

Professor Craig Chapman
Presents:

The utilisation of knowledge for the rapid development of design engineering automation solutions

Knowledge Information Data (KID) management



International Conference on
Design and Production Engineering
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BIRMINGHAM CITY University

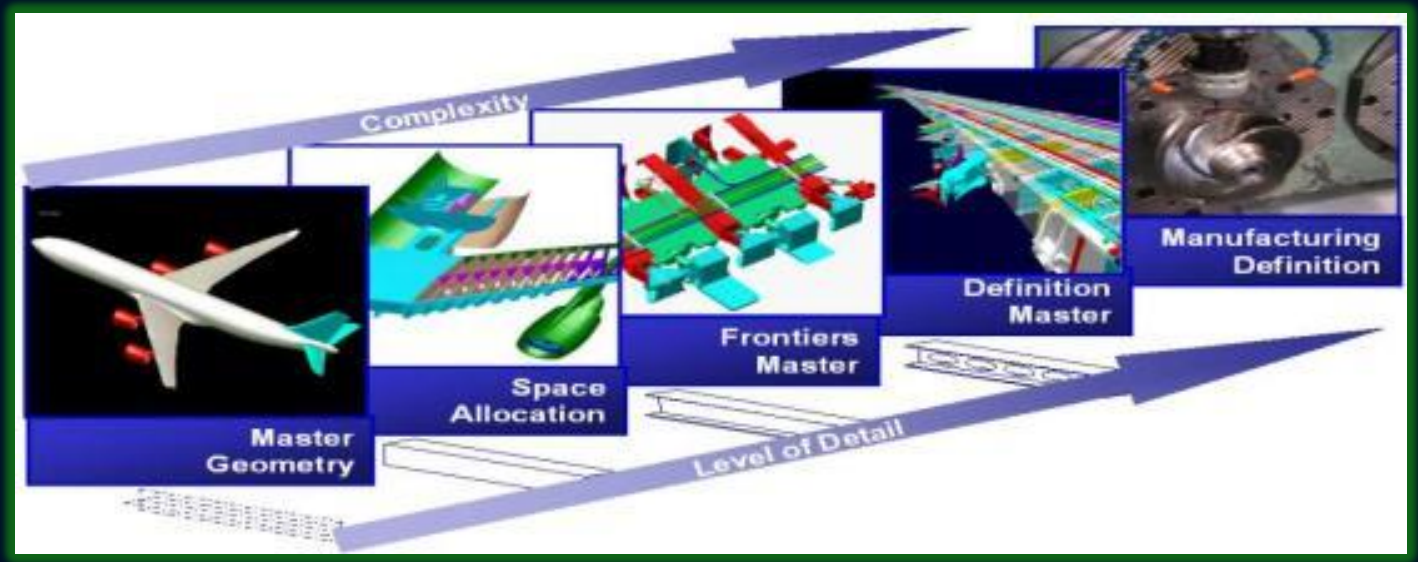
Outline

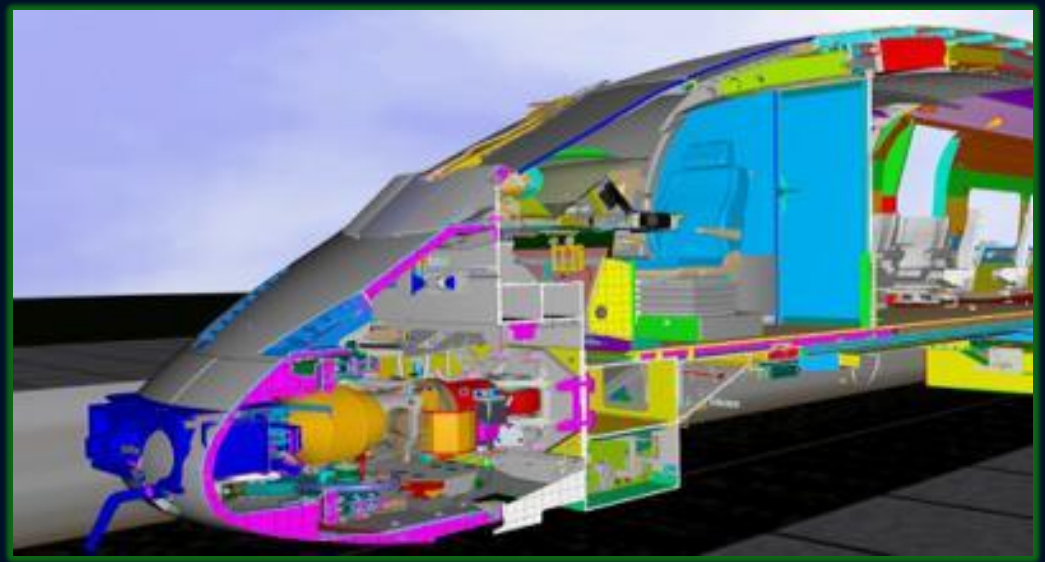
- Where are we now (manual, semi-automatic)
- KBE– situation today + examples
- So where do we need to GO?
- Why I do KBE

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Virtual Engineering

"Virtual Engineering is aimed at allowing the synthesis, analysis, evaluation and optimal development of a product in a computer environment that mimics the understanding and behaviour of the solution to the realization of that solution in reality" *C Chapman*.





Consider all the other required models - FEM, Physics, cost, process – are they coupled

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Its never really been about the 'Geometry is the Master Model' & associated documentation - Consider a Simple Shaft

Engineering Rules

Bearing size to suit shaft diameter
Bearing life to suit load and life requirements
Calculation of bearing life
Tapped end hole to suit shaft diameter
Tap length to engineering standards
Surface finish to suit auxiliary components e.g. Oil seal
Calculation of max permissible load (load type: radial, axial, combination)
Weld calculations (possible/strength) for hybrid shafts
Shaft diameter for brake size
Fan or non-fan vented
Keyway size to suit diameter
Tolerance to suit required standard and final assembly
Material properties
Thread and keyway standards
Motor output and phase

Multiple Model Requirements

Geometric Rules

Extension overall length
Shaft overall length
Extension diameter
Keyway length
Keyway width
Bearing diameter
Rotor groove positions
Fan area diameter
Chamfer dimensions
Fillet dimensions
Undercut dimensions
Number of extension segments

Engineering Processes

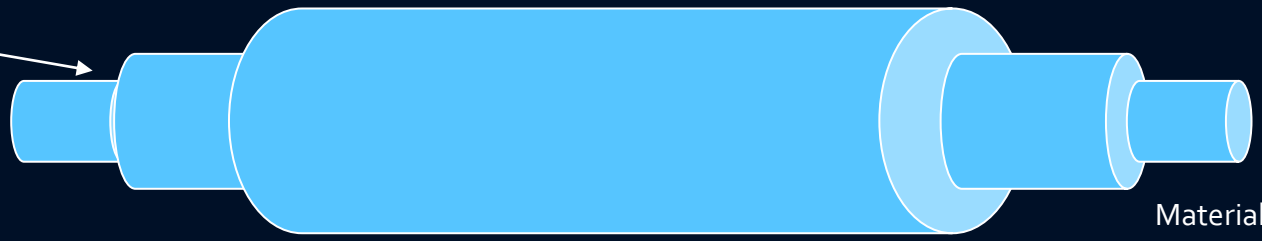
Manufacturing Rules

Machine capacities
Machine capacity (tolerance)
Machine set-up times
NC tool path information
Grinding allowances
Tooling availability
Material availability
Fastest throughput, route
Material type

Assembly Rules

Reduce part count
Standardise
Modularise
Handling
Insertion

Multiple topologies



Cost Rules

Standard bar size
Material cost (type, volume, economic batch size)
Direct labour costs
Overhead costs per machine (machine/hr rate)
Lowest cost route
Extras pricing band

Service

Maintenance

Legislative standards

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Models / KID / Tools in automation?



- Data-exchange for AUTOMATION?
- We need to consider model-transformation and automate this process.
- *Computer based tools have developed to complement or assist the multidisciplinary team, giving the ability of each member to access a common product model data base (CAD, CAE, CAM, PDM, PLM, etc). At present, these models are limited in their ability to use the product and process KID needed for automation and infer on design engineering changes, and it still remains the duty of the team member to asses the impact of any change to the product model.*

Common Computational Model - Discuss

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Knowledge Based Engineering Examples

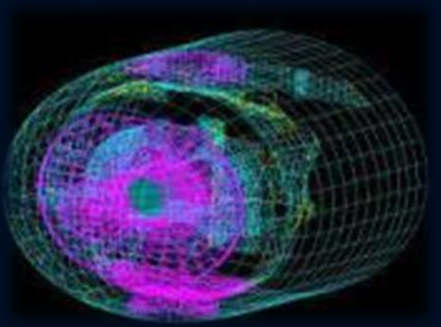
- Lockheed Martin – Gimal Design & Synthesis (shows KBE as an intelligence layer within existing CAD/CAE environment)
- Rolls-Royce – Key System – Design, Analysis, Simulation, Tooling.
- Aker Solutions – Capture of engineering enterprise knowledge for product realisation and knowledge reuse.
- New Trend – Real 'Physical' to Virtual.

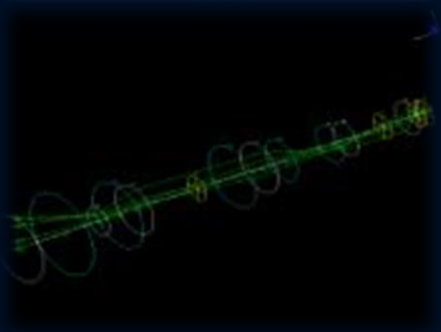
Special thanks to: TECHNOSOFT

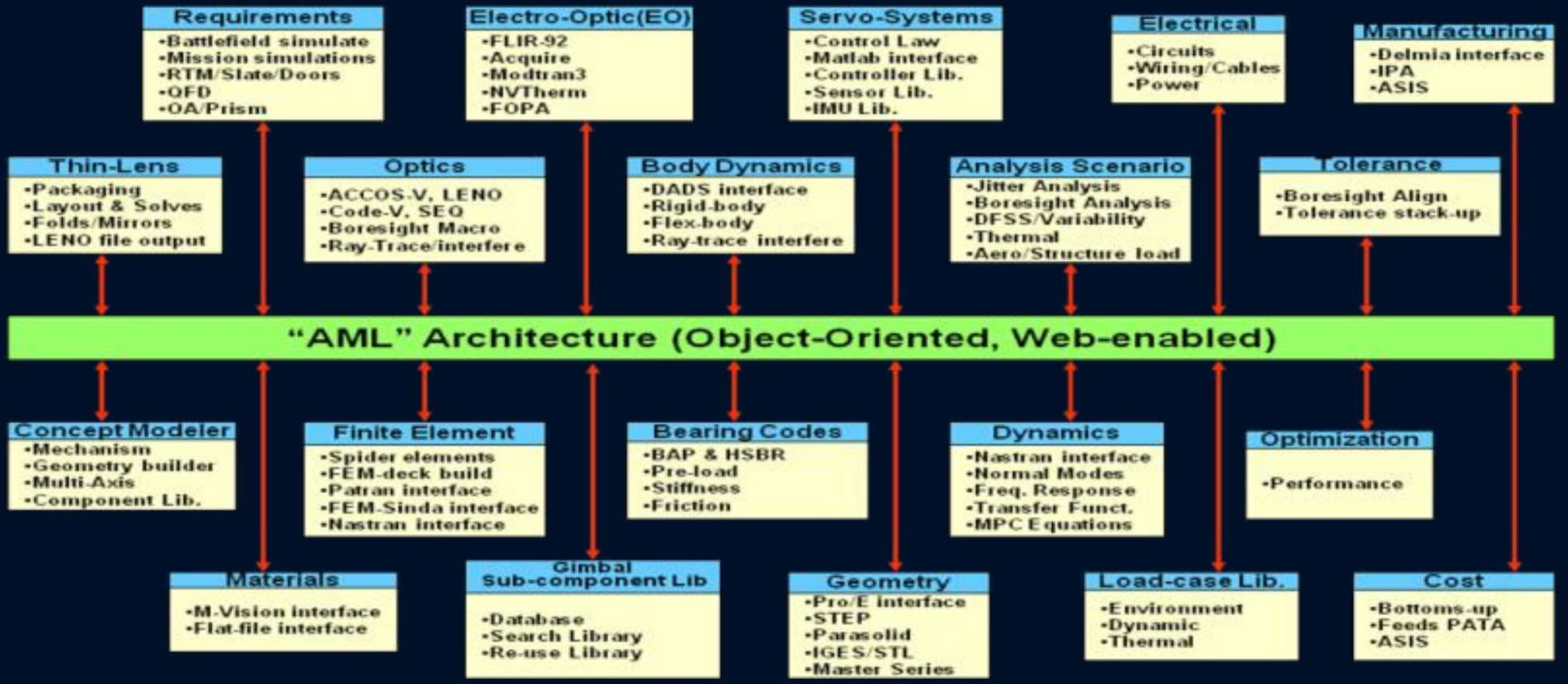
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Gimbal Design and Synthesis







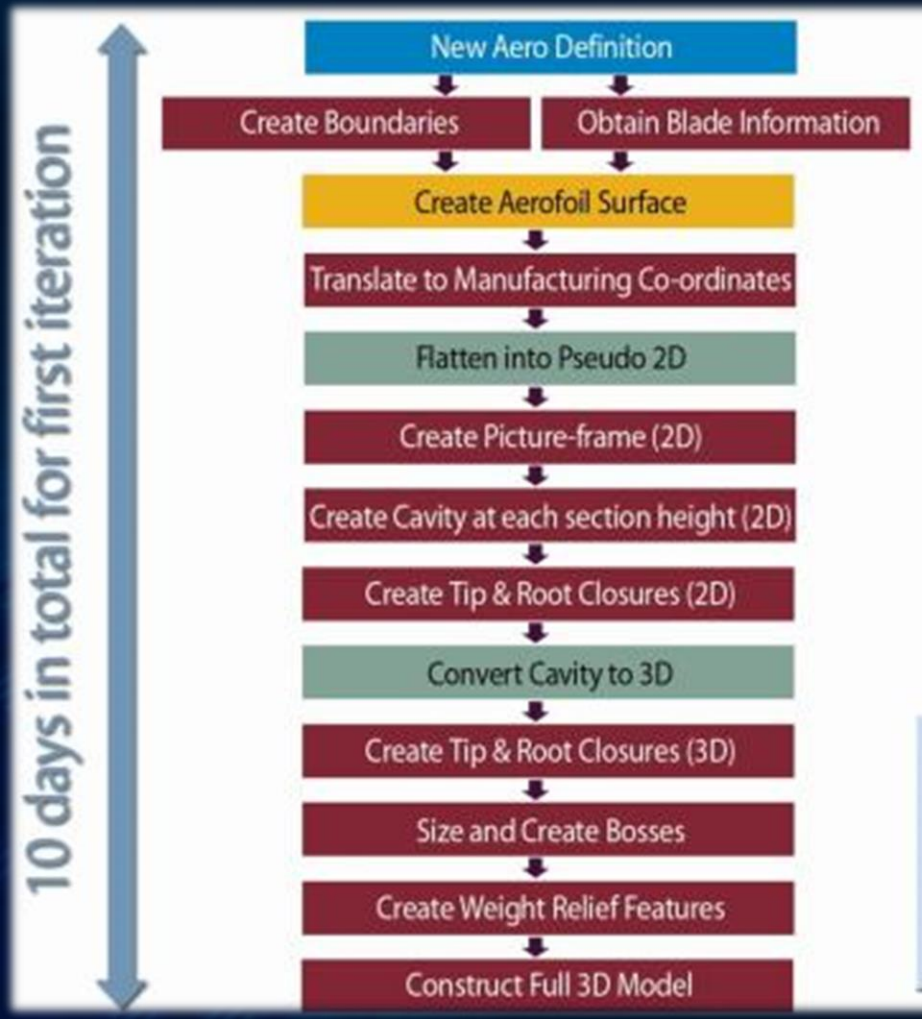


TechnoSoft Inc. / Lockheed Martin

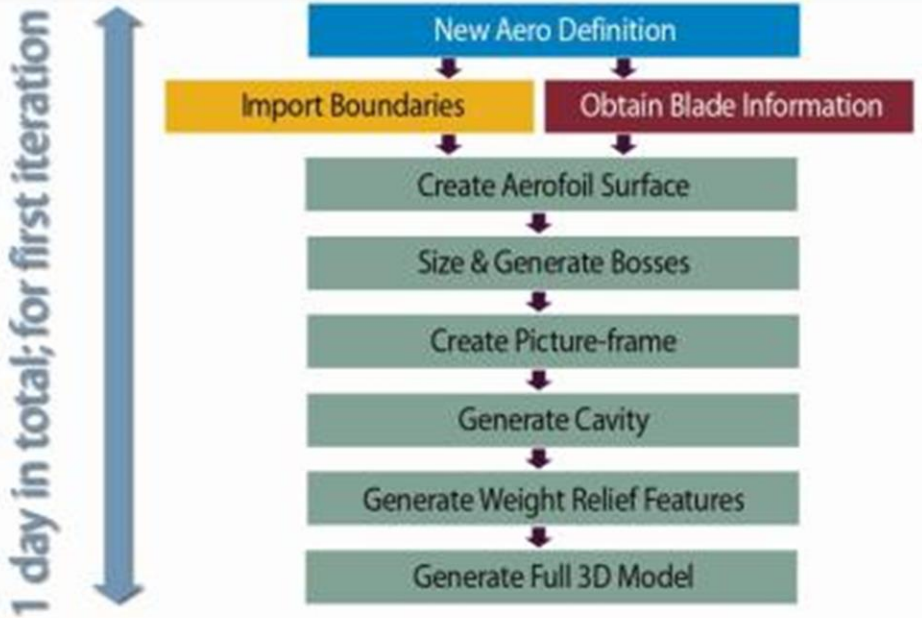
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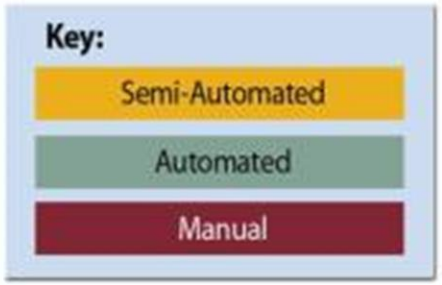
Example of KBE: A Leaner Process

Old Process without KBE System



New Process with KBE System

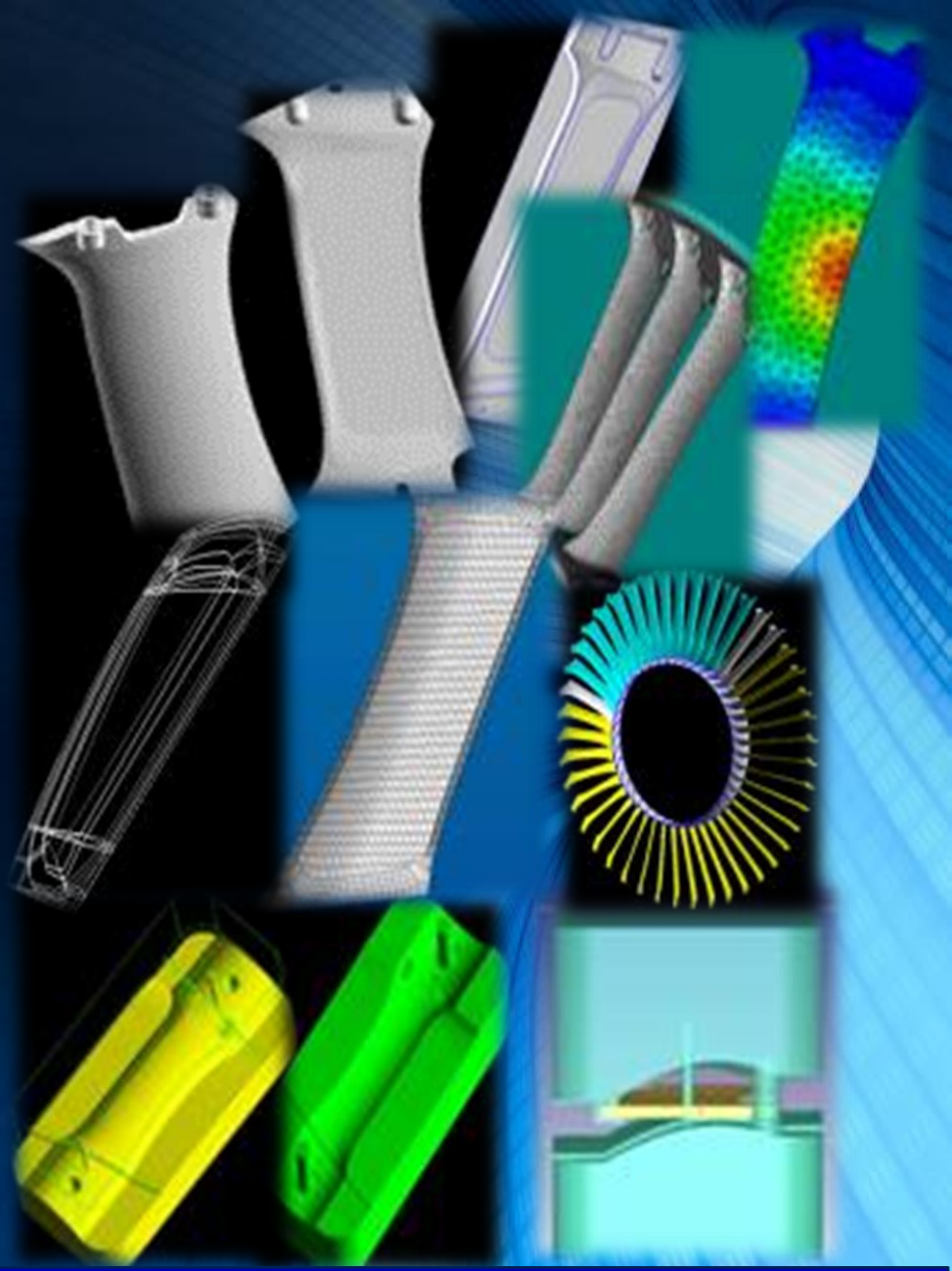




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Usage and Benefits Delivered: Fan

- Used on civil and military NPI programmes
- £0.5M net benefit to-date in Design and Manufacturing Engineering modelling activities (technical time)
  - **system developed in 4 months**
- 10 fold increase in engineering productivity
- Over 40% reduction in overall engineering lead time
  - **99% reduction in modelling time for design geometry & finite element mesh**
  - **99% reduction modelling time for manufacturing stage & tooling geometry**
- 50% reduction in design staff used
- 100 fold reduction in the number of CAD geometry entities handled by the engineer: 950 surfaces & solid (7000 geometric entities) down to 7 major features, thus reducing scope for human and digital error
- Less material used on flat packs & dies
- 10 fold reduction in data storage requirements

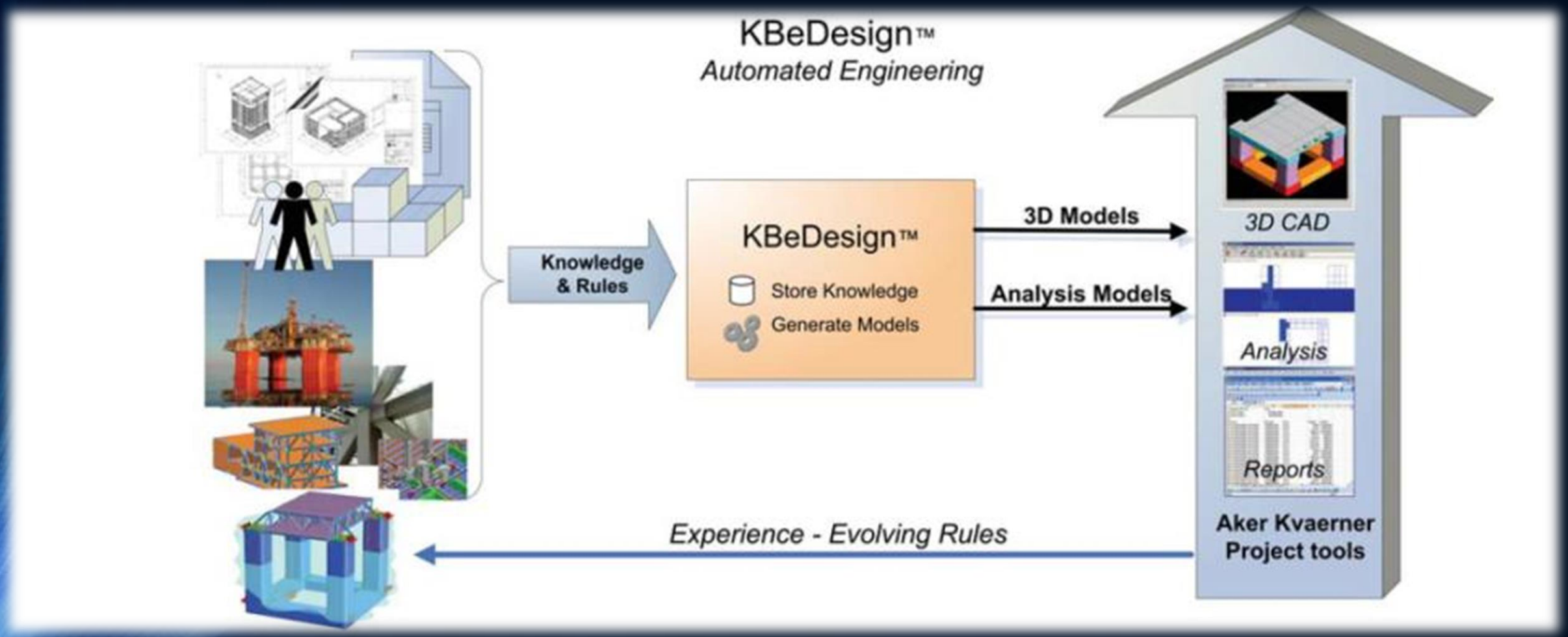


TechnoSoft Inc. / Rolls-Royce

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Aker Solutions
Company Knowledge

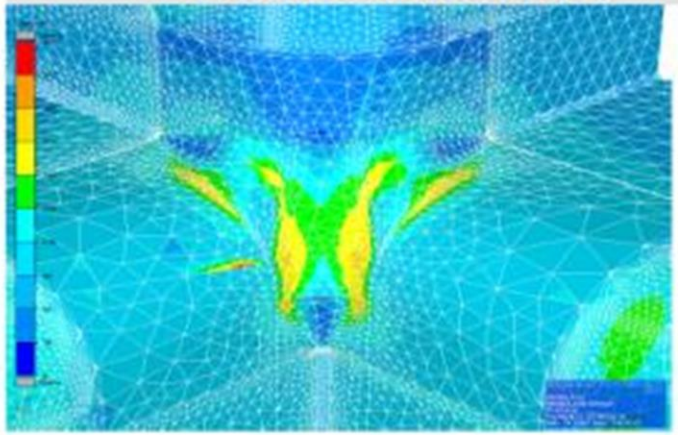
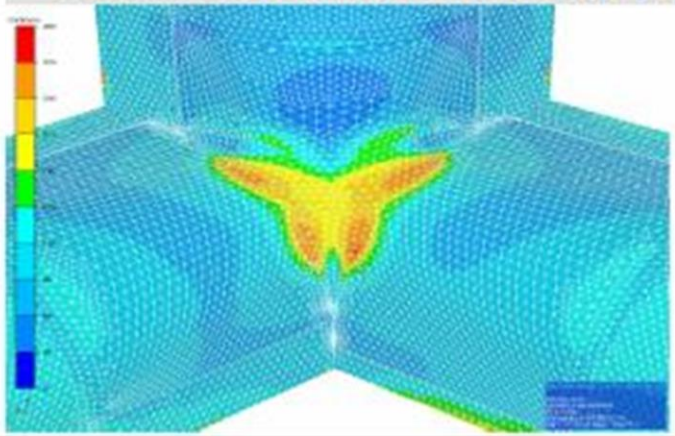
Aker Solutions
Projects

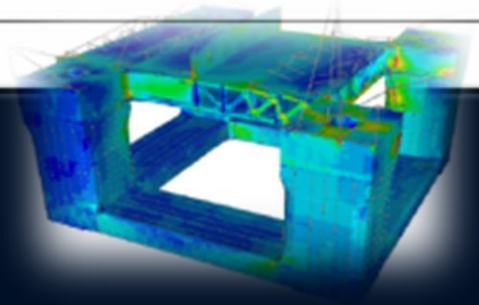


Clients whish to develop new fields with reduced time between concept and commercialization.

KBeDesign™ makes Aker Solution knowledge available to projects and automates the process of creating engineering models.

Comparison of Detail Analyses Models

	Traditional modeling	Generated using KBeDesign/AML
		
Re-use of knowledge	Difficult	Easy
Modeling time	4-5 weeks first time. 1 week for changes.	5 minutes. Standard values set in KBeDesign.
Handling changes	Difficult. For each change a new model needs to be established.	Easy. Parameters like element thickness, radii, lengths and mesh density can easily be changed.
Geometry model	Fair	Very good
Model/mesh quality	Fair	Very good
Type	Verification tool	Design tool



AkerSolutions

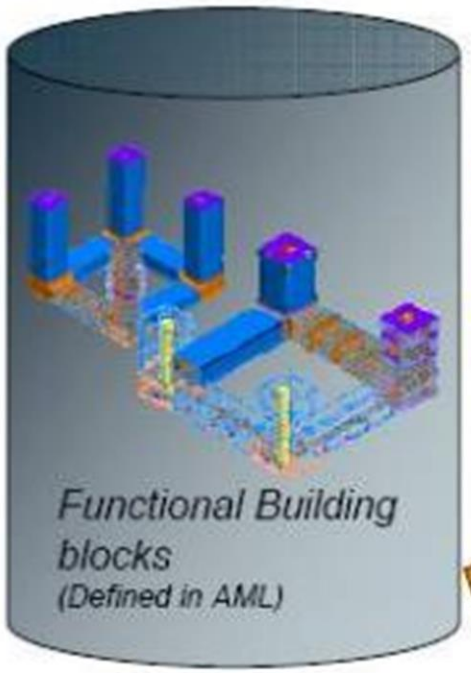
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The Key is to Structure and Store relevant Knowledge in the Knowledge Base

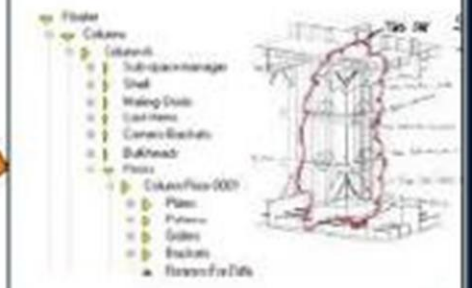
Proven Designs



Aker Solutions Product Knowledge Base



Experience, Improvements & New Designs



Classification societies rules and regulations



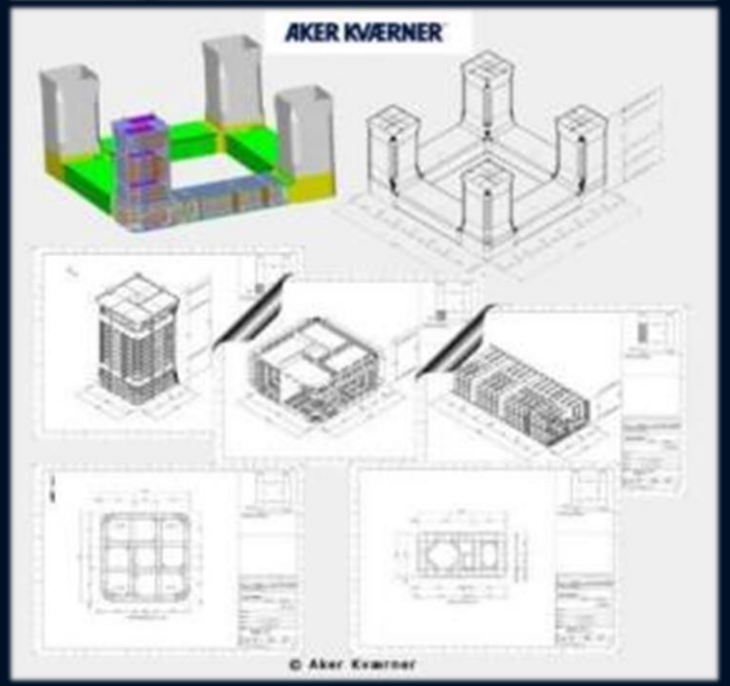
Aker Solutions Standards, Methods & Tools



AkerSolutions

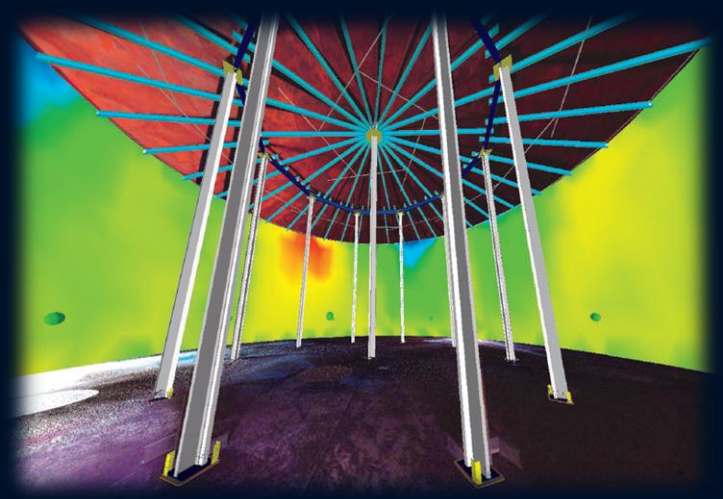
11-Jun-08 Slide 13 © 2008 Aker Solutions part of Aker

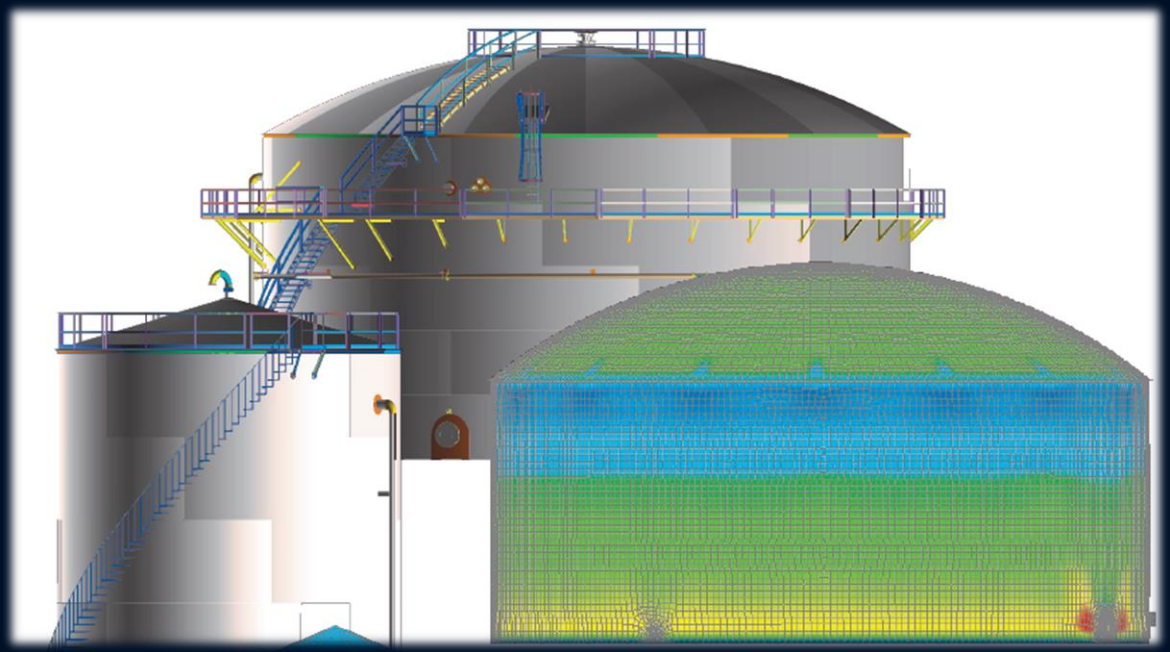


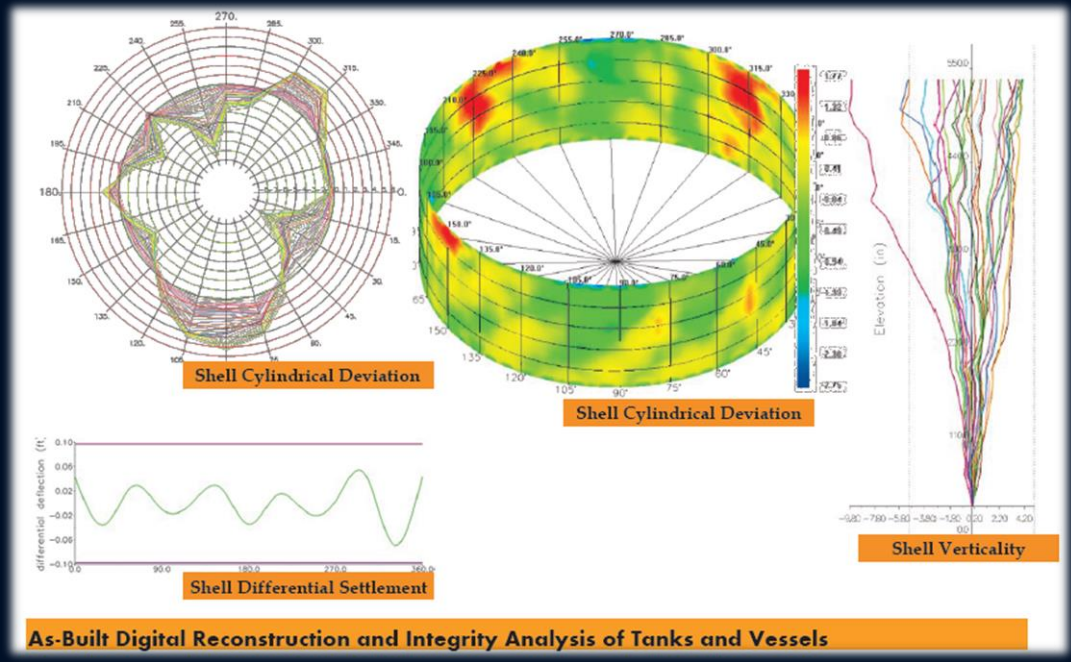


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New Trend:
Physical to Virtual & back again

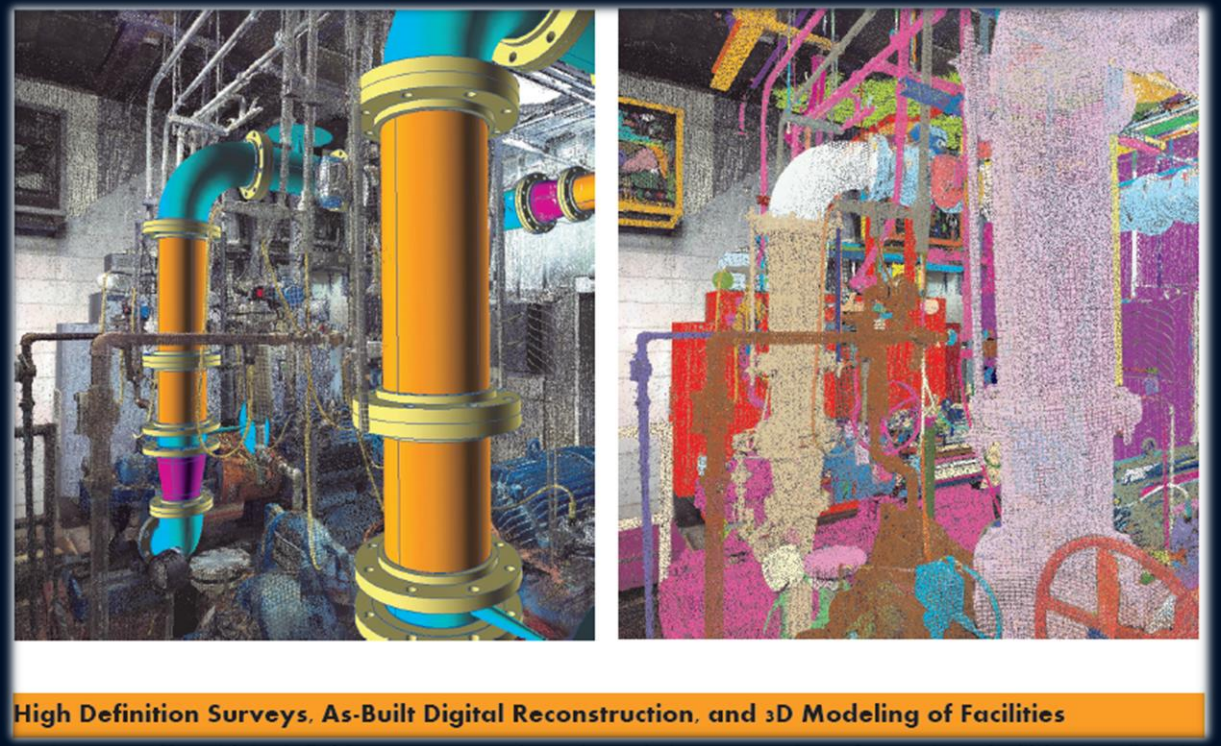




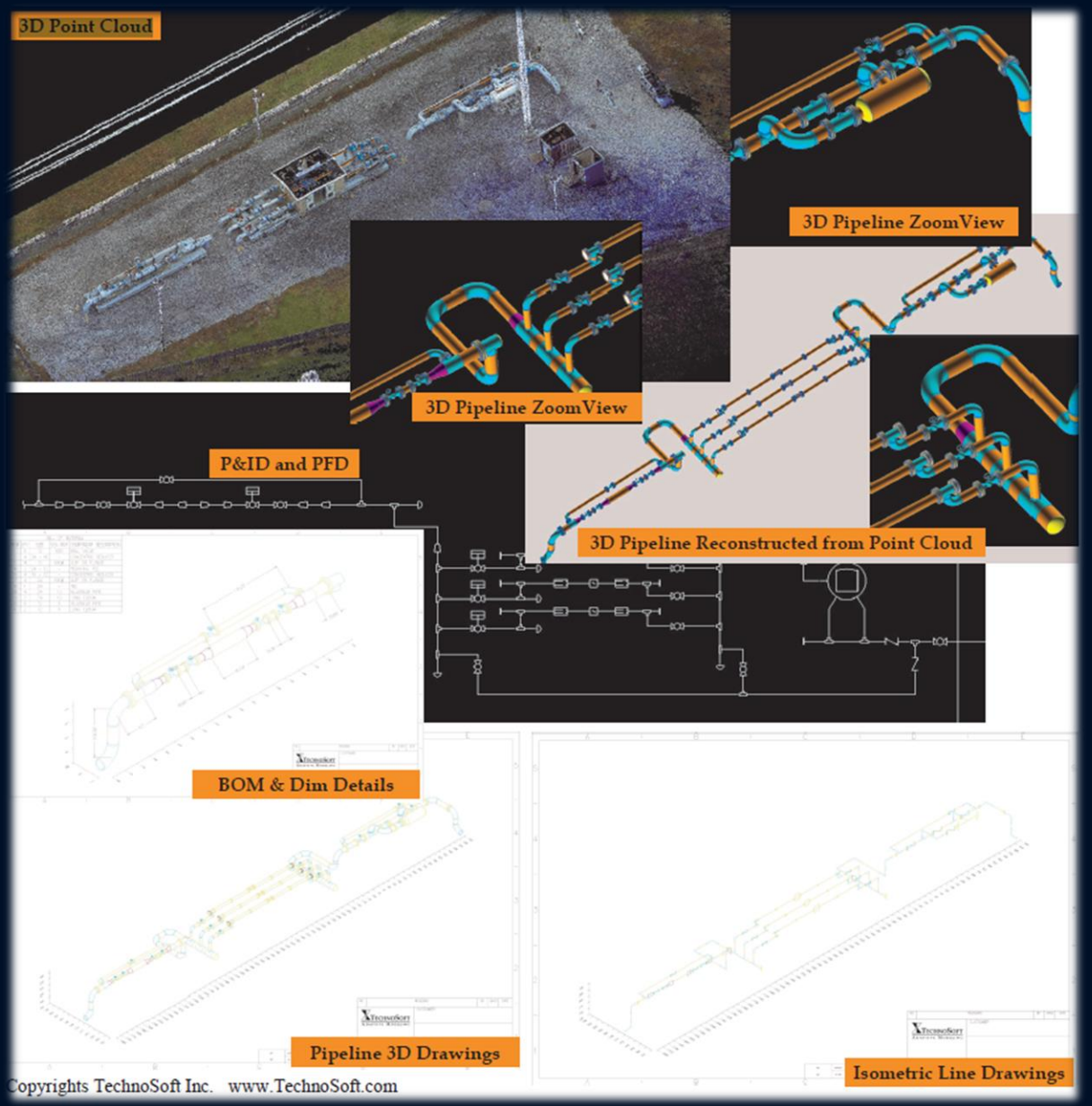


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New Trend:
Physical to Virtual & back again



High Definition Surveys, As-Built Digital Reconstruction, and 3D Modeling of Facilities



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Is Knowledge Based Engineering New?

All Engineering
is
Knowledge Based Engineering

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What do you see?



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What did you see (OBJECTS?)

'Lots of OBJECTS characterised by ATTRIBUTES that have RELATIONSHIPS to each other, who's STATES have changed by PROCESSES acting on the OBJECTS ATTRIBUTES at given EVENTS at moments in TIME throughout the Products lifecycle'.

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Domain Knowledge

Application Knowledge

Anything in common?

Think **STEM**

C-DAM = Understand - Capture - Model - Explore - Produce – Reuse – Learn ……(not sequential)

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How does our ‘PHYSICAL’ become our ‘VIRTUAL’ ?

Reverse engineering, multi-perspective views, common computational model ….)











.....



Costs
Resources
Product
Components
Processes
Parts
Events
Features
Logic
Tasks
Rules
Politics
Environment
STEM.....

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We need to CAPTURE it all

(depending on what your being paid to do)

Start

IDEA / REQUIREMENT / DESIGN BRIEF

This is what the stakeholders WANT or think they want – not how to do it, that's a SPECIFICATION (you really want to do that☺)

AS-IS (STATE) – help you understand the problem, forge relationships & find opportunities

How do we get here?

To-BE (STATE) – what your going to build to satisfy the stakeholders

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Know what we want – Get it

Humans

- Interviews (they're always busy)
- Observations (walk through the process, look at the products/components/features)
- Scenarios / Teach back (stories)



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Know what we want – Get it



Document & Models

- Engineering Drawings (are your friend)
- Maintenance & Service documents (are your friends)
- Specifications (how they did it that way, if they exist)
- Process documents/models (make sure they're up to date)
- Models (a final state but good to talk around – CAD/CAE/Cost)
- The physical products themselves.

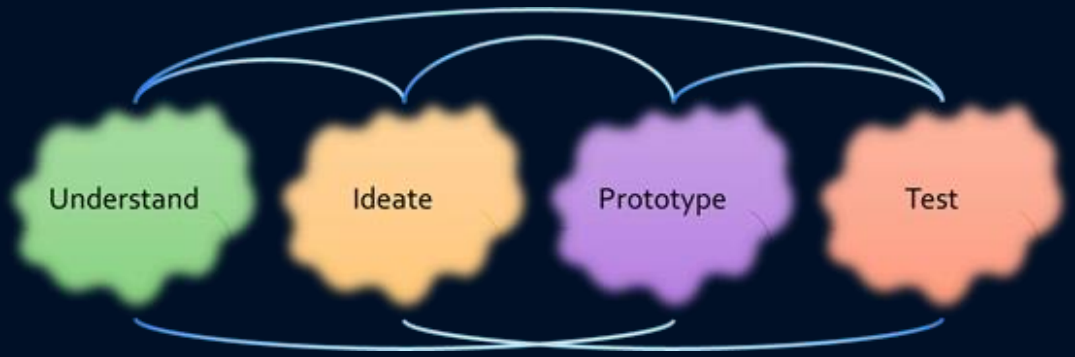
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Know what we want – Get it

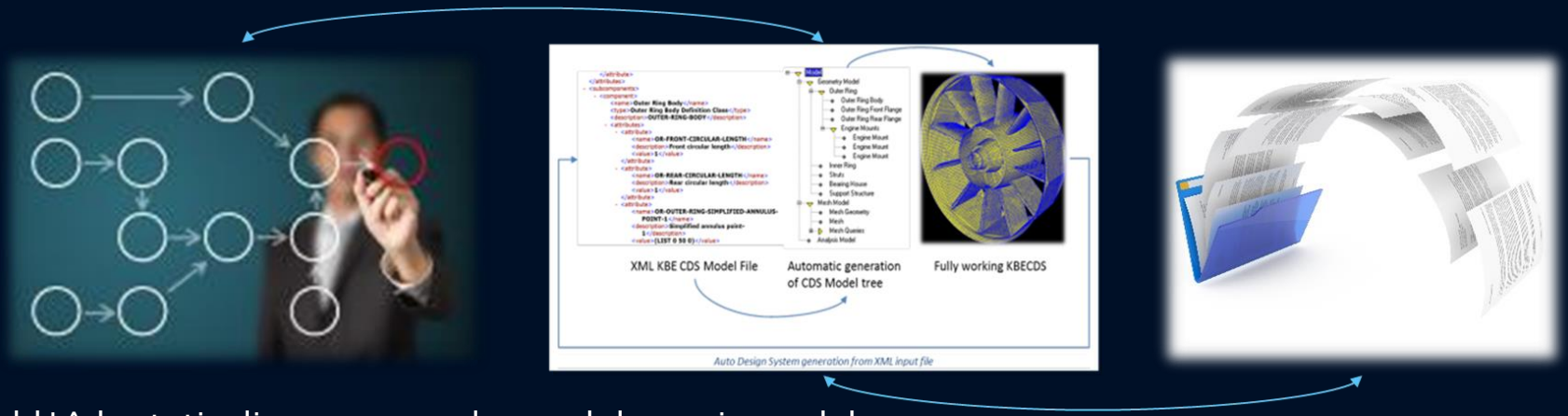
Techniques: (there's a number dedicated to KBE but as we stated KBE is just design engineering, implemented in KBES)

Design Thinking

A method of problem-solving strategy wherein the data collected is expressed visually in order to create new strategies, ways and methods to solve problems, create opportunities or strengthen weaknesses.



Build our models with the outputs of our design thinking process



So many techniques and bl*^dy static diagrams, we demand dynamic models

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Moving on (developing partnerships to make it happen)

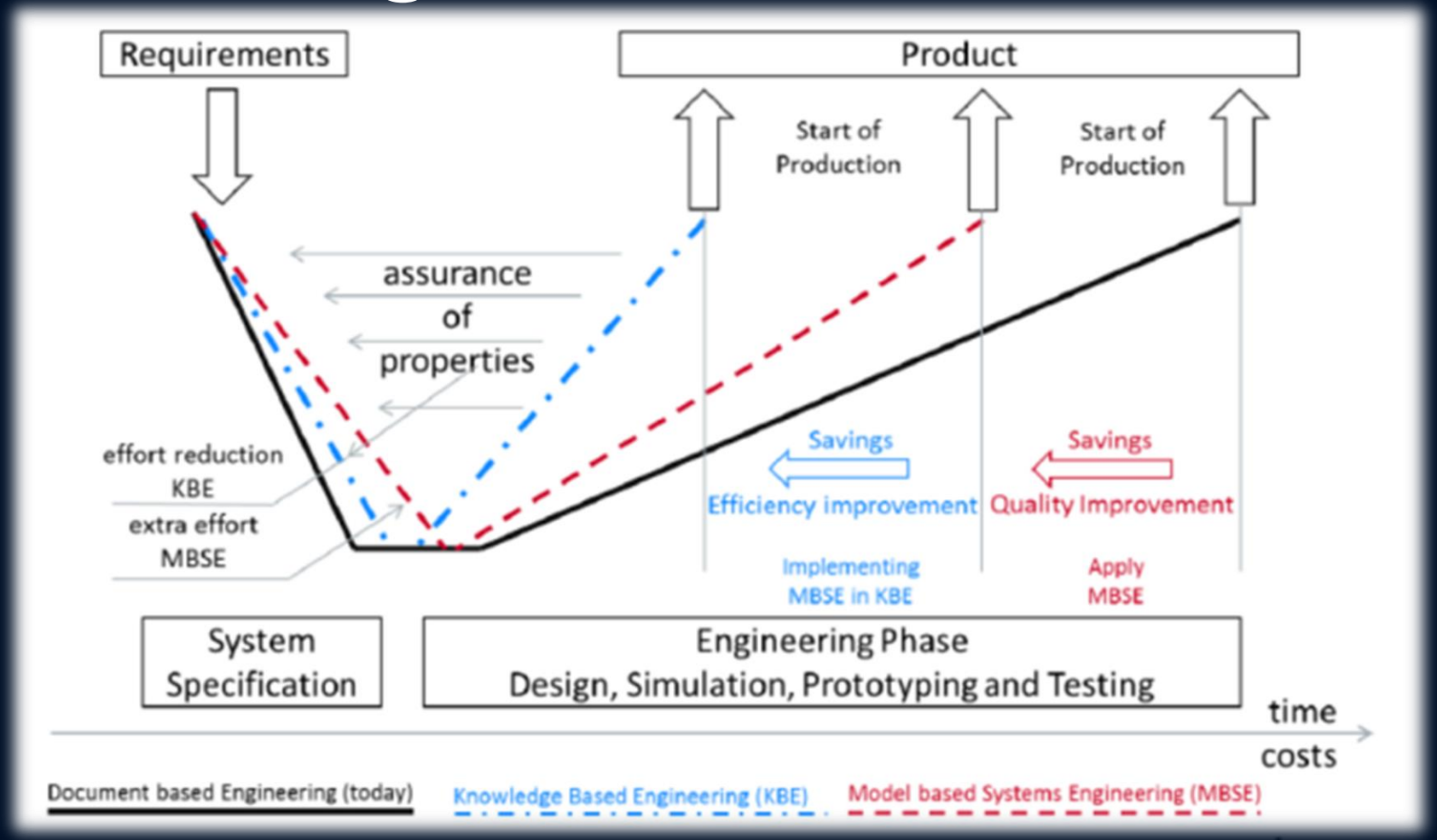


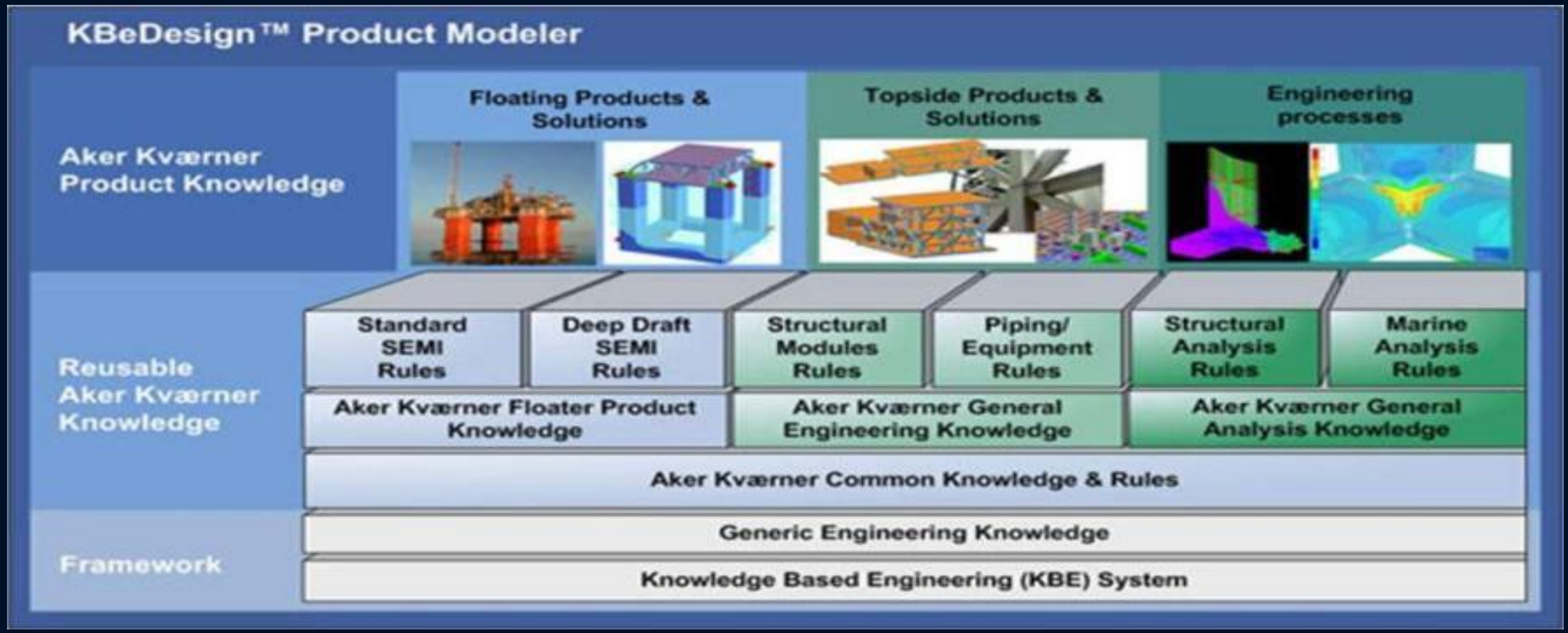
fig.: Effect of MBSE and KBE on the development process according to the V-model

Quelle: O. Dietz, Wincor Nixdorf International GmbH, Paderborn, 2015

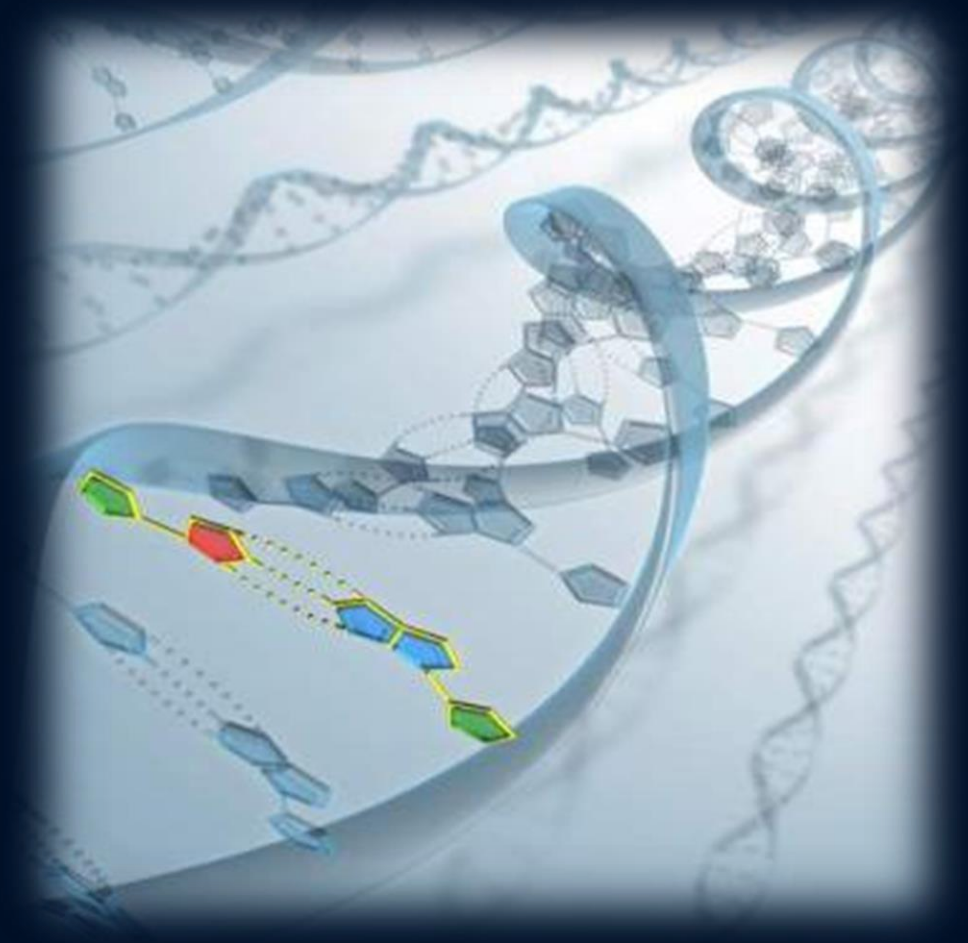
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A Framework for knowledge



Knowledge Based Engineering



Knowledge Based technologies provide an environment to create dynamic multidisciplinary business solutions that allow participants to collaborate, optimise, synchronise, mass customise, capture, retain and utilise their corporate knowledge capital.

Information in context, when we need it & more importantly for automation the utilisation of that information by both human & machine users.

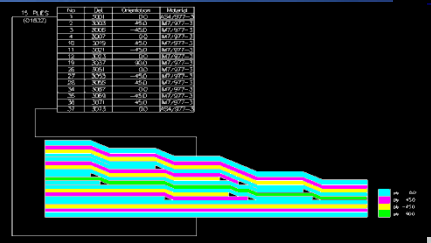
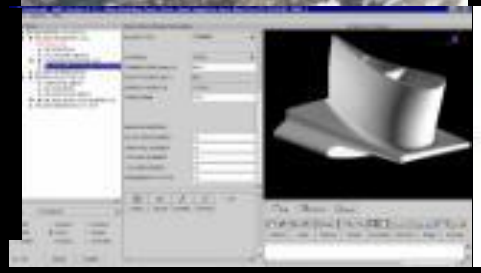
Digital DNA

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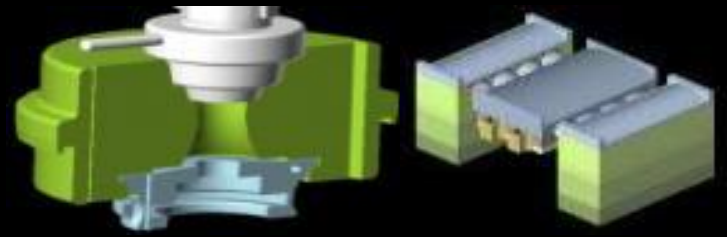
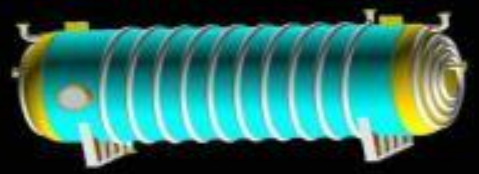
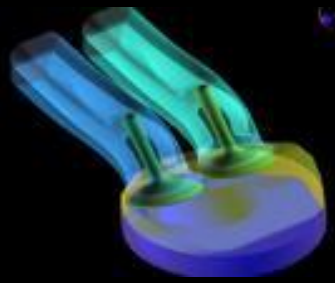
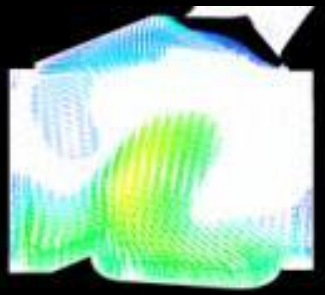


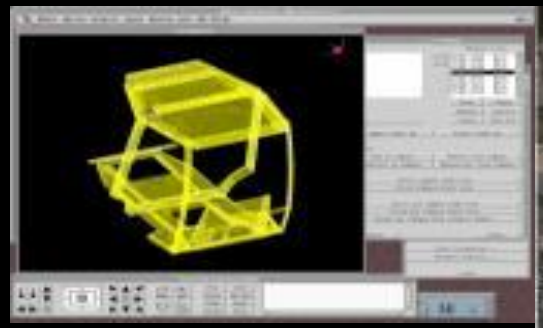


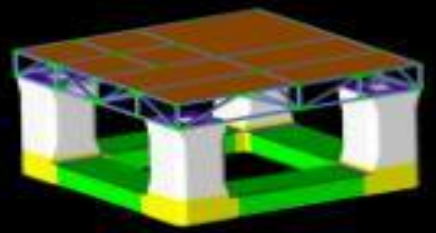


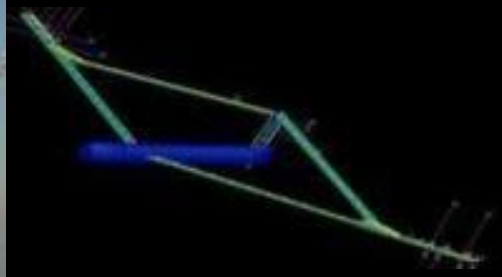
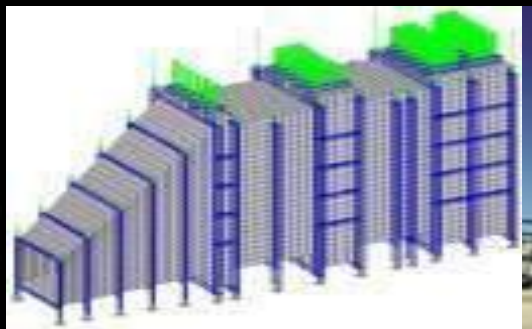






Thank you for listening



This is WHY ☺

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