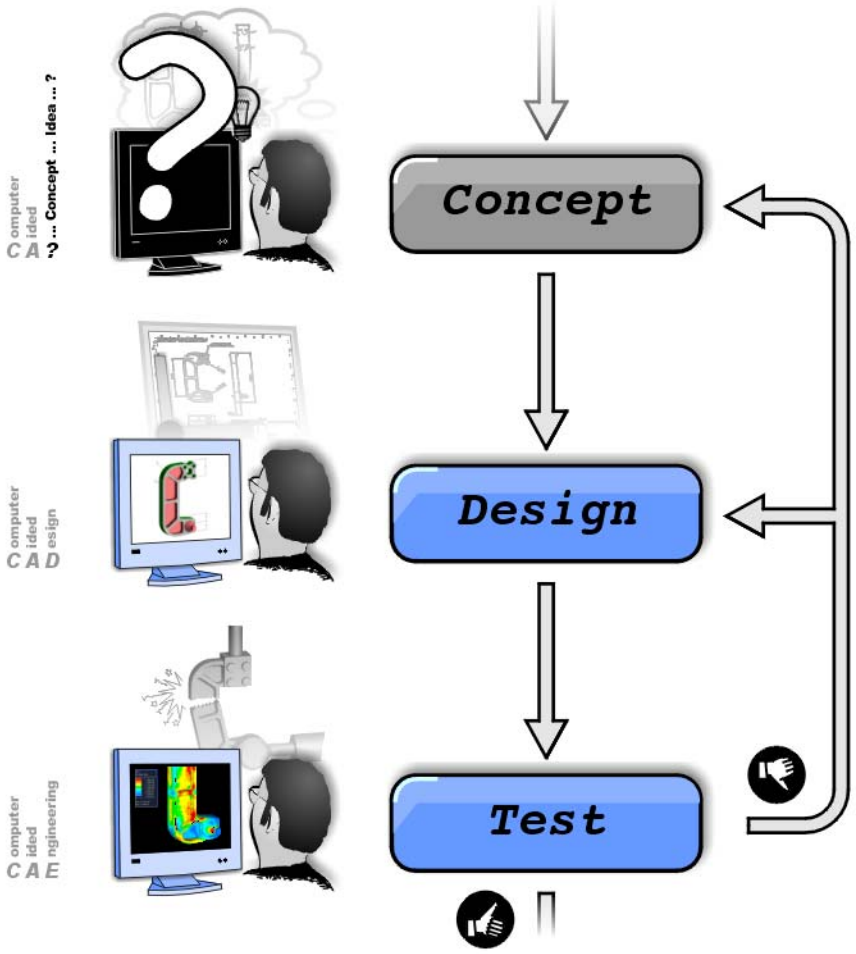


- In the concept phase most of the importand decisions are made !
- This phase is most important to control the cost of the design developmet !

If the design does not fulfill the requirements iteration is necessary !

If the design fulfills the requirements, the process is finished !

Phases of Design Development

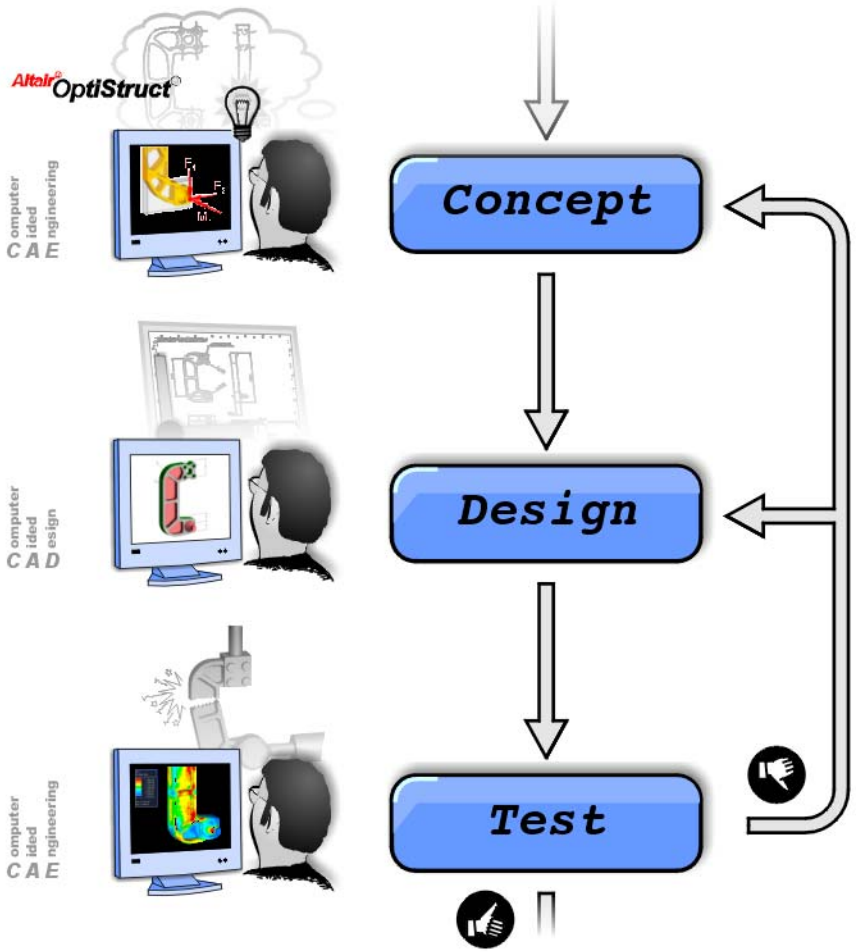


Is there a way to support the most critical concept phase of the design process?

... CAD drastically reduced the effort to maintain design states and to make modifications to drawings ...

... CAE allows quick and reliable assesment of the design ...

Phases of Design Development

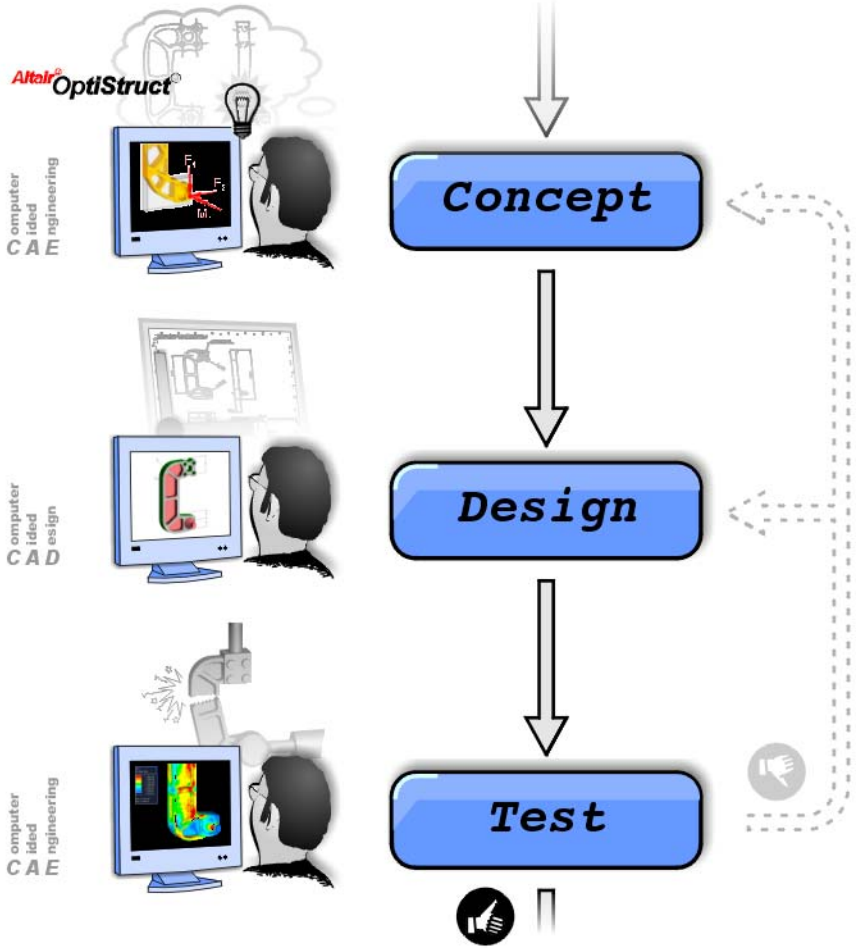


Optimization brings CAE into the concept phase and so helps to get the concept right the first time!!!

... CAD drastically reduced the effort to maintain design states and to make modifications to drawings ...

... CAE allows quick and reliable assesment of the design ...

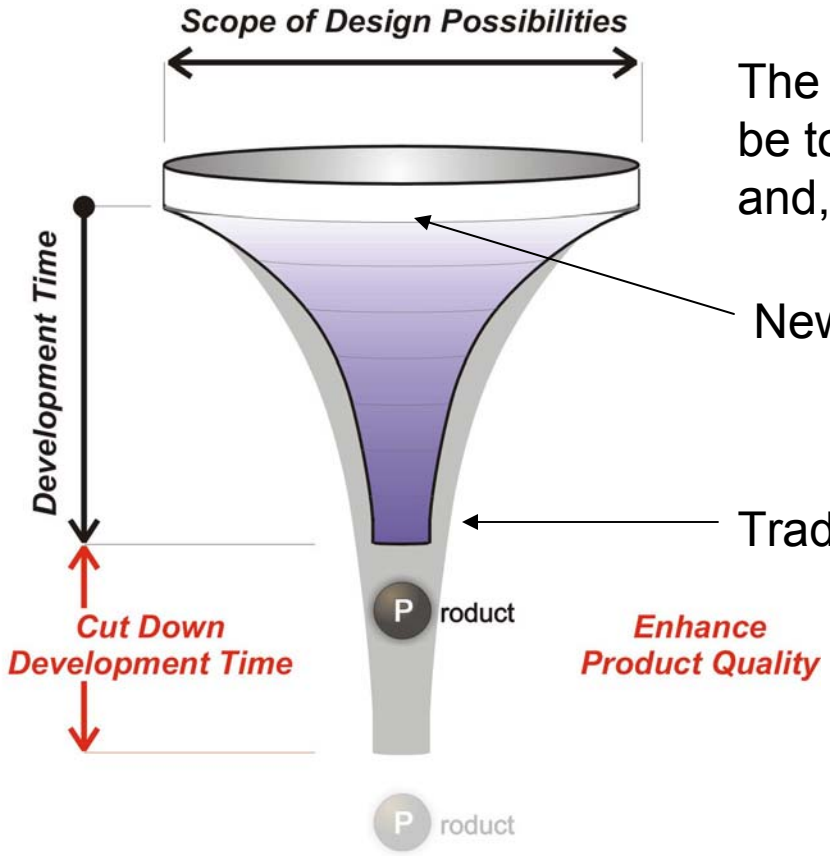
Phases of Design Development



Optimization brings CAE into the concept phase and so helps to get the concept right the first time!!!

Design iterations are minized!

The Funnel



The fuller the funnel, the surer we can be to find the right concept and, hence the best design

New place of CAE (Optimization)

Traditional place of CAE (Verification)

Virtual Prototype

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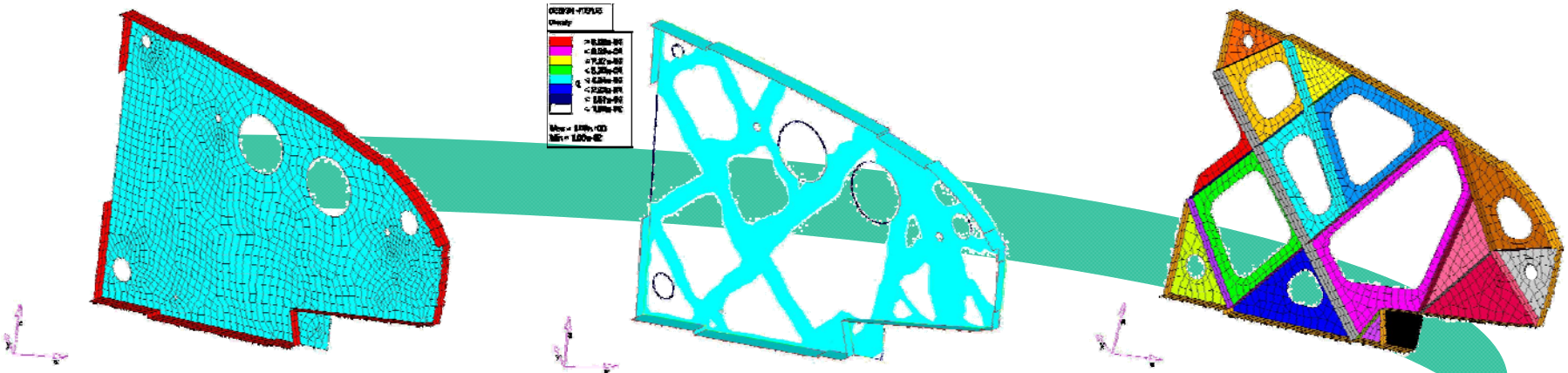
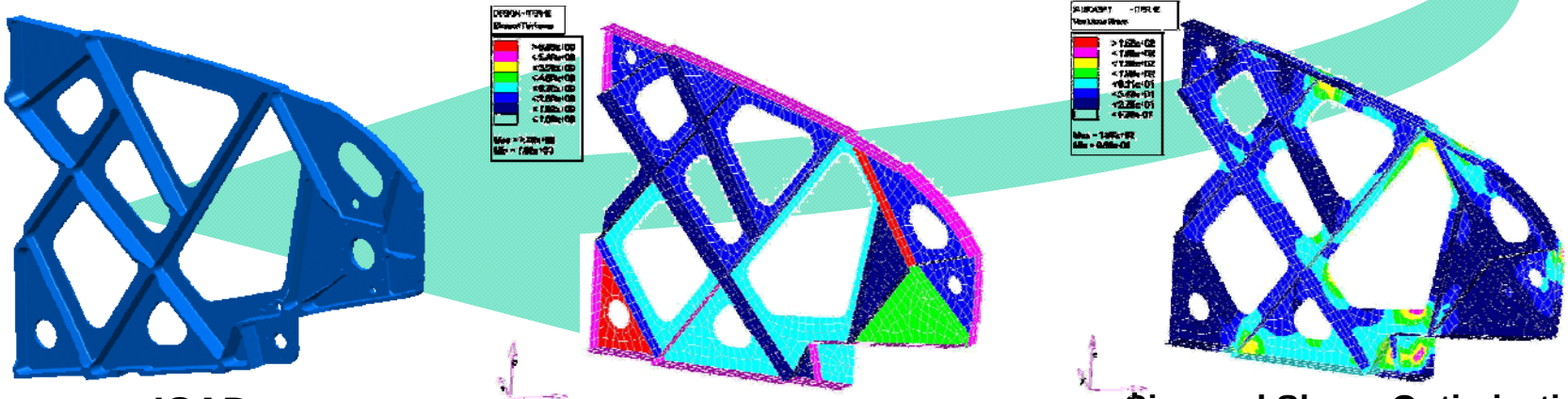
AIRBUS



Topology Optimization
Design Space and Load

Topology Optimization
Stiffness Material Layout

Topology Optimization
Geometry Extraction



ICAD
Solid Geometry Extraction

Size and Shape Optimization
Geometry Extraction

Size and Shape Optimization
Buckling and Stress

Airbus A380 Leading Edge Rib Design

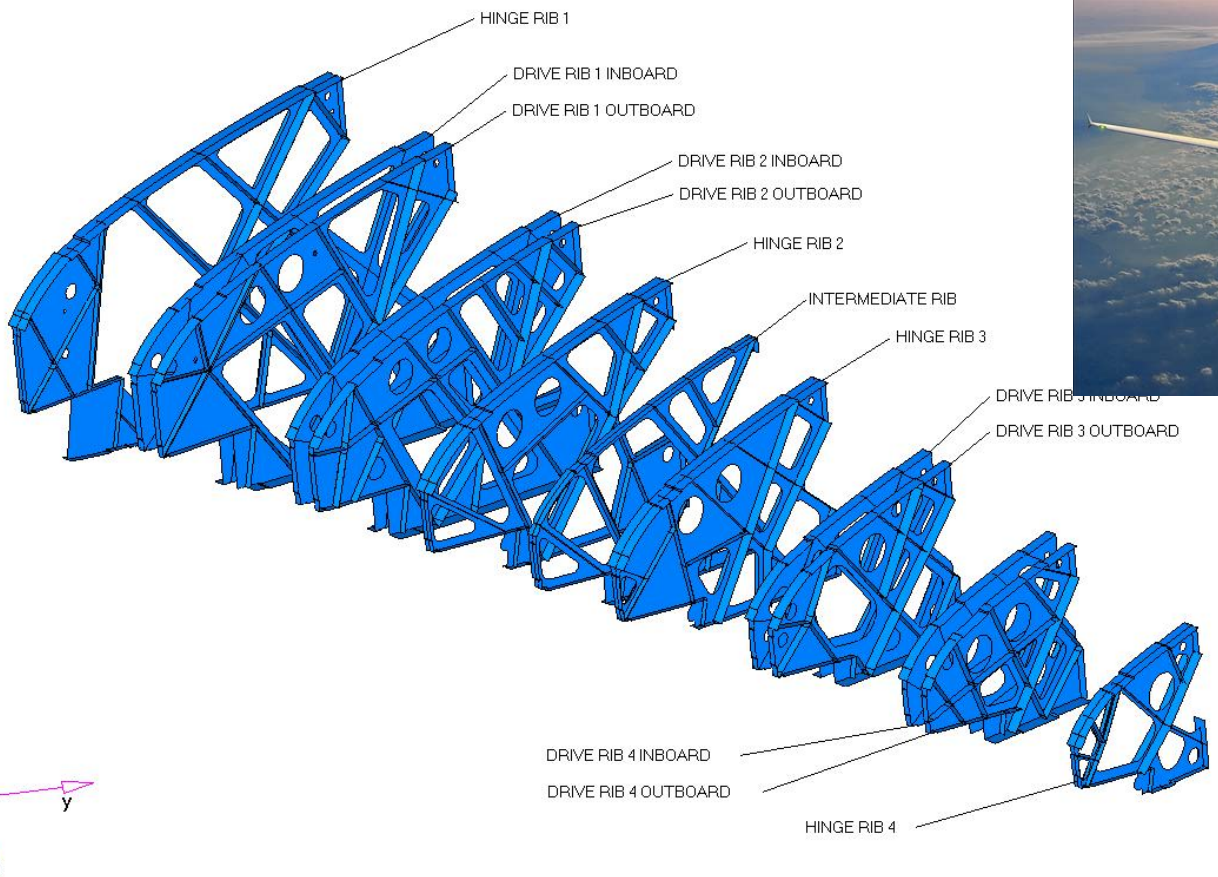
Altair

AIRBUS

Airbus A380 Leading Edge Rib Design

Altair

AIRBUS



Functional Virtual Prototyping

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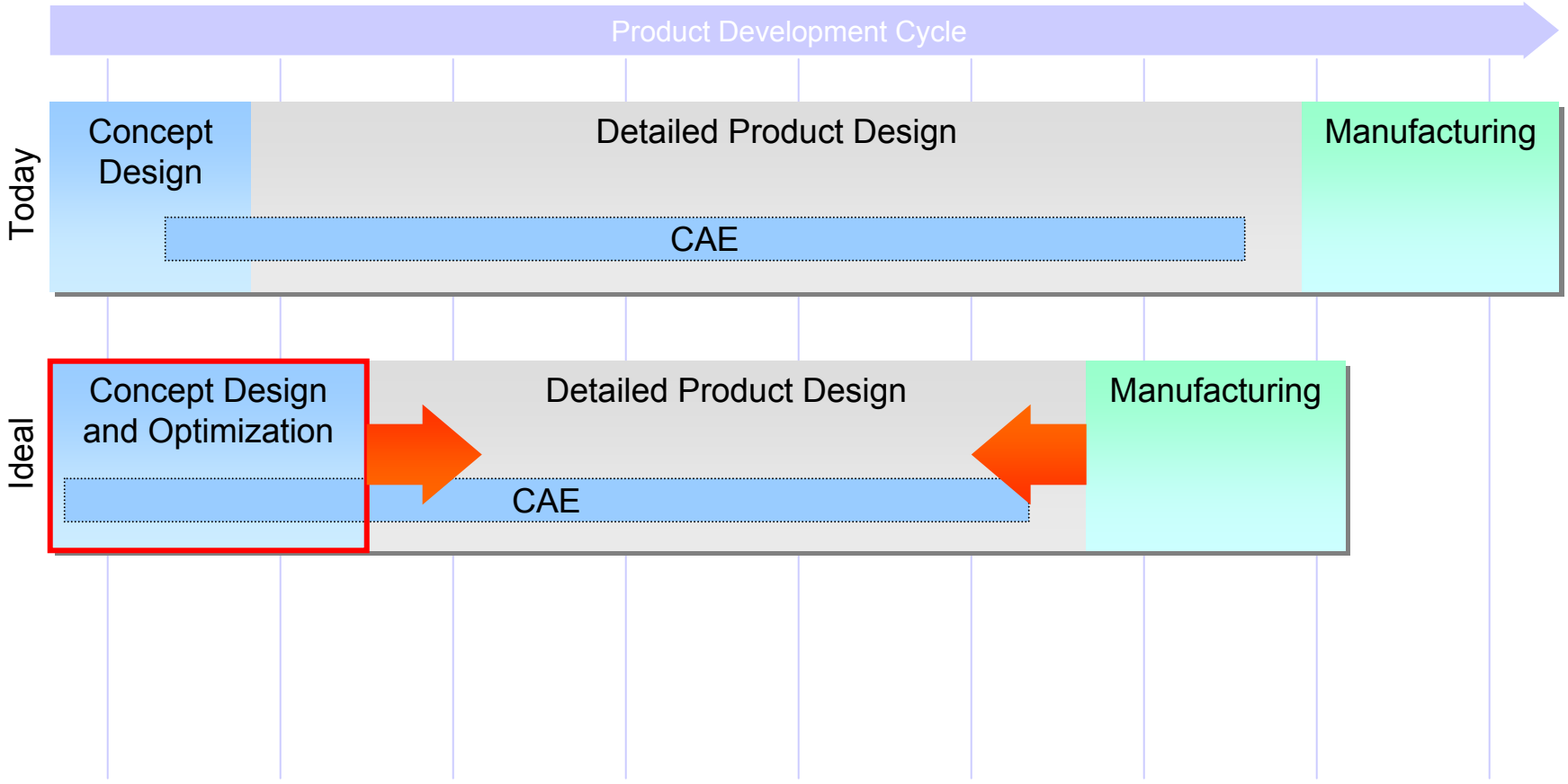
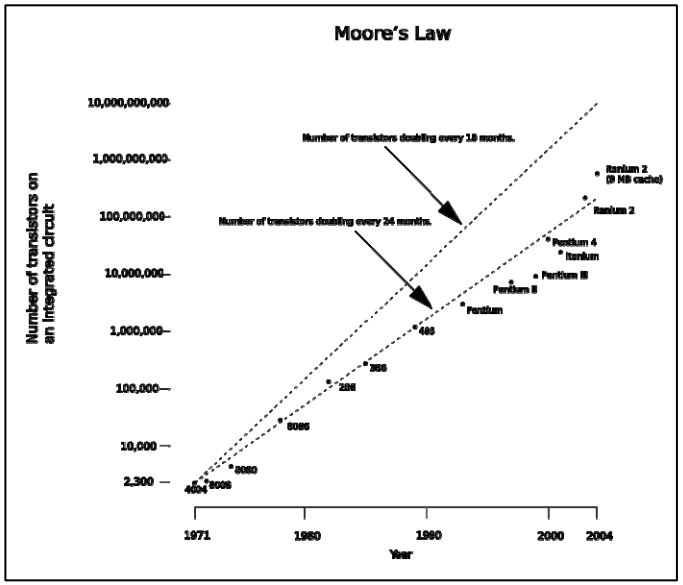
- Non-parametric geometry
  - Mesh
  - Facets
- Easy manipulation
  - Morphing
  - Plug and play
- Functional
  - Predictive
  - Interactive
- Realistic rendering
  - Photo realistic, real time
  - Capturing appearance and emotion

Move CAE Upstream and Capture Concept Design

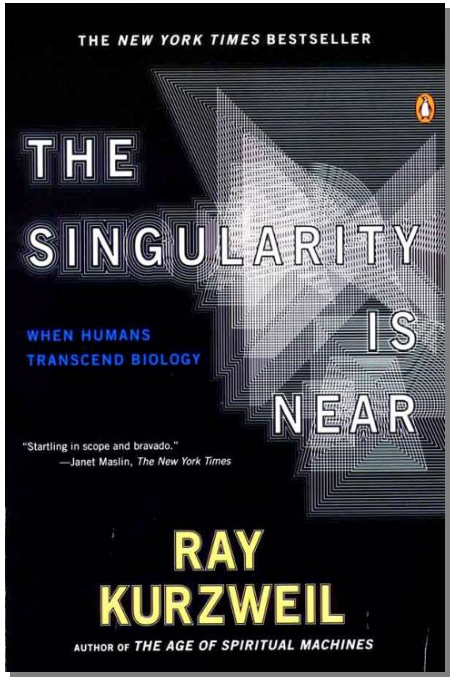


Computation

- At the center of the creative process
- Moore's law
  - 2 times speed in 1.5 - 2 yrs.
- 2008 to 2020 → 12yrs → 64 to 256 times speed
- 12min → 3s



Computation

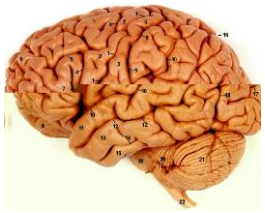


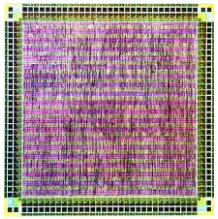
By 2020, … "it's reasonable to expect non-biological, computational capacity that can emulate the human brain will be available for approximately $1,000."

By 2050, $1,000 of "computing will exceed the processing power of all human brains on earth."

Source: The Singularity is Near by Ray Kurzweil

Computation





"We will become vastly smarter as we merge with our technology … from biological thinking to a hybrid."

Source: The Singularity is Near by Ray Kurzweil

Engineering Framework

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- Automated modeling and performance assessment
- Engineering data management (engineering data is the keeper of design knowledge)
- Knowledge capture and data mining
- Multi-disciplinary reporting, trade-off and collaboration
- Computational ideation, Plug and play
- Optimal material layout technology with manufacturing considerations
- Robust and reliability-based design
- Mathematical modeling and computational simulation for multi-physics attributes
- Virtual manufacturing validation
- Ubiquitous access to compute power
- Massively parallelized computation (local, distributed)
- On demand licensing

Put the E back in CAE

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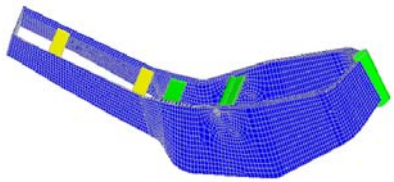

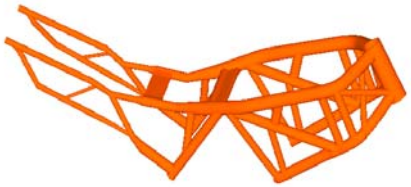

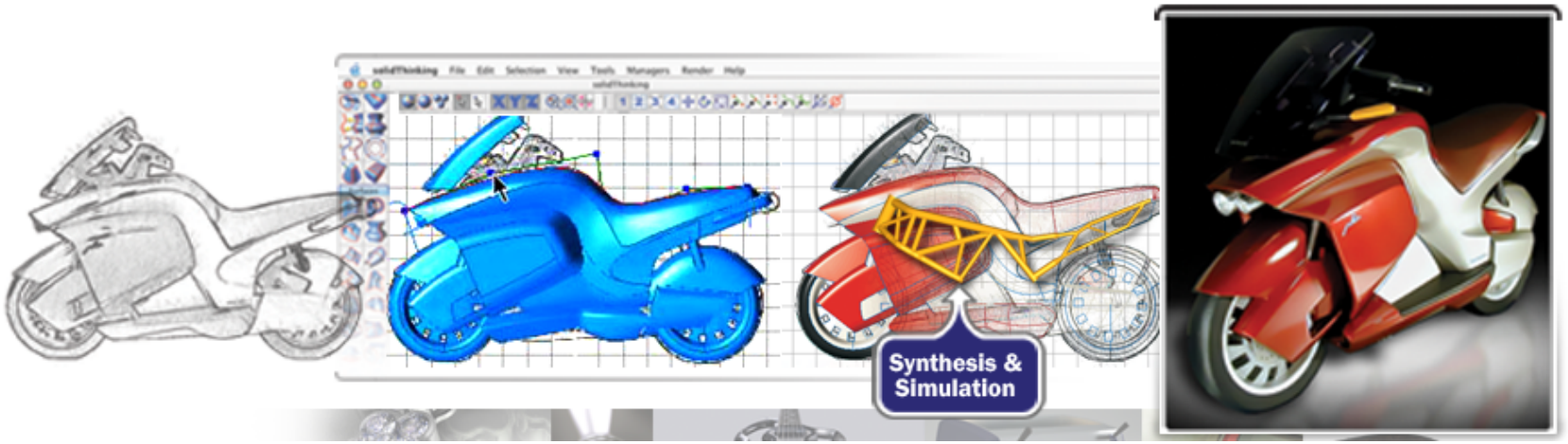

2020

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- New means of user interaction with computer and software
- Massive computation in a mix of local and distributed resources
- Collaborative interactive design environments based on functional virtual prototypes
- Interactive, predictive multi-disciplinary performance and manufacturing evaluation

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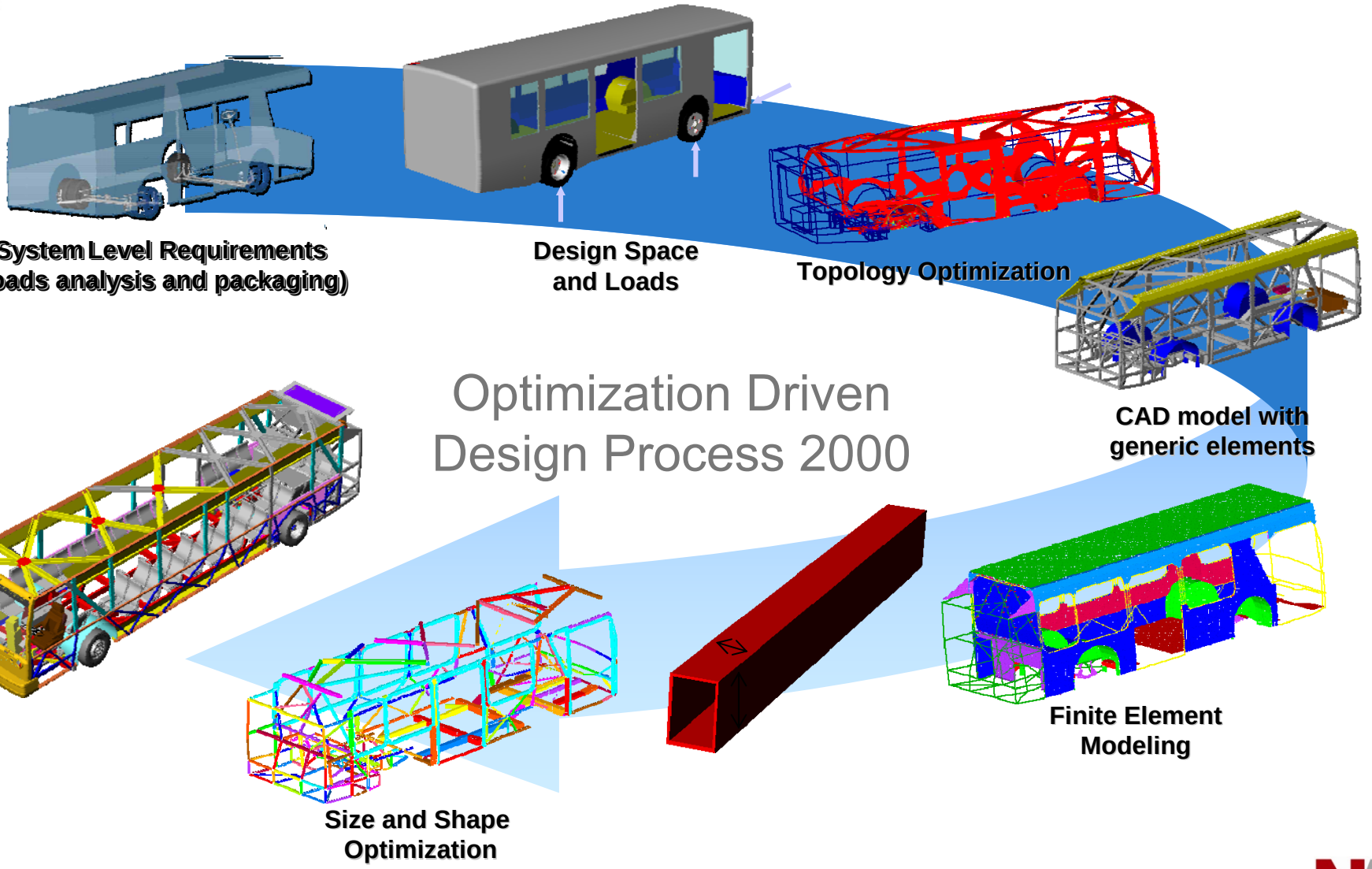
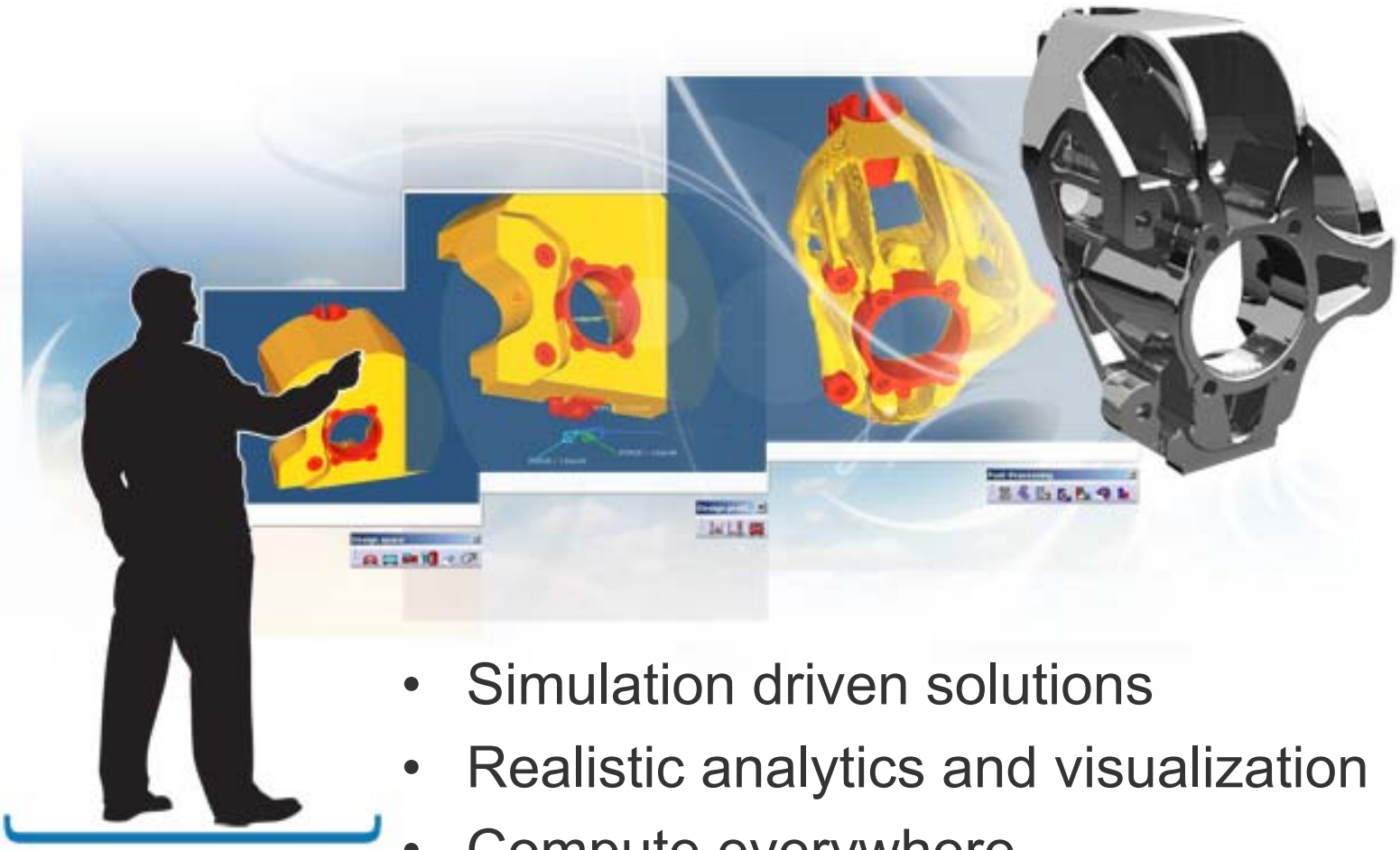

System Level Requirements
(loads analysis and packaging)
Design Space
and Loads
Topology Optimization
CAD model with
generic elements
Optimization Driven
Design Process 2000
Finite Element
Modeling
Size and Shape
Optimization

Conclusion



- Simulation driven solutions
- Realistic analytics and visualization
- Compute everywhere
- Per-use licensing