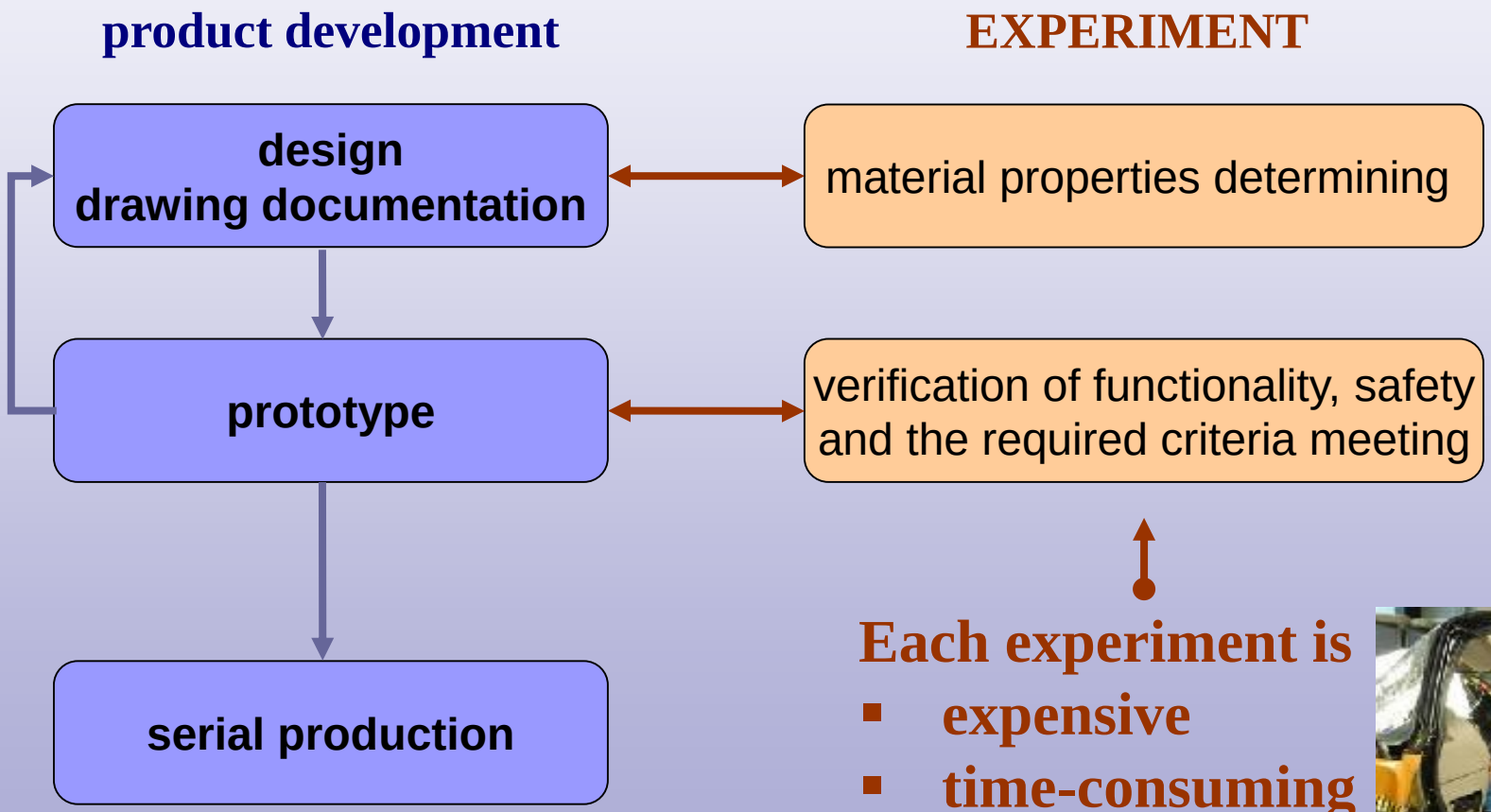
Experiment in technical practice

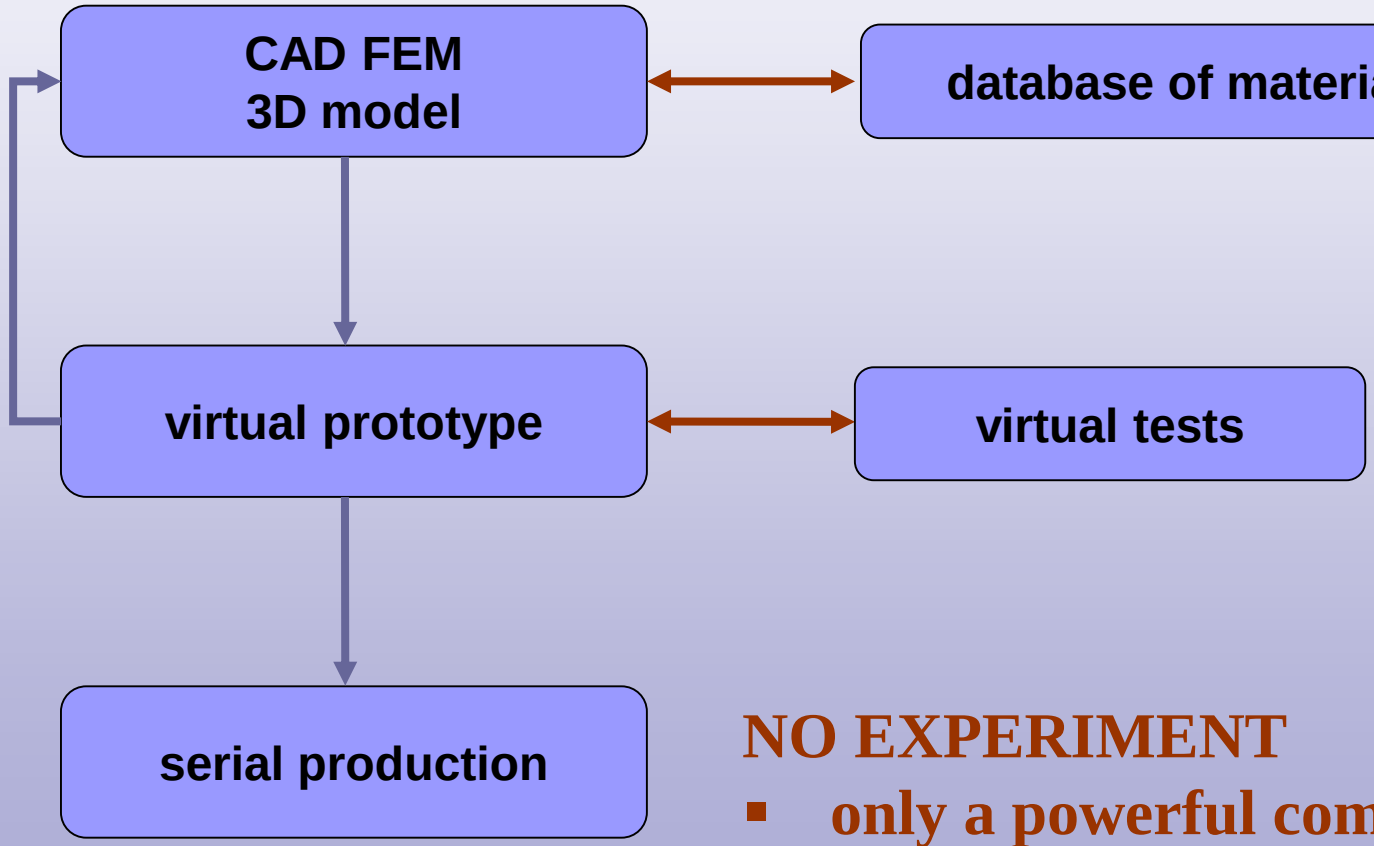
1. Application of the experiment in product development

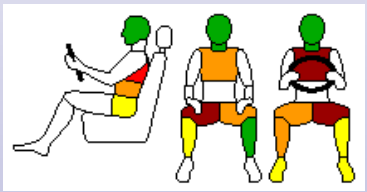
Classic (historical) process (last century)

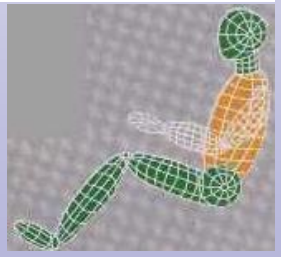


The new idea of the process (about in the 2000 year)

product development







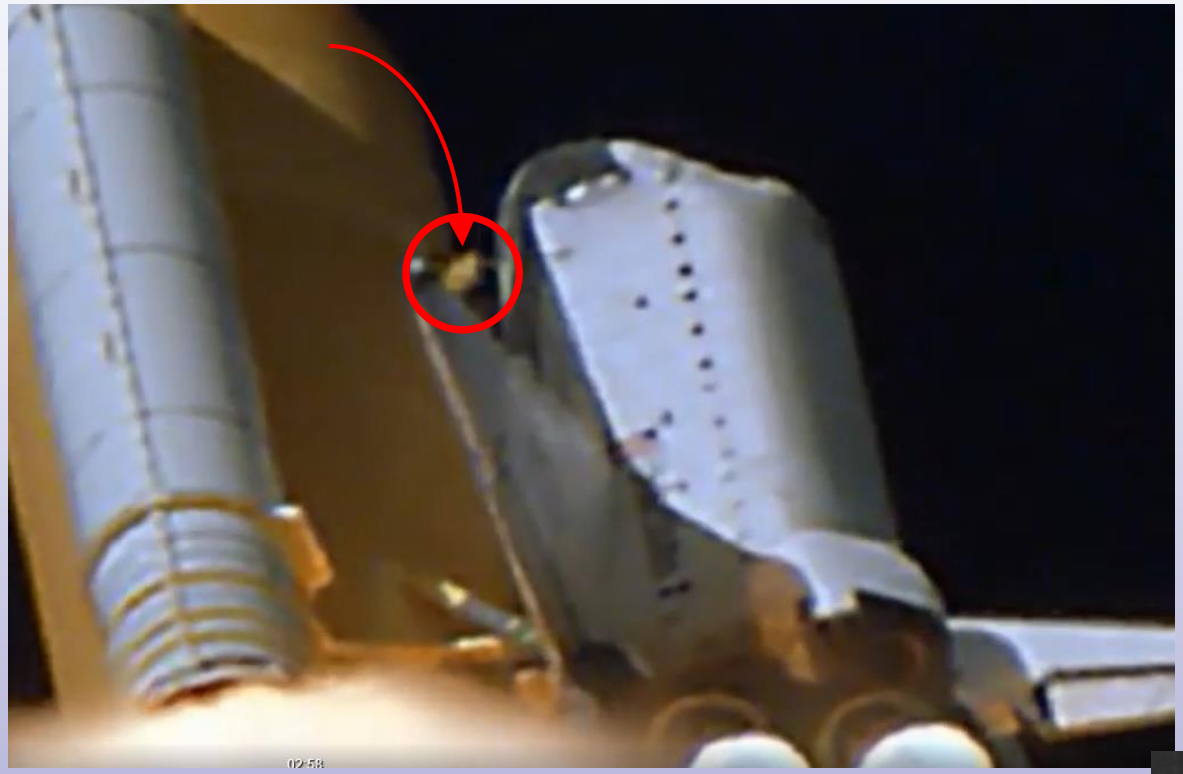
NO EXPERIMENT

- only a powerful computer and SW
- cheap, fast solution

This idea can be very dangerous !!!!

The space shuttle Columbia tragedy - February 2, 2003

the space shuttle Columbia tragedy



A small piece of insulating foam was released from the tank and hit the left wing of the shuttle during the start.

It had no effect during the start, the shuttle normally flew into orbit.

the space shuttle Columbia tragedy

Engineers in the Flight Center drew attention to this problem, the impact was recorded on the video.

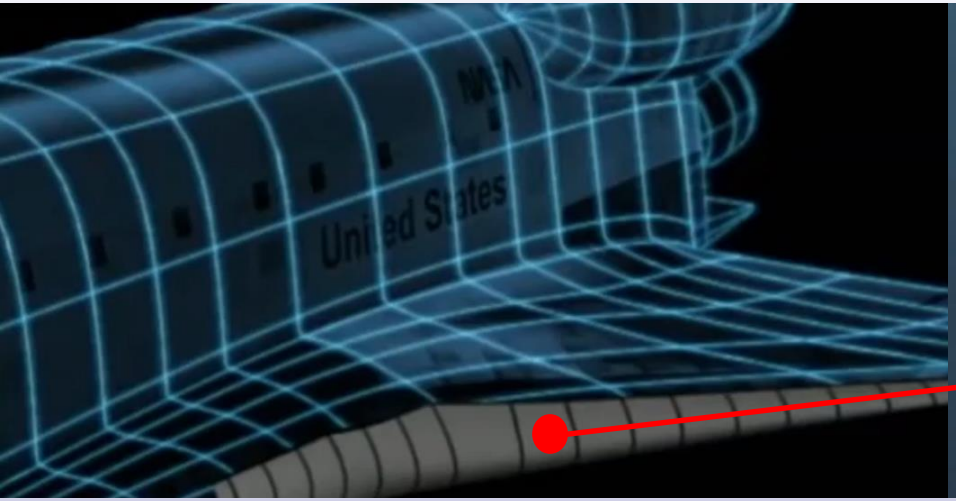
The management decided only to simulate the impact by the computer !!!

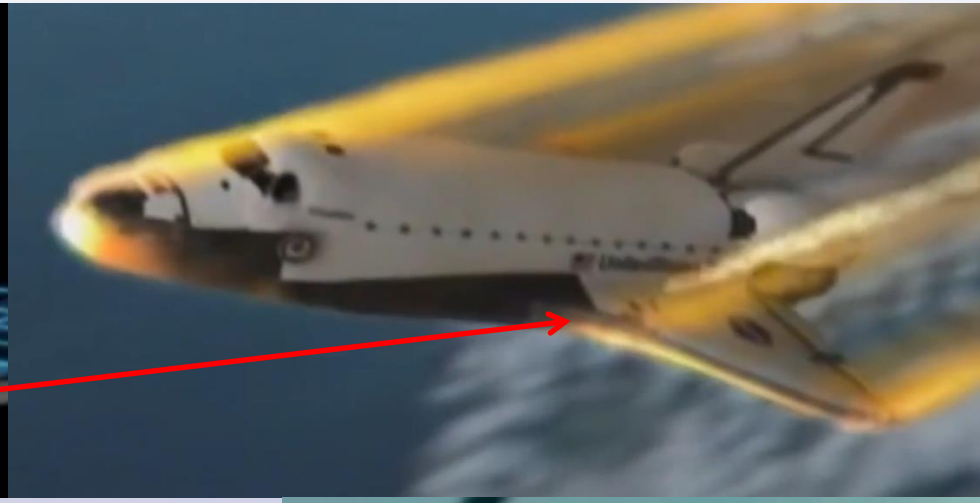
The simulation result? NO PROBLEM, the foam is too soft, it could not damage the wing.
But engineers still warned that the result might not be good and they wanted an experiment.

The management decided - no experiment, we believe in the simulation result!!!!

AND REALITY?

the space shuttle Columbia tragedy





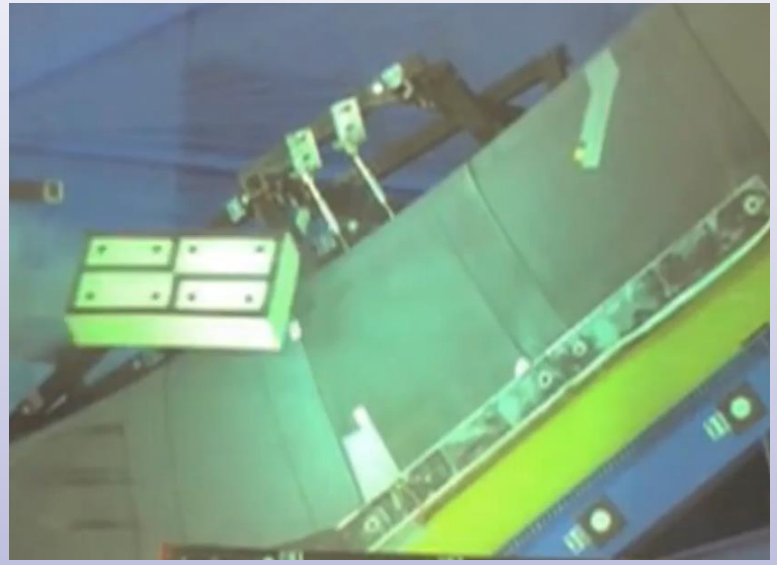
One thermal ceramic protection plate was destroyed by the foam impact!

The shuttle was disintegrated during the landing.
All seven astronauts died!!!

the space shuttle Columbia tragedy

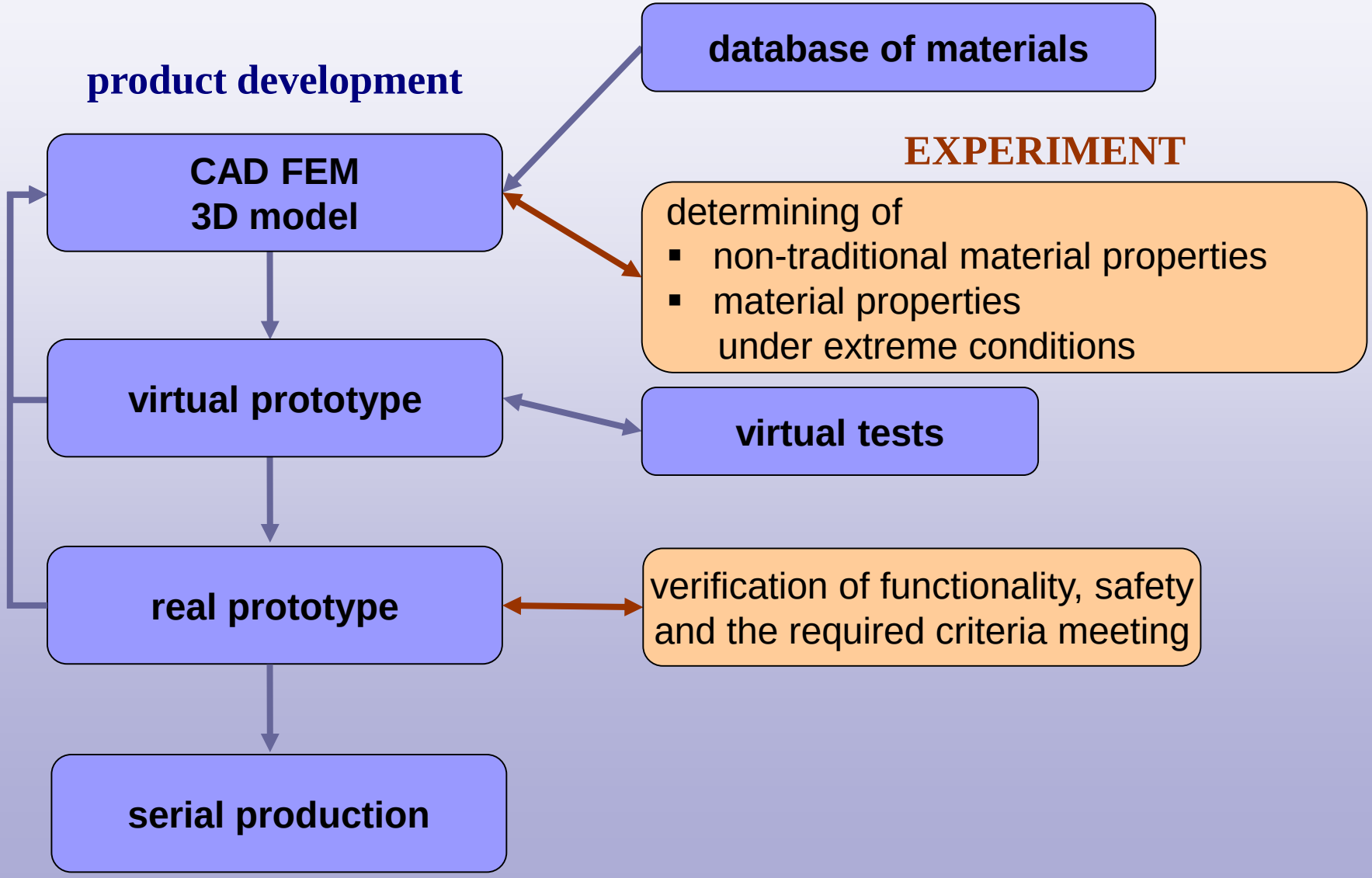
A real impact test was conducted during the accident investigation.

The ceramic plate was destroyed by the impact of the foam!!



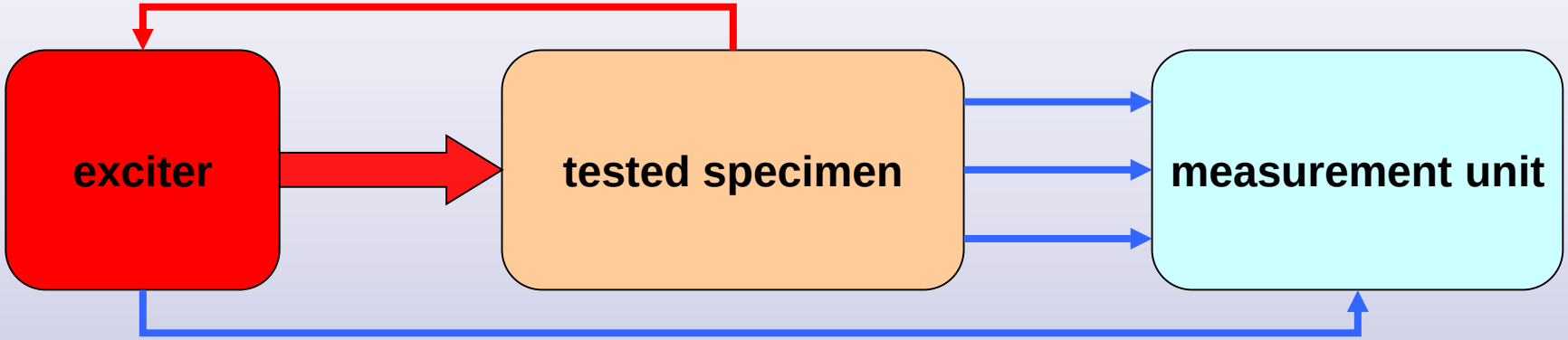
… but this finding came too late for the shuttle crew.

The current approach



2. Methodology of the experiment

real experiment



- exciter
  - generates a load signal
  - corrects load parameters by the feedback

- measurement unit
  - measures the loading signal
  - measures the response of the specimen to the load
  - displays measured signals in real time
  - performs time recording of the signals

3. Classification of experiments

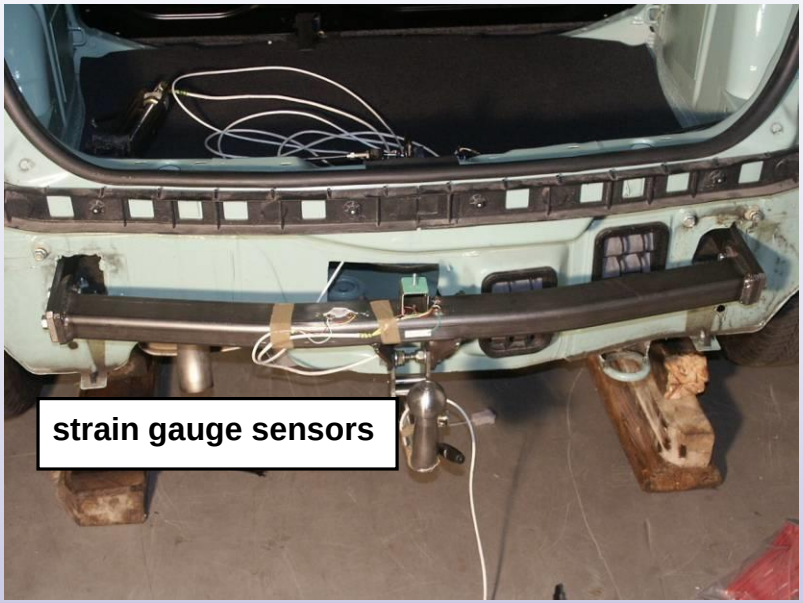
- Short-term and one-off experiments
  - excitation by various signals - periodic, non-periodic, random, real
  - adherence to the exact shape, amplitude and speed of the excitation signals
    - precision exciter and its control system to maintain the exact shape, amplitude and speed of excitation signals
  - monitoring and measuring many physical quantities
    - precision measurement device for monitoring, measurement and recording a lot of signals

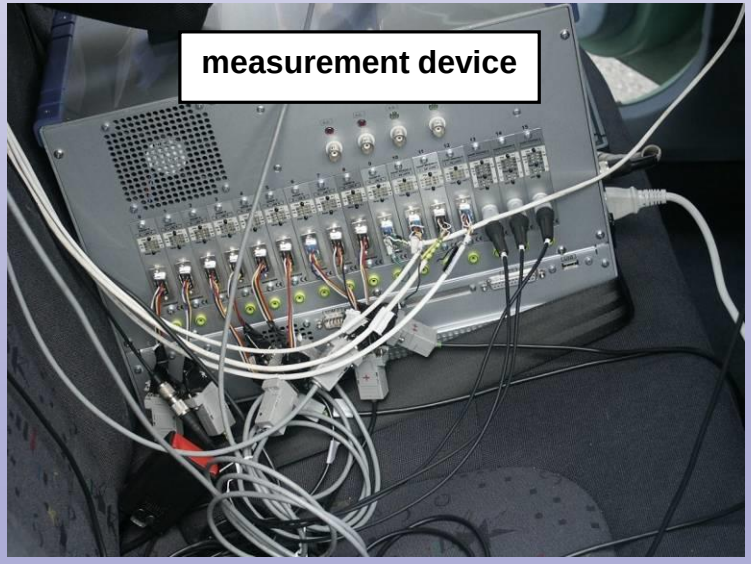
- Long-term experiments
  - excitation by various signals – periodic, random, real
  - often millions of cycles, it is usually not necessary to follow the exact shape of the signal
    - long-life exciter and its control system, long-term stability
  - usually simple monitoring, often the only criterion is to achieve a specified number of cycles without destroying the object
    - no measurement device
  - periodically repeated measurement and recording (eg every 1000th cycle)
  - automatic measurement and recording only when a criterion is met
    - long-term stability of the measurement device
    - possibility to set criteria for automatic recording

- Single-purpose experiments
  - periodically repeated experiment (quality control of serial production)
  - usualy simple excitation and simple monitoring
  - often evaluating results in real time and sending a "good, bad" signal
  - often automatic experiment implementation in an unattended production line
    - long-term stability of the exciter and the measurement device
    - possibility of programming for automatic operation
    - resistance to the operating environment

Experiment examples

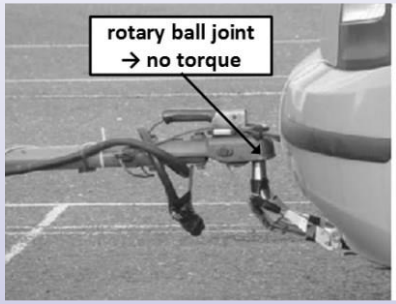
measurement
of the tow hitch beam stiffness
during riding

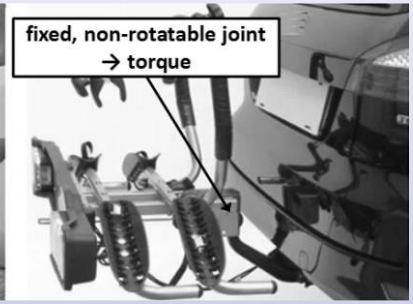


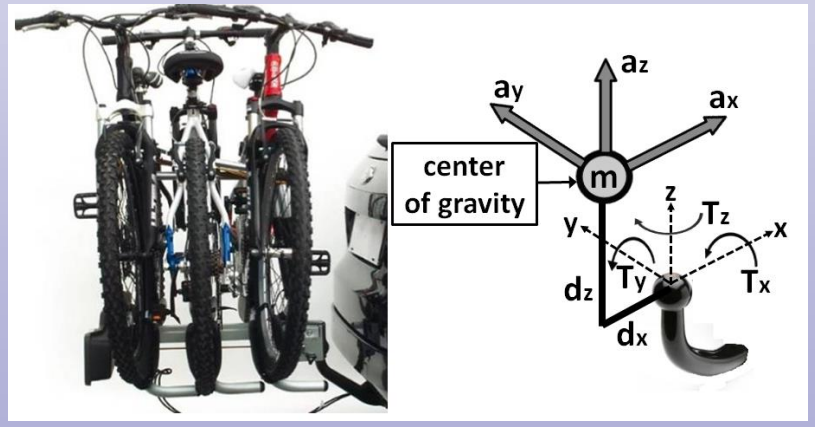


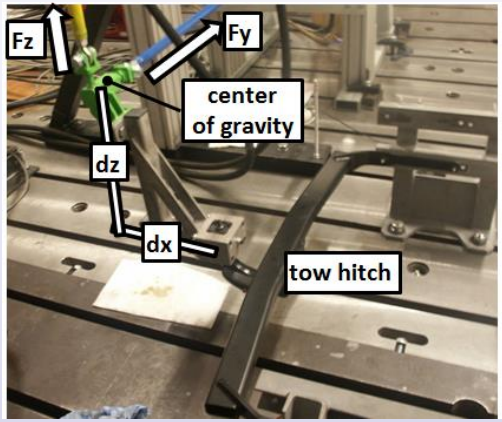
Experiment examples

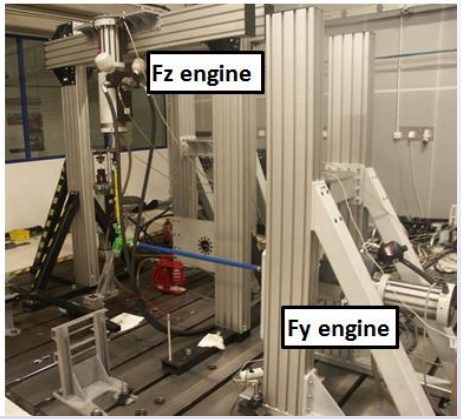
long-term test
of the tow hitch with a bike carrier





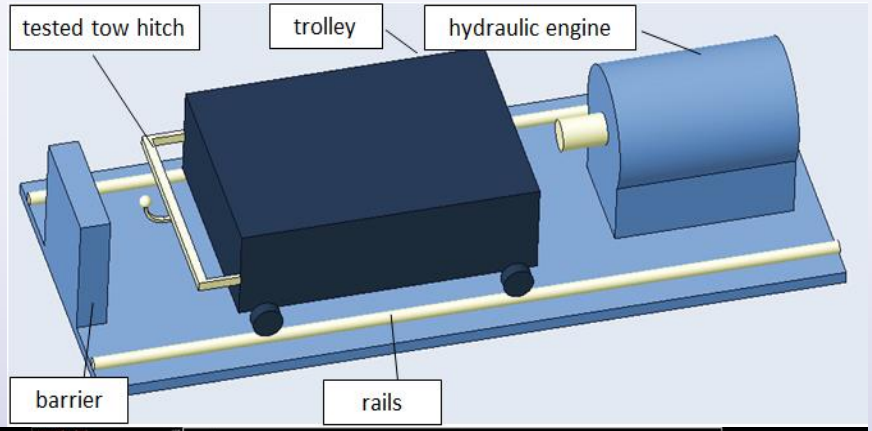




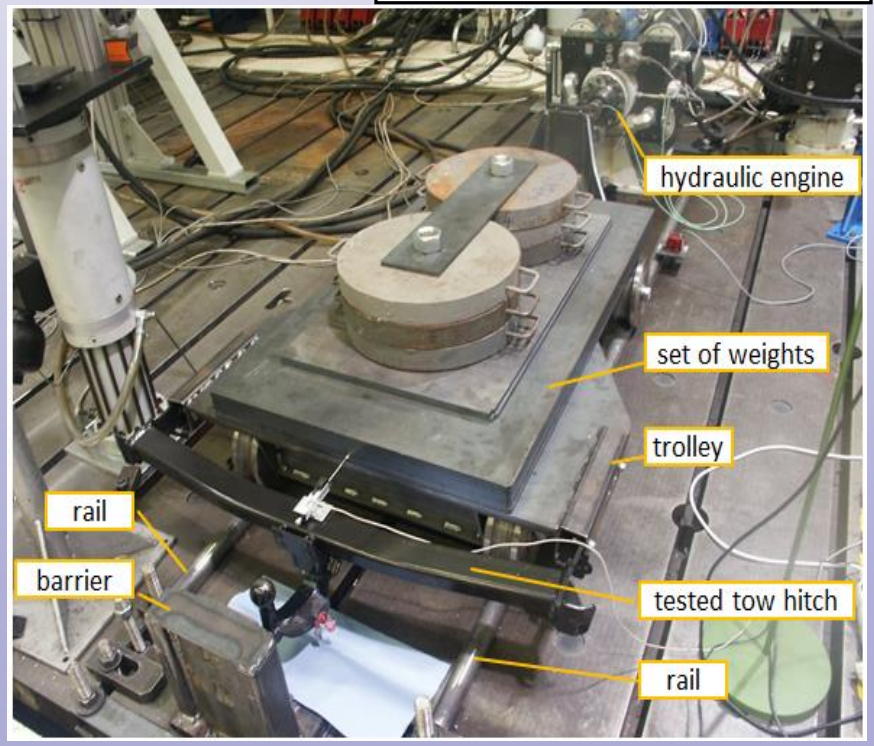


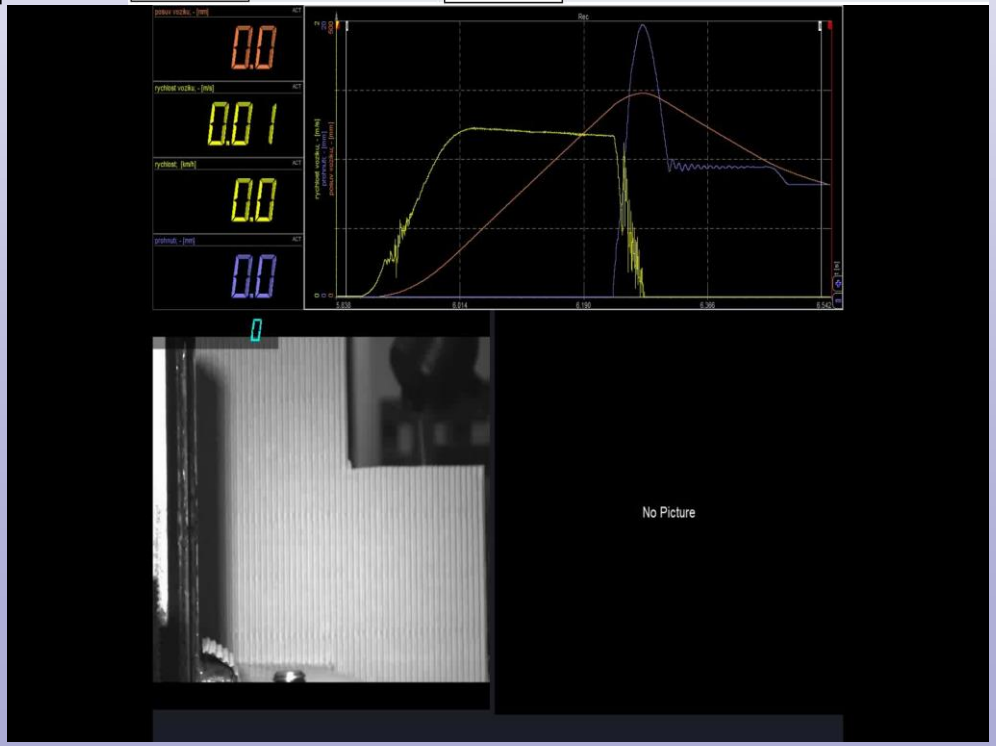
Experiment examples

crash test of the tow hitch - simulation of the crash to a wall when reversing



impact speed 1.2ms $^{-1}$

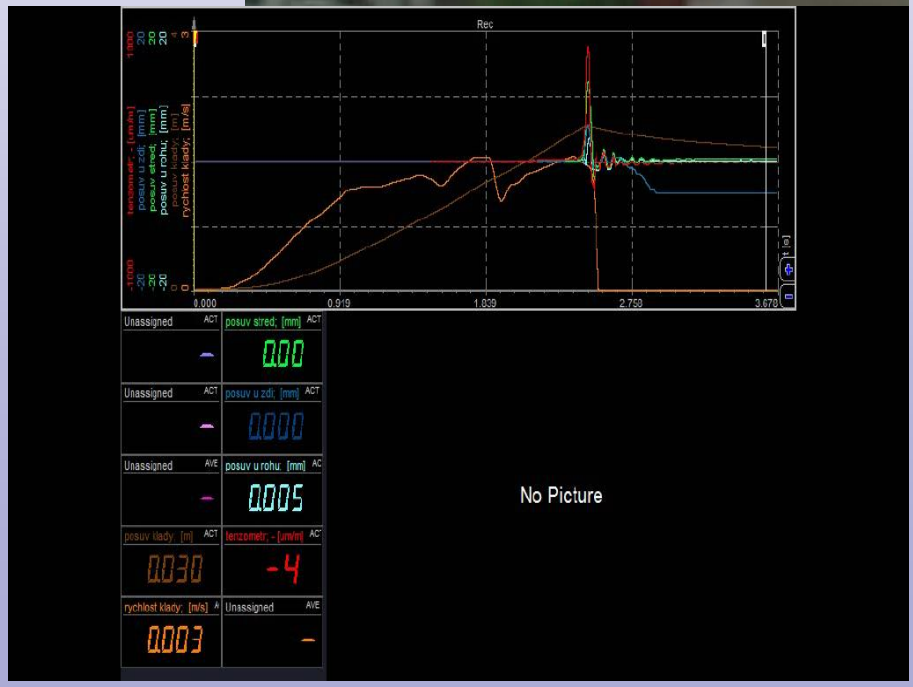




Experiment examples

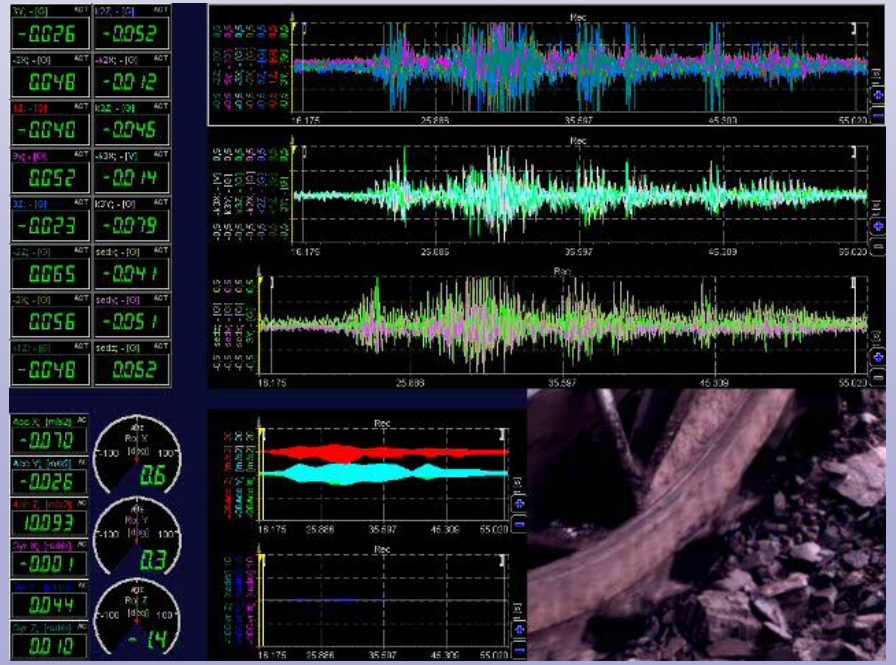
crash test of the flood barrieres - simulation of the wood log crash into a flood barrie

4m long and 400kg heavy wood log impact speed 2ms $^{-1}$



Experiment examples

measurement
of the mining machine
cabin vibrations

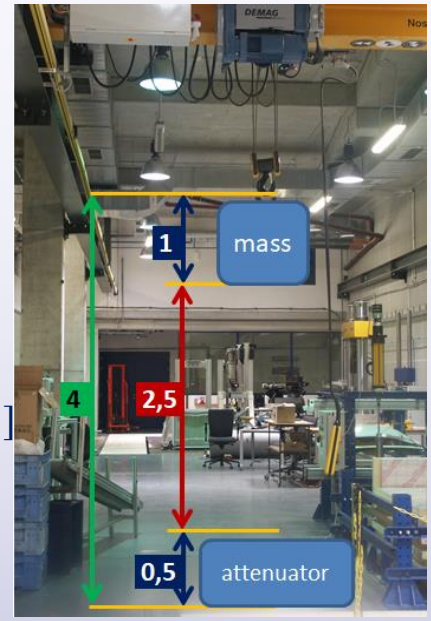


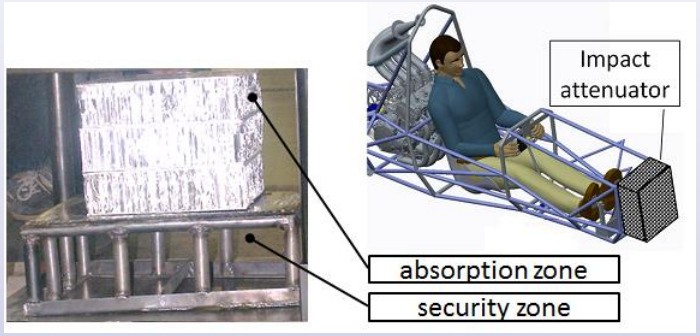
Experiment examples

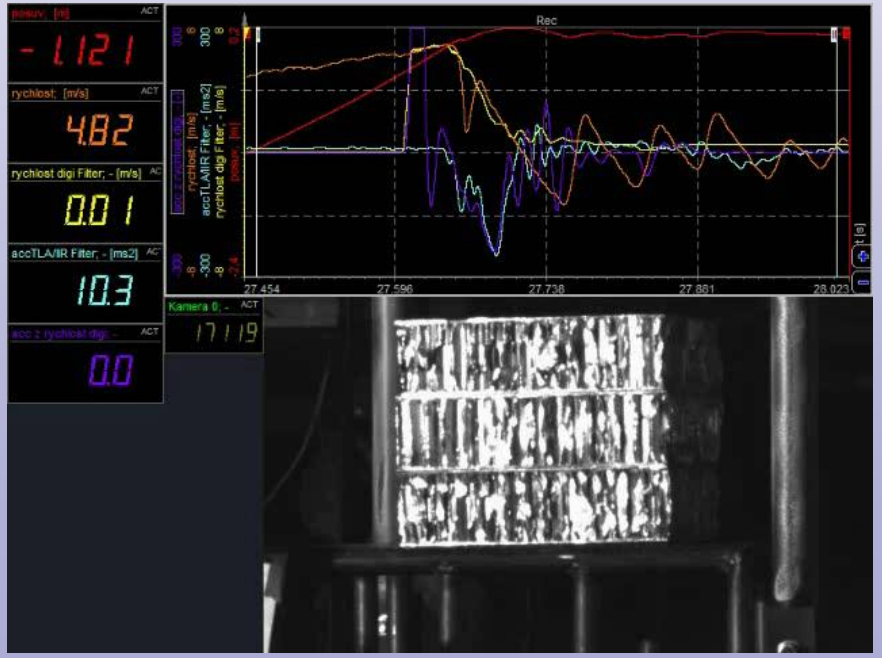
crash test of the student racing car
impact attenuator

$$v = \sqrt{2 * g * h} = \sqrt{2 * 9.81 * 2.5} \cong 7\ [ms^{-1}]$$

$$m = \frac{2 * E}{v^2} = \frac{2 * 7350}{7^2} \cong 300\ [kg]$$





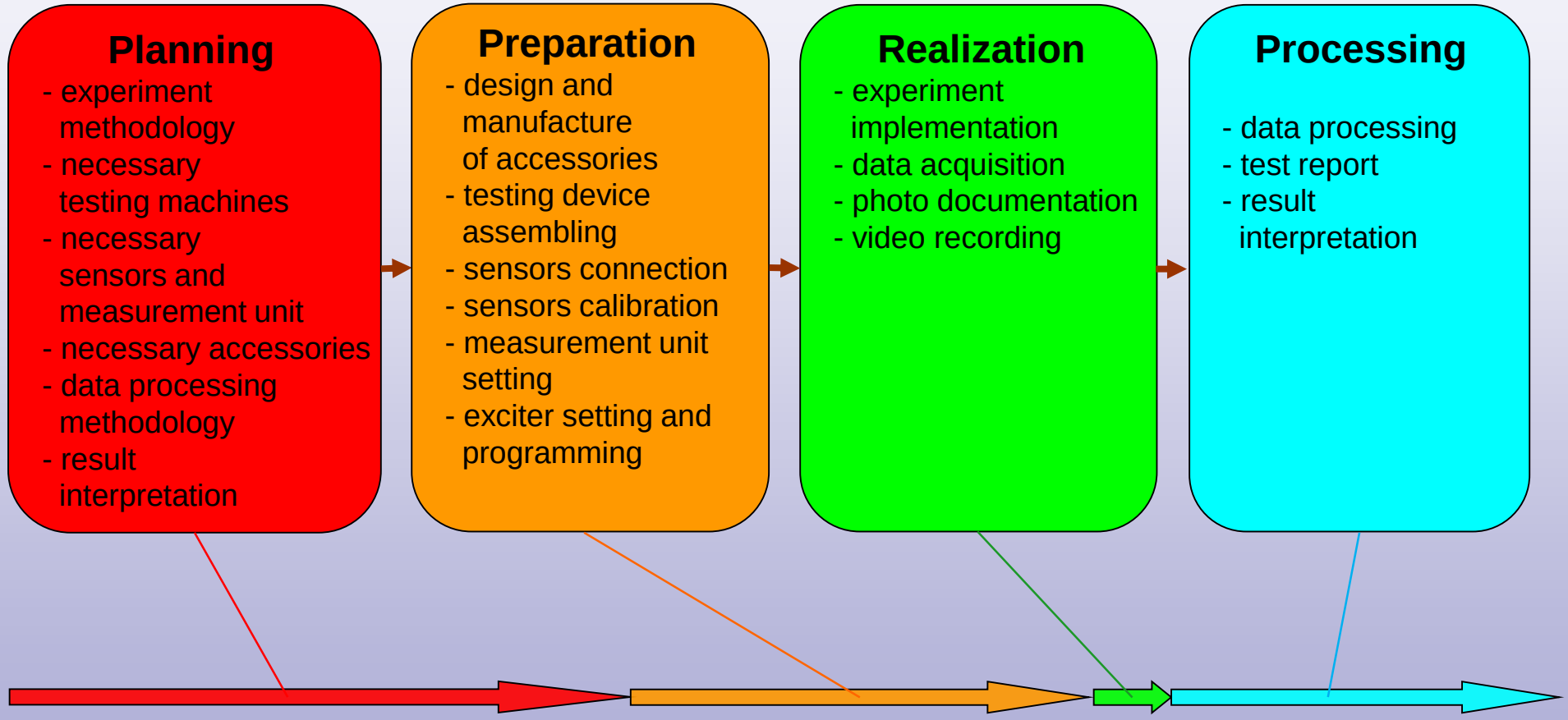


Experiment examples

measurement
of forces and torques
during carving skiing

deformation body with sensors
under the ski binding

4. Experiment realization procedure



Exam questions

- Application of the experiment in product development
  - historical and current state, block diagrams (pages 2 and 9)
- Methodology of the experiment
  - block diagram (page 10)
- Classification of experiments
  - types of experiments and their brief characteristics (page 11, 12)
- Experiment realization procedure
  - 4 steps of the experiment realization and their brief characteristics (page 20)