S.S.D. ING-IND/15

Disegno e Metodi dell'Ingegneria Industriale

LECTURE 2

Product Development Process and Cax

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DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

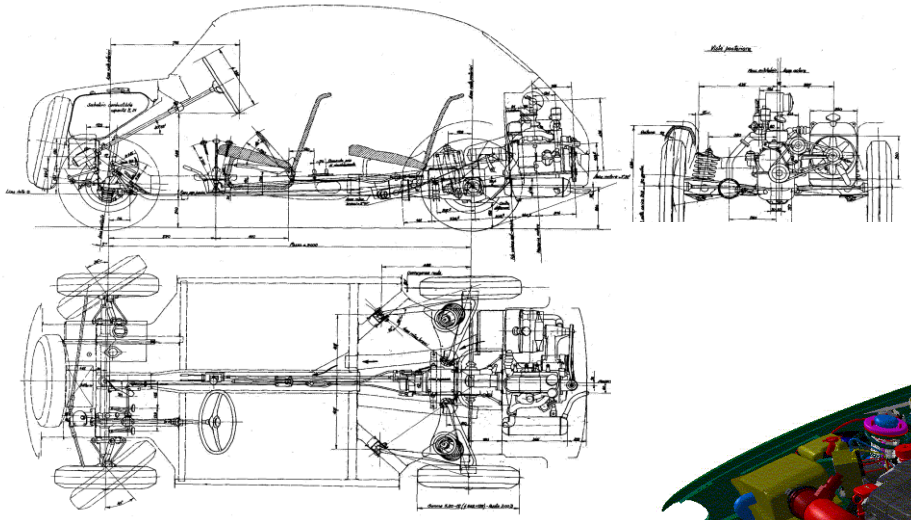
Fraunhofer Joint-Lab

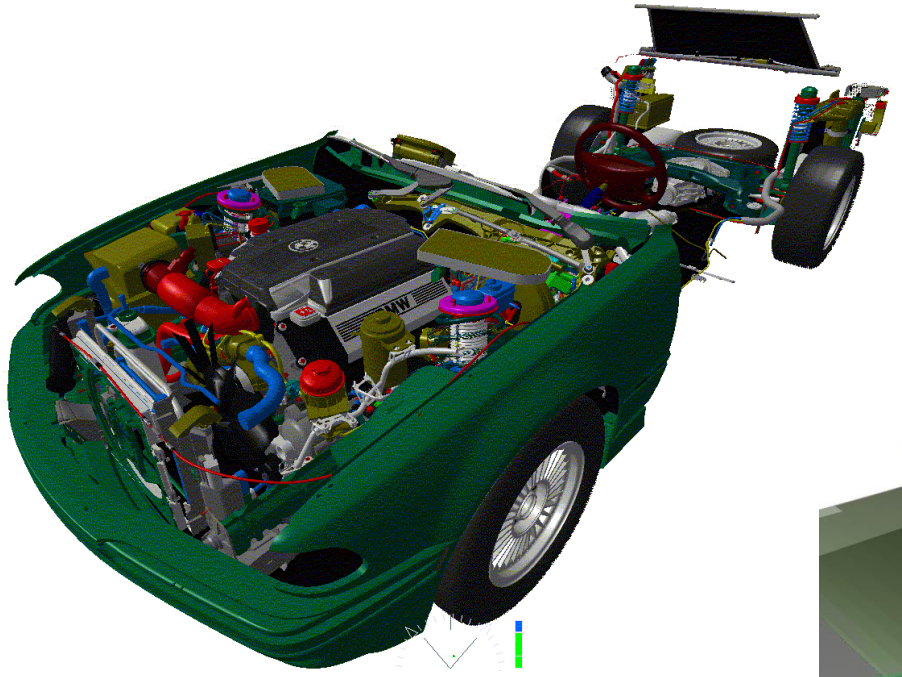
ideas

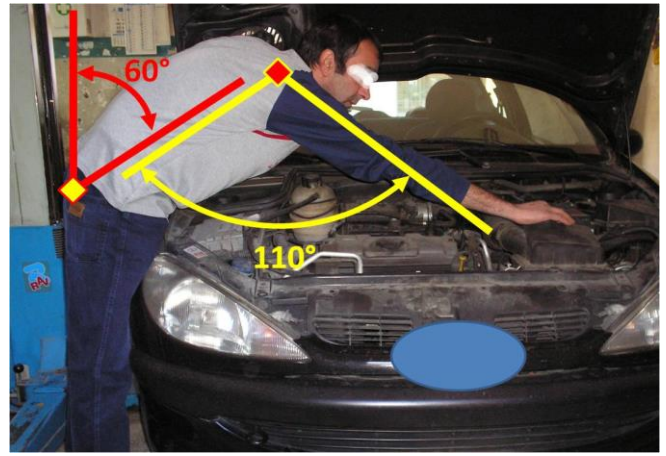
INTERACTIVE DESIGN AND ERGONOMICS APPLICATIONS IN VIRTUAL REALITY

ideaInVR

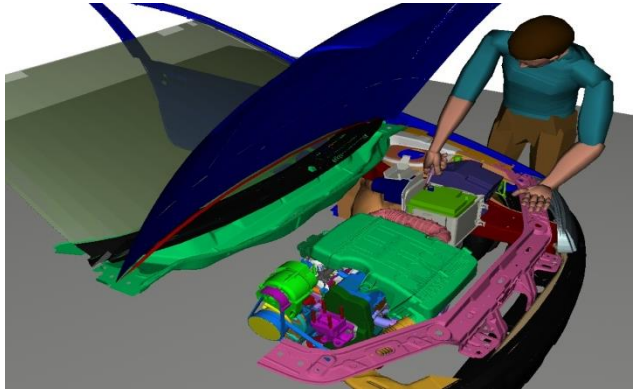
Evolution of design methods





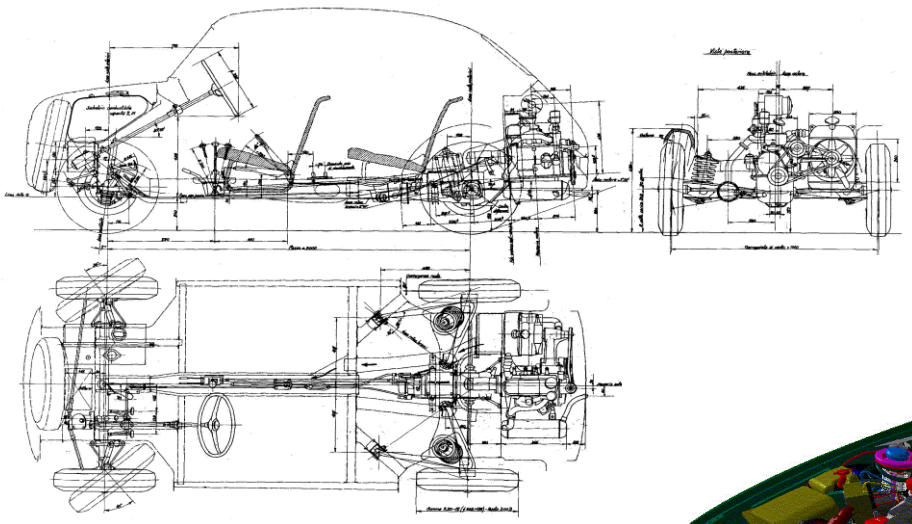


3D models

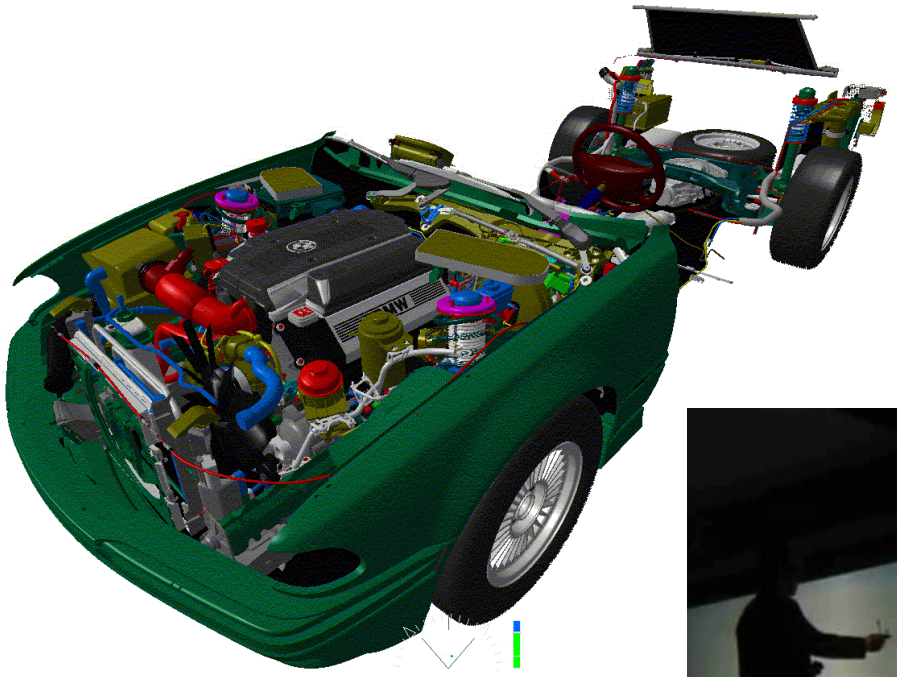


Virtual prototypes

Evolution of design methods



2D models



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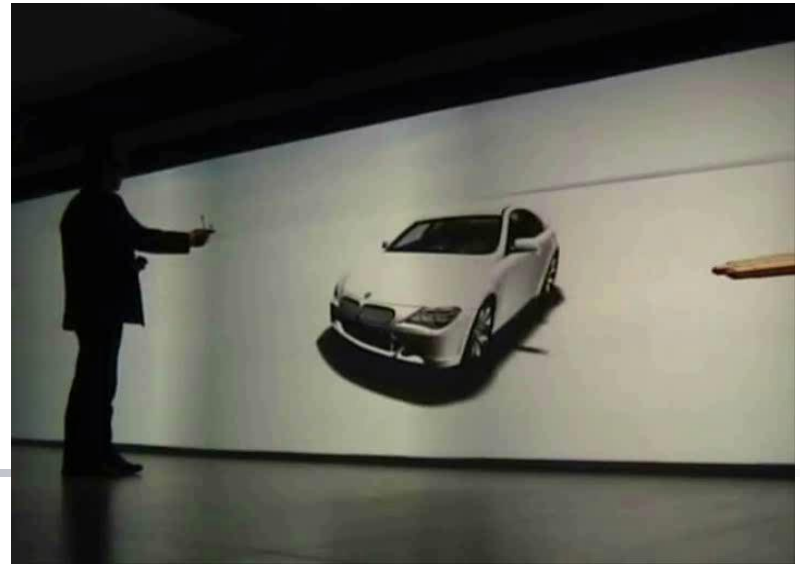
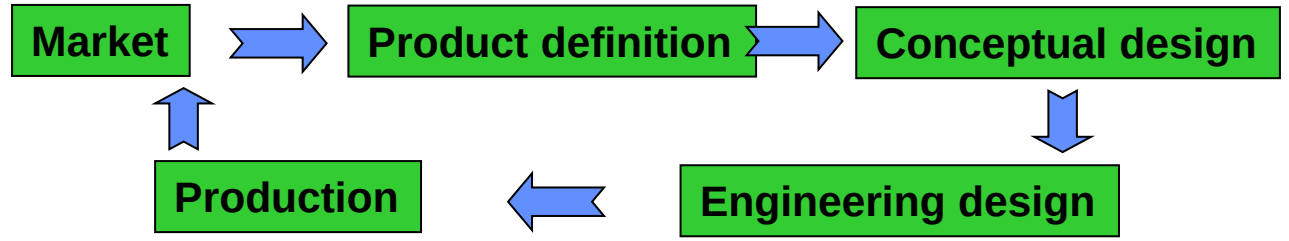
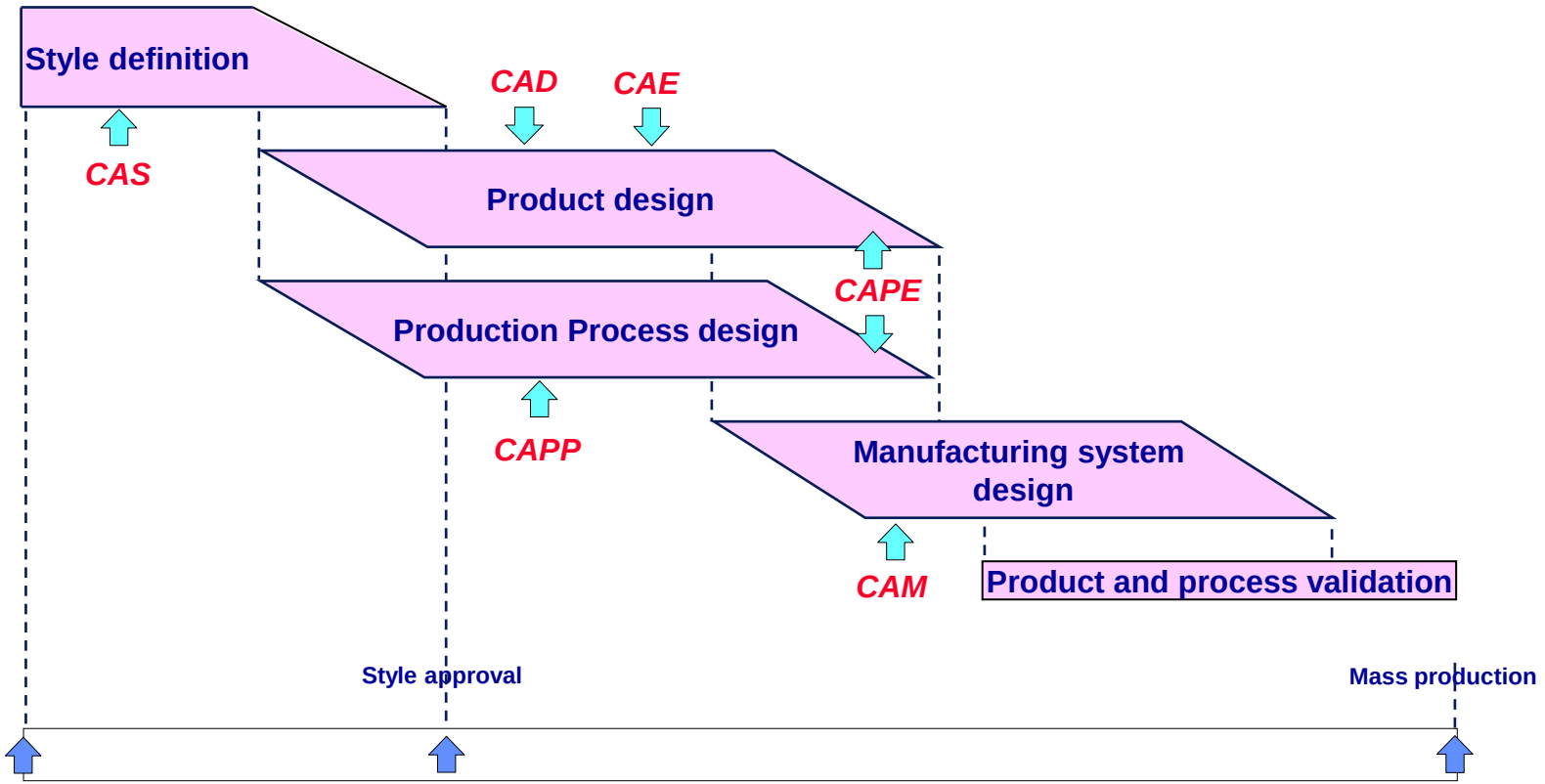


Virtual prototypes

Product Development Process and CAx





Computer Aided Process Planning

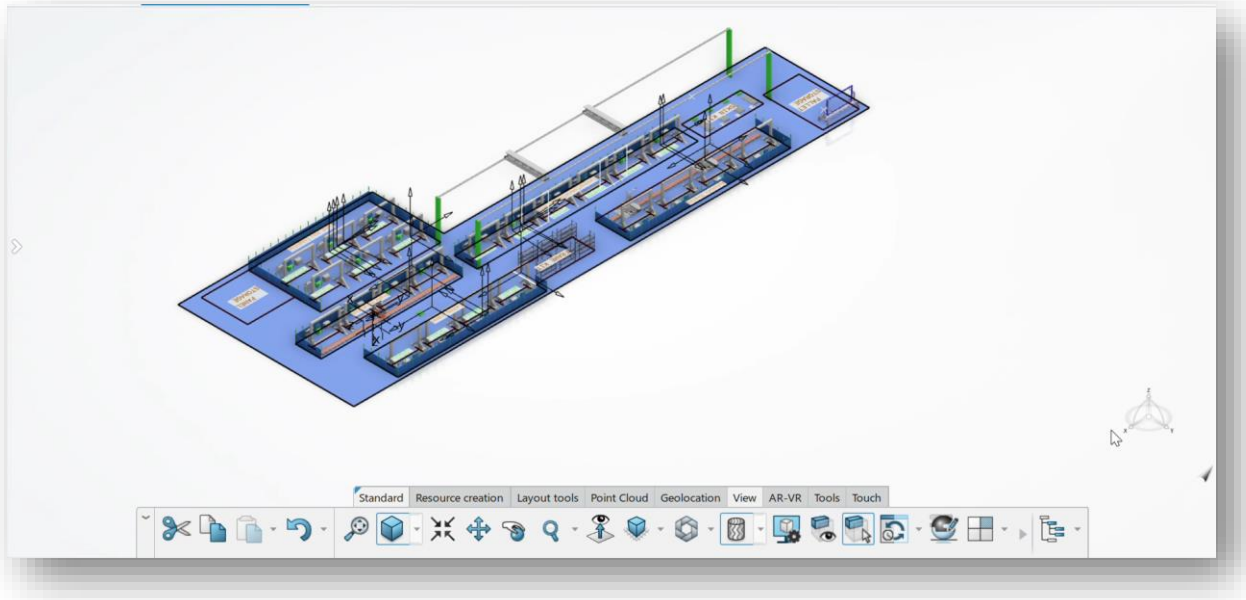
3DExperience Used Packages

Drawing Catia V6

- Implementation 2D layout

Plant Layout Design

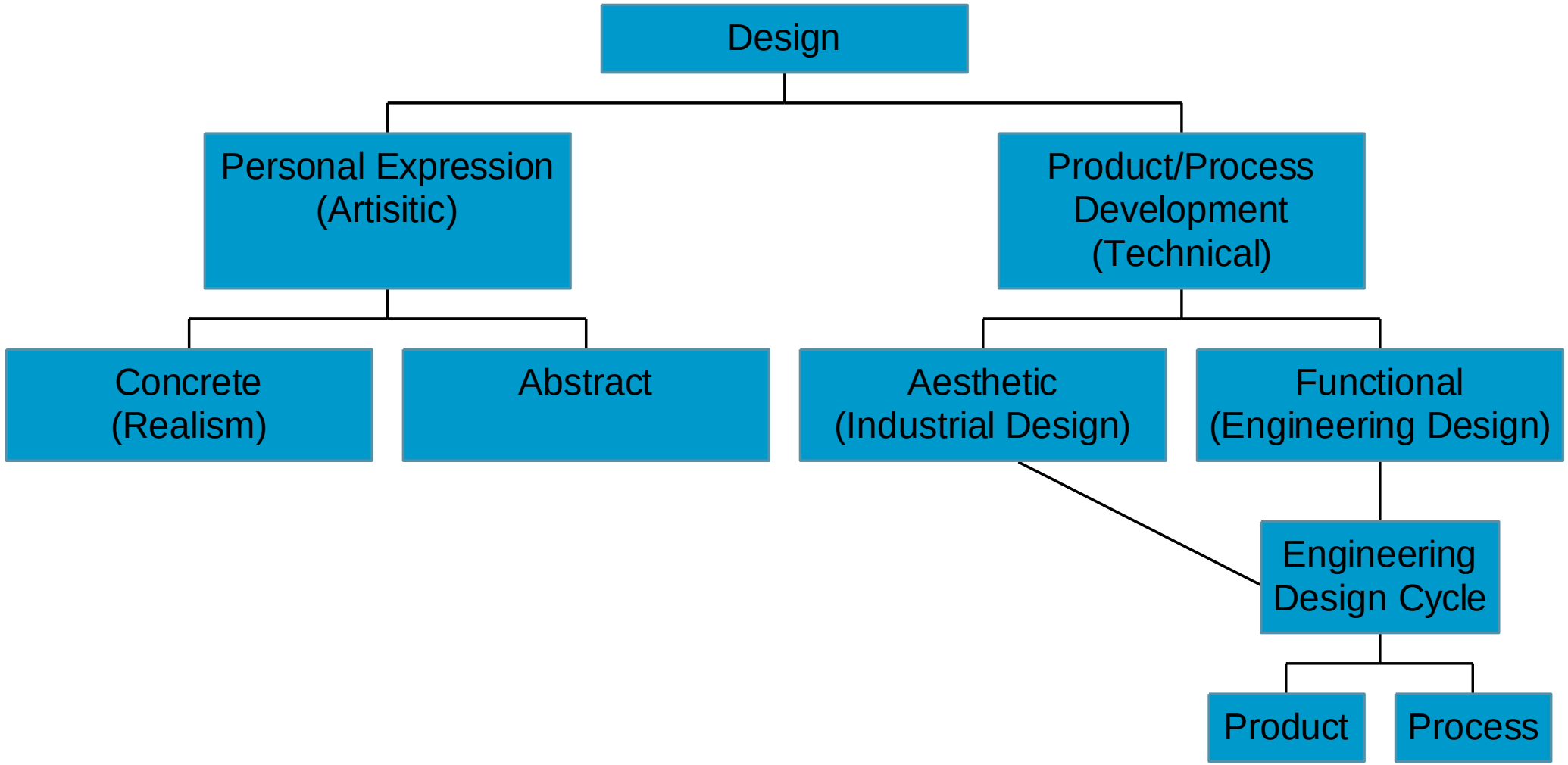
- 3D Plant Modeling



Factory Flow Simulation

- Factory Simulation
- Results Analysis

Declination of «Design»

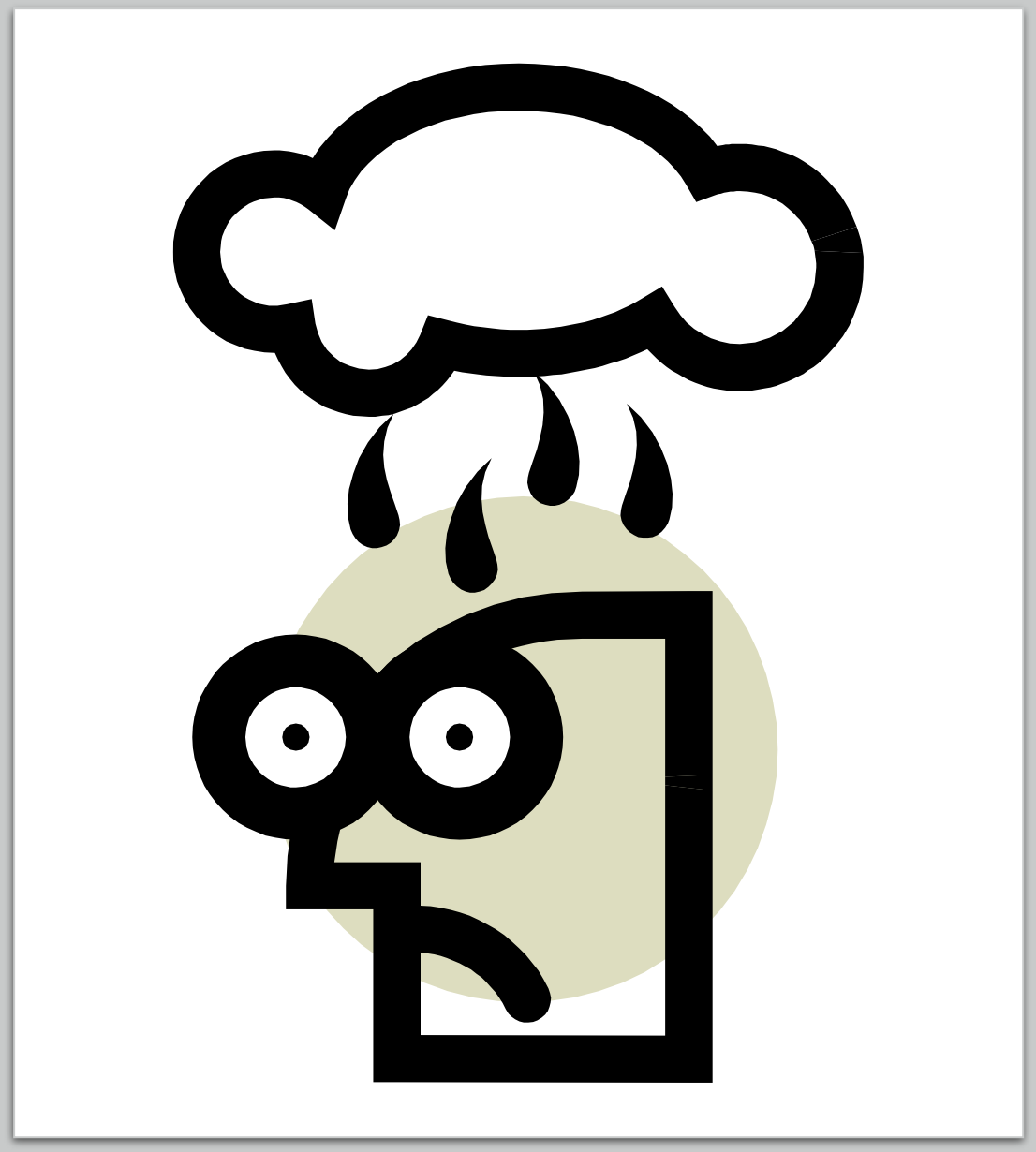


Design phases

- Problem identification and formalization
- Preliminary design
- Conceptual design
- Engineering Analysis
- Optimization
- Implementation and documentation

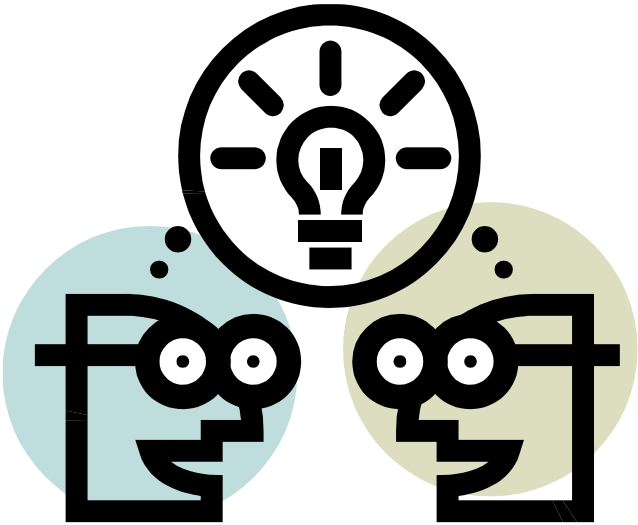
1) Problem identification and formalization

- Description of the problem
- Requirements
- Conditions that must be met
- Create a priority list
- Limitations
- Determine the constraints (of cost, space, weight, environment, etc.)
- Has the problem already been addressed in the past?
- Are there already solutions to similar problems?



2) Preliminary design

- *BRAINSTORMING*
- Groups of 4-8 people
- Everyone provides their own ideas without evaluating them too much
- Even the most imaginative ideas are encouraged
- Highly creative stage
- Paper support through sketches



3) Conceptual design

- *Select the best preliminary ideas*
- *Evaluate the merits of each idea*
- *Combining ideas*
- *Refine the sketches*
- *Develop a single digital model on the computer*

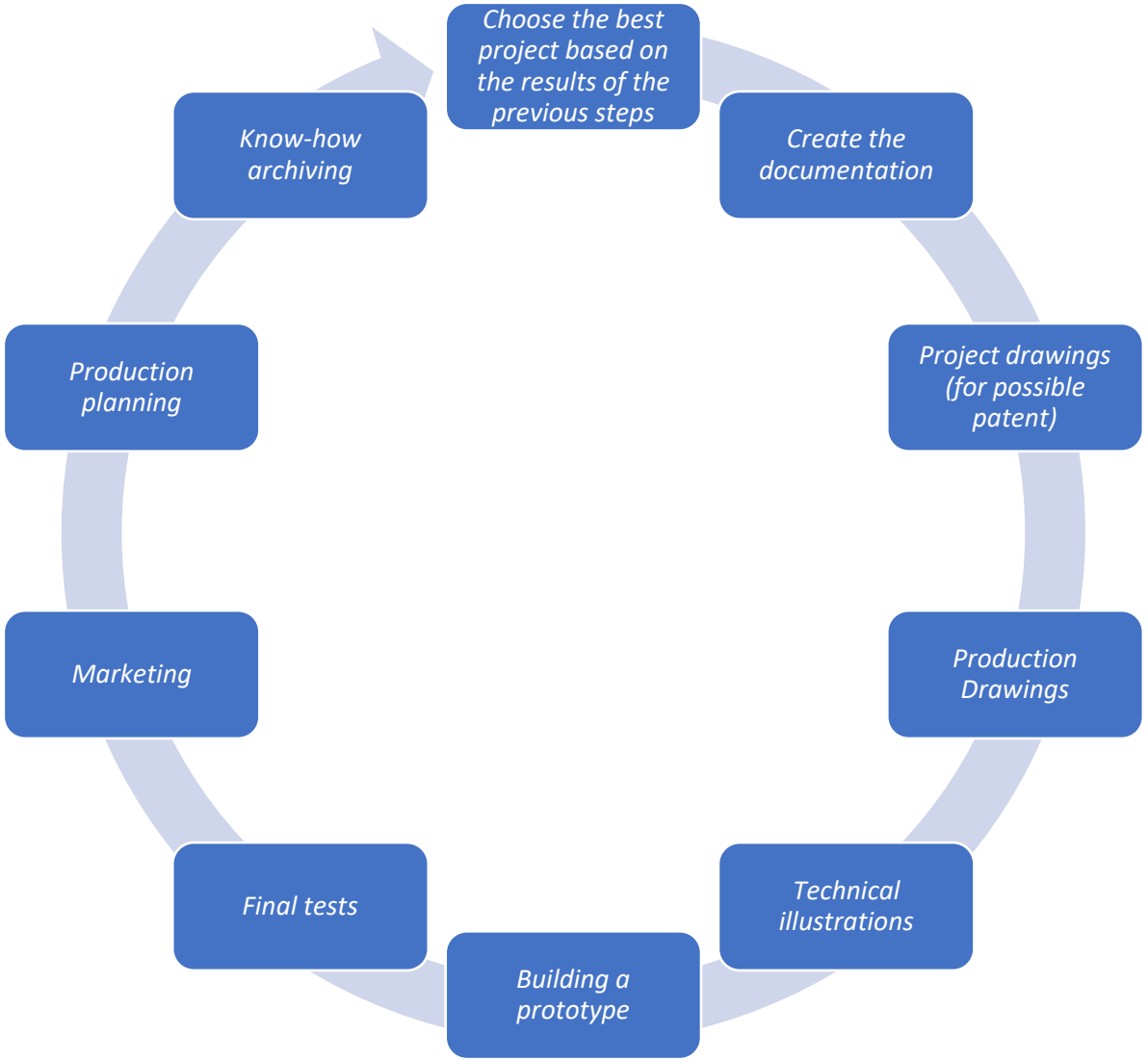
4) Engineering analysis

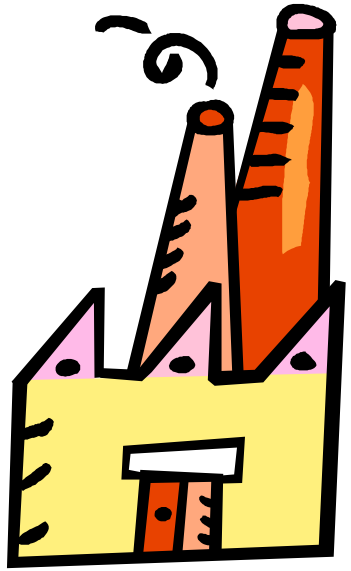
- *Apply engineering and scientific principles to evaluate the design*
- *FEM, Fatigue, Wear analysis*
- *Thermal analysis, etc.*
- *Using CAE software*
- *Ergonomic analysis*
- *Assemblability or assembly compatibility analysis*
- *Maintainability analysis*

5) Optimization

- *Look at the best ideas from the previous step*
- *Improve the details of the project*
- *More sophisticated computer model (project view)*
- *How will the proposed solution integrate with the other systems?*
- *How will the parts be made?*
- *What materials will be used?*
- *Additive manufacturing*

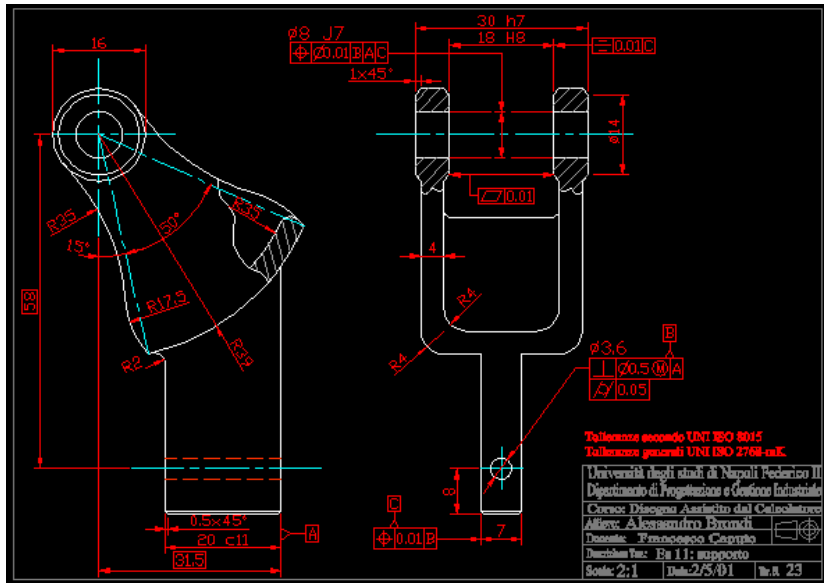
6) Implementation and documentation



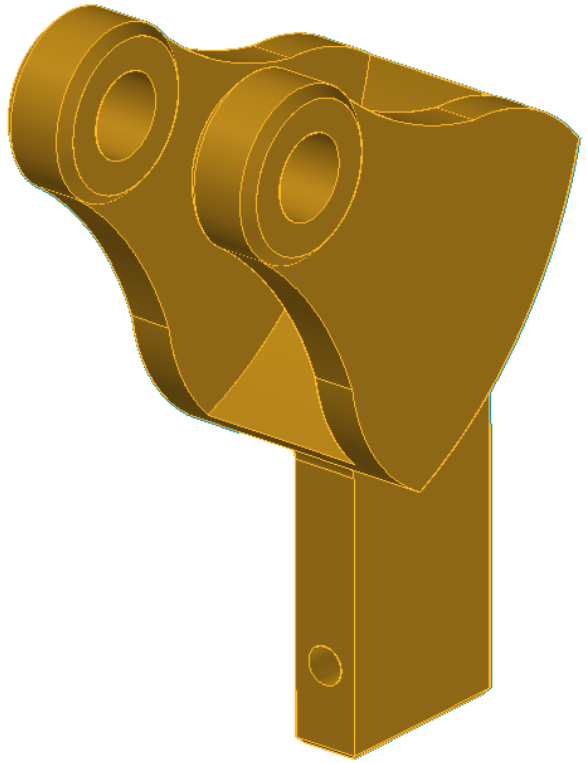


Possible Approaches

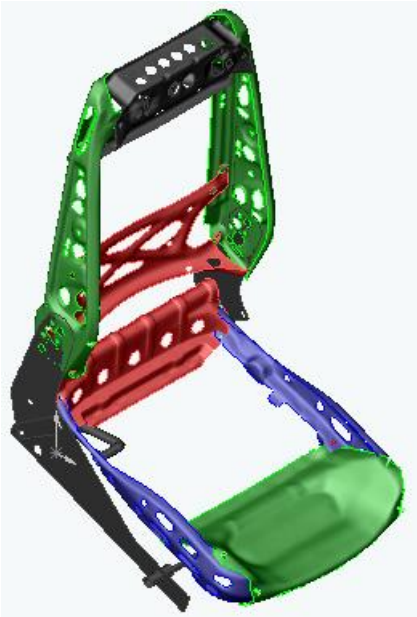
Technical drawings



3D models

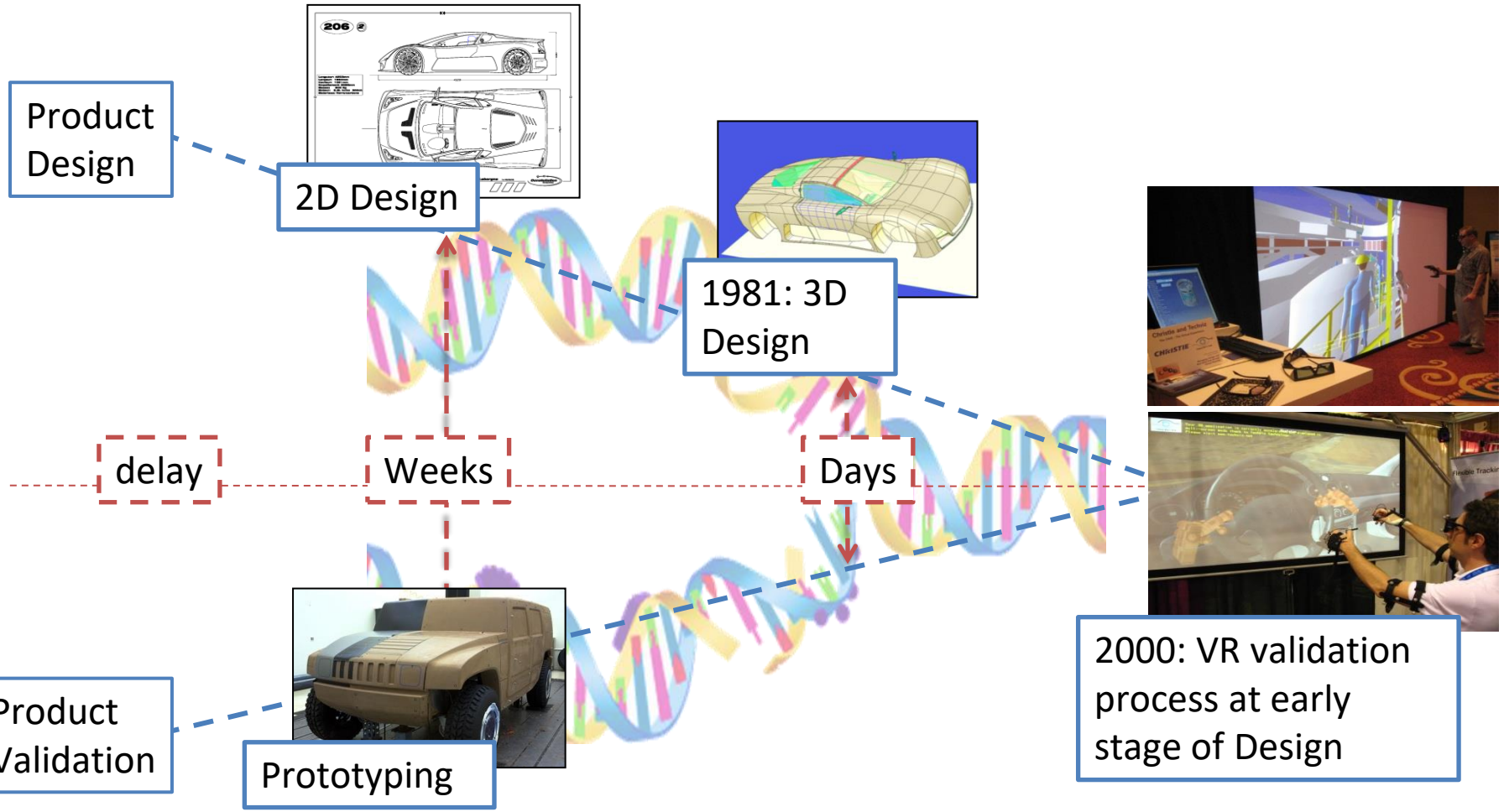


Physical prototype



Virtual prototype

Evolution of Design vs. Validation



Physical vs Virtual Prototype

Physical prototype

Virtual Prototype

Sketchpad
Ivan Sutherland
MIT 1963

Computer
MIT Lincoln Labs TX-2


CORNING

Model

- The model is a substitute for an object:
- Really existing
- That will be realized
- That will never be realized
  - *Ex: Representation of a product that we only want to display*

Modeling is the process of describing an object or scene so that we can eventually draw it.

Modeling

Each model contains two descriptions:

1. ***The structural*** description is basically the *geometry* of the model

2. ***The appearance*** describes how the surface of the model interacts with light: color, shininess, and transparency

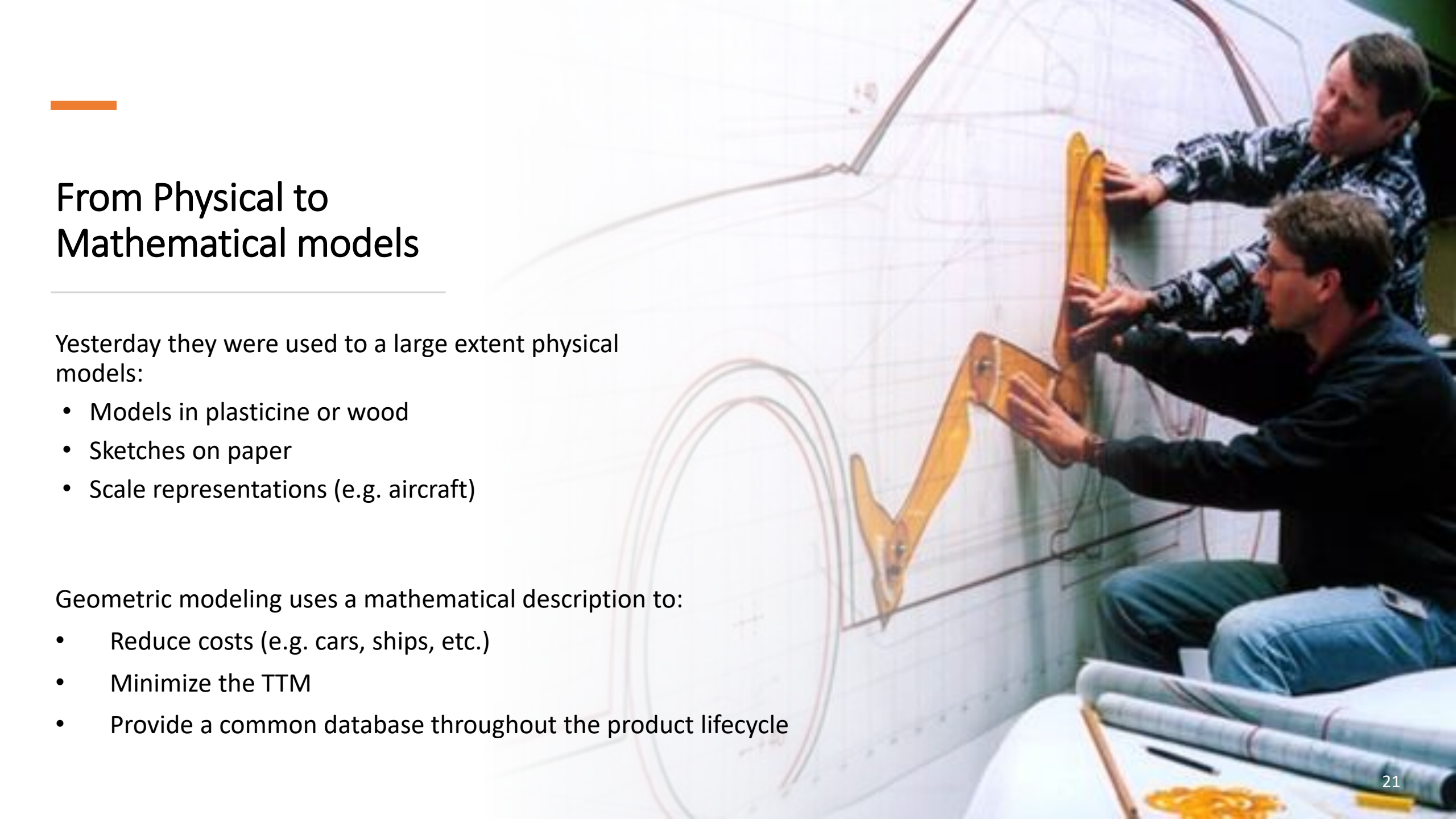
From Physical to Mathematical models

Yesterday they were used to a large extent physical models:

- Models in plasticine or wood
- Sketches on paper
- Scale representations (e.g. aircraft)

Geometric modeling uses a mathematical description to:

- Reduce costs (e.g. cars, ships, etc.)
- Minimize the TTM
- Provide a common database throughout the product lifecycle

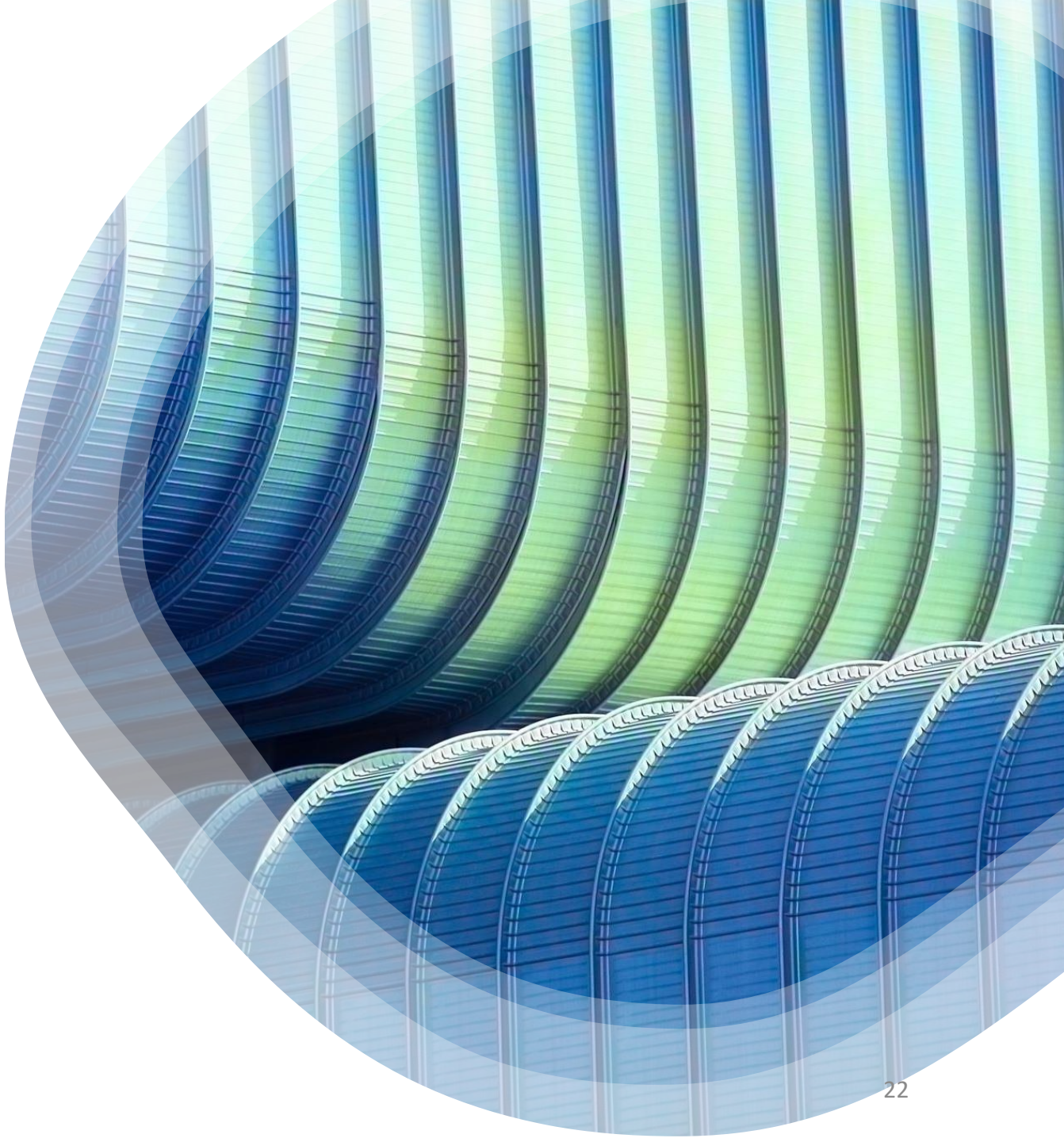


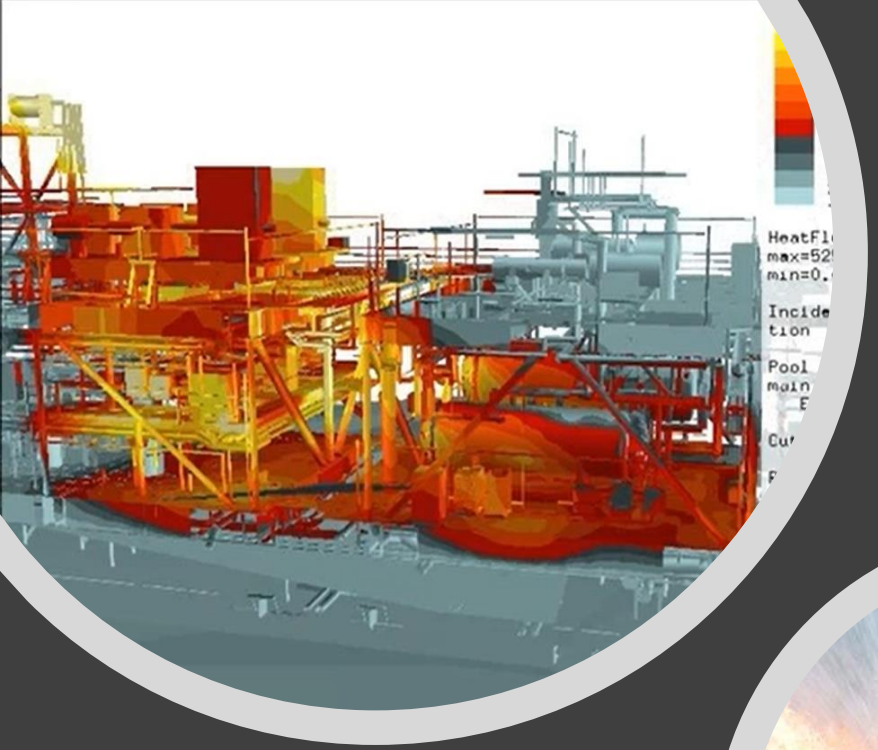
Virtual model

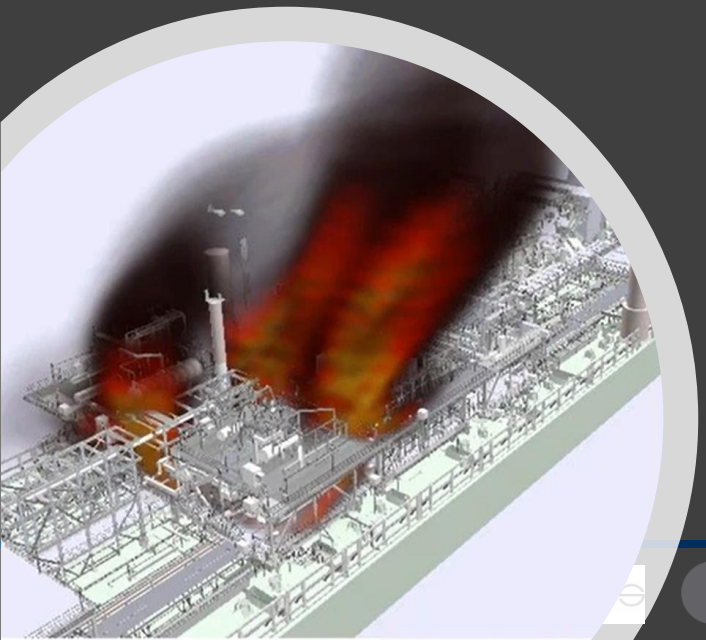
A computer representation of an object or system with the required level of detail.

Virtual simulation

Use of a mathematical and / or computerized model for the description of its behavior (kinematic, thermal, etc.) based on a set of initial parameters (boundary conditions).



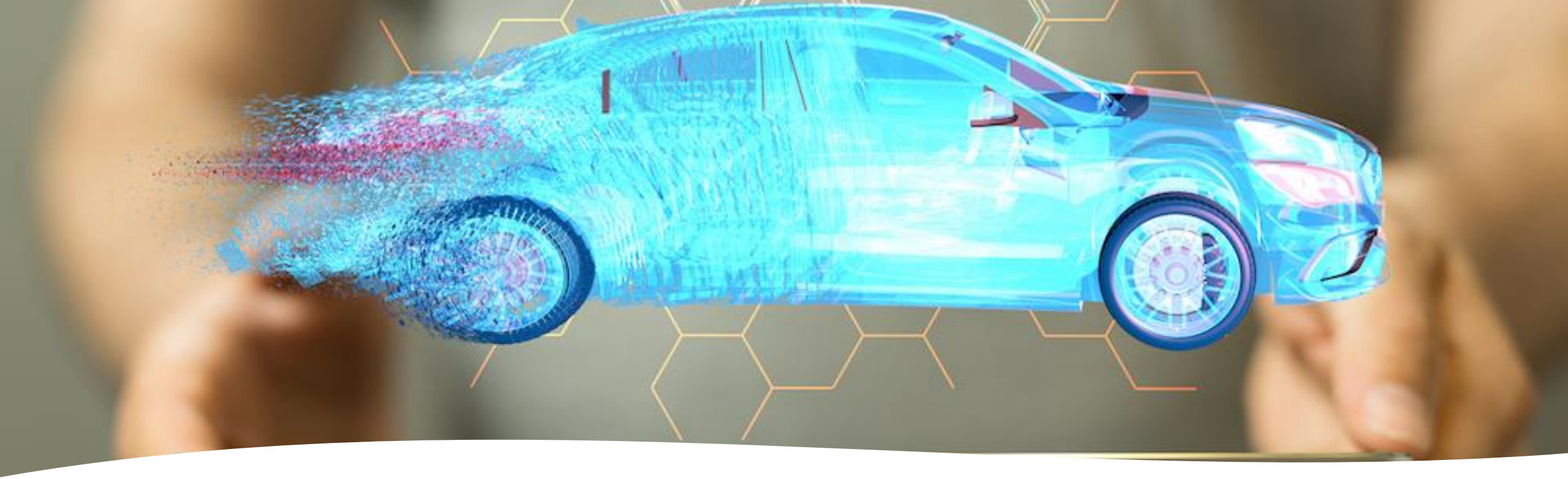




Simulation… why?

Experimentation is not always possible:

- Inaccessible input and output data
- The experiment is too dangerous
- The cost of the experiment is too high
- The time needed may not be compatible with man
- The experiment can be disturbed or perturbed in an uncontrolled manner.



Geometric modeling… …what is?

Geometric modeling is the technique for representing (in digital format) the geometry of real or imaginary components.

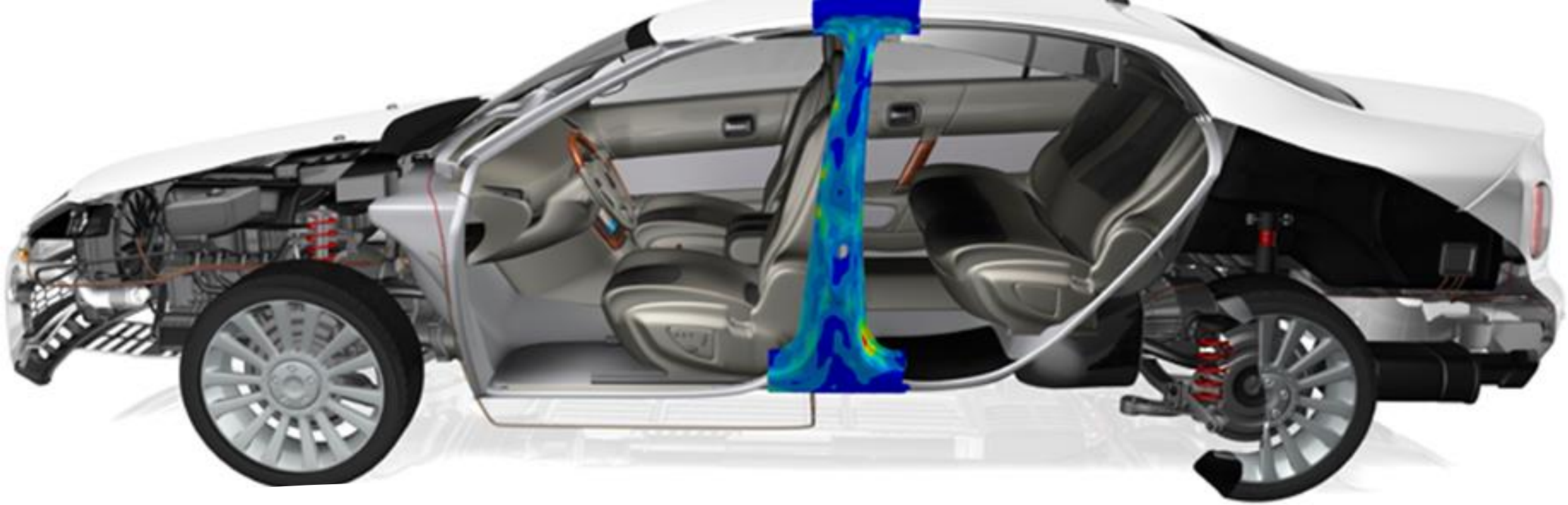
- It was born at the end of 1960, with the electronic computer, to drive the numerically controlled machines.
- It is a multidisciplinary activity involving:

Mathematics

- Differential geometry, Linear and Boolean algebra, Topology
- Numerical methods, vectors and matrices, set theory

Information technology

- Data structures
- Algorithms
- Programming



Virtual prototyping … …what is?

Geometric modeling will be "supplanted by ***virtual prototyping*** or product modeling, which not only includes the geometry of the object, but any information or data that is needed to design, develop, produce and support the product through its entire life cycle."

Ault, Holly K. (1999). 3-D Geometric Modeling for the 21st Century. The Engineering Design Graphics Journal, 63 (2), p.38.

Virtual Reality

- …methods and techniques that allow the design team to simulate human-product interaction when the product is still “immaterial”.

CAD model +

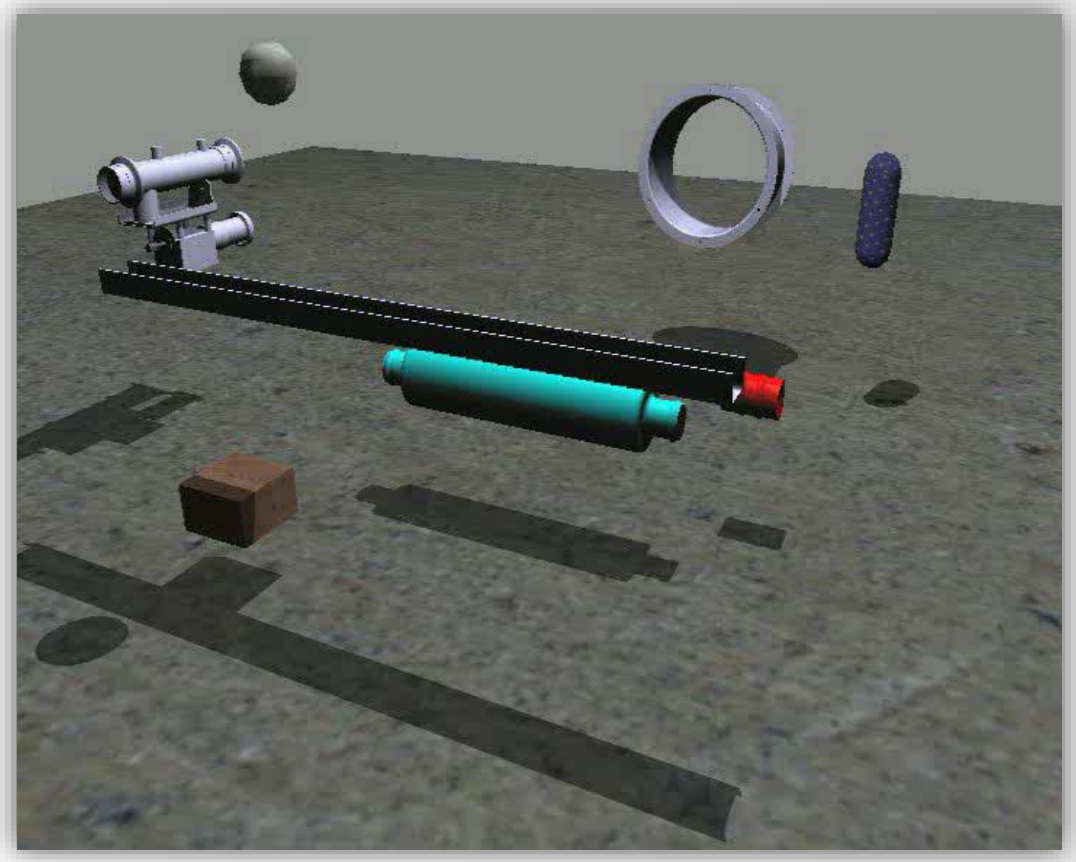
- ***Material, textures, shaders and lights***

CAD model +

- *Material, textures, shaders and lights*
- ***Kinematic behaviors***
  - ***Direct***
  - ***Inverse***

CAD model +

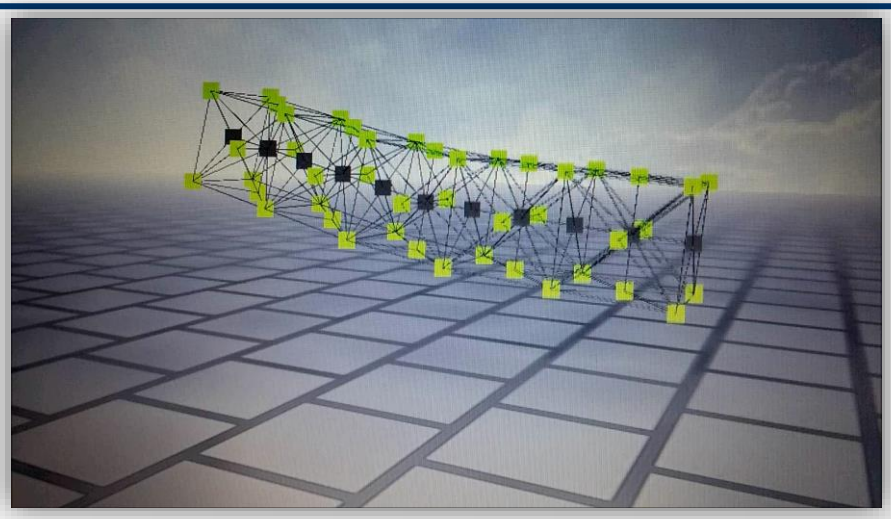
- *Material, textures, shaders and lights*
- *Kinematic behaviors*
  - *Direct*
  - *Inverse*
- ***Dynamic behaviors***
  - ***Rigid body***

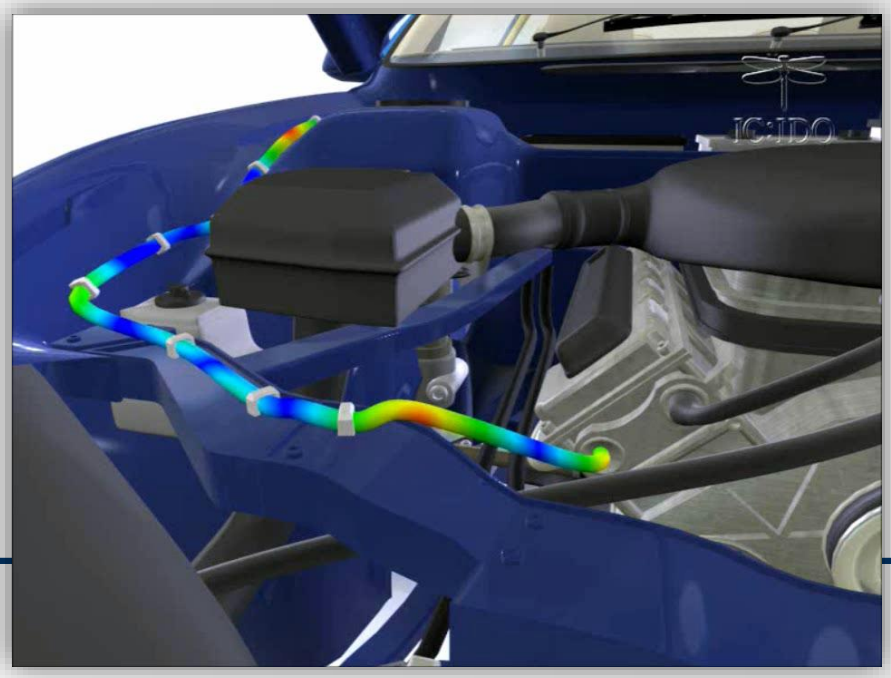


Virtual Prototype

CAD model +

- *Material, textures, shaders and lights*
- *Kinematic behaviors*
  - *Direct*
  - *Inverse*
- ***Dynamic behaviors***
  - *Rigid body*
  - ***Deformable body***





CAD model +

- *Material, textures, shaders and lights*
- *Kinematic behaviors*
  - *Direct*
  - *Inverse*
- *Dynamic behaviors*
  - *Rigid body*
  - *Deformable body*
- ***Sensitivity to collisions***
  - ***Detection***
  - ***Gliding***
  - *Avoiding*

CAD model +

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