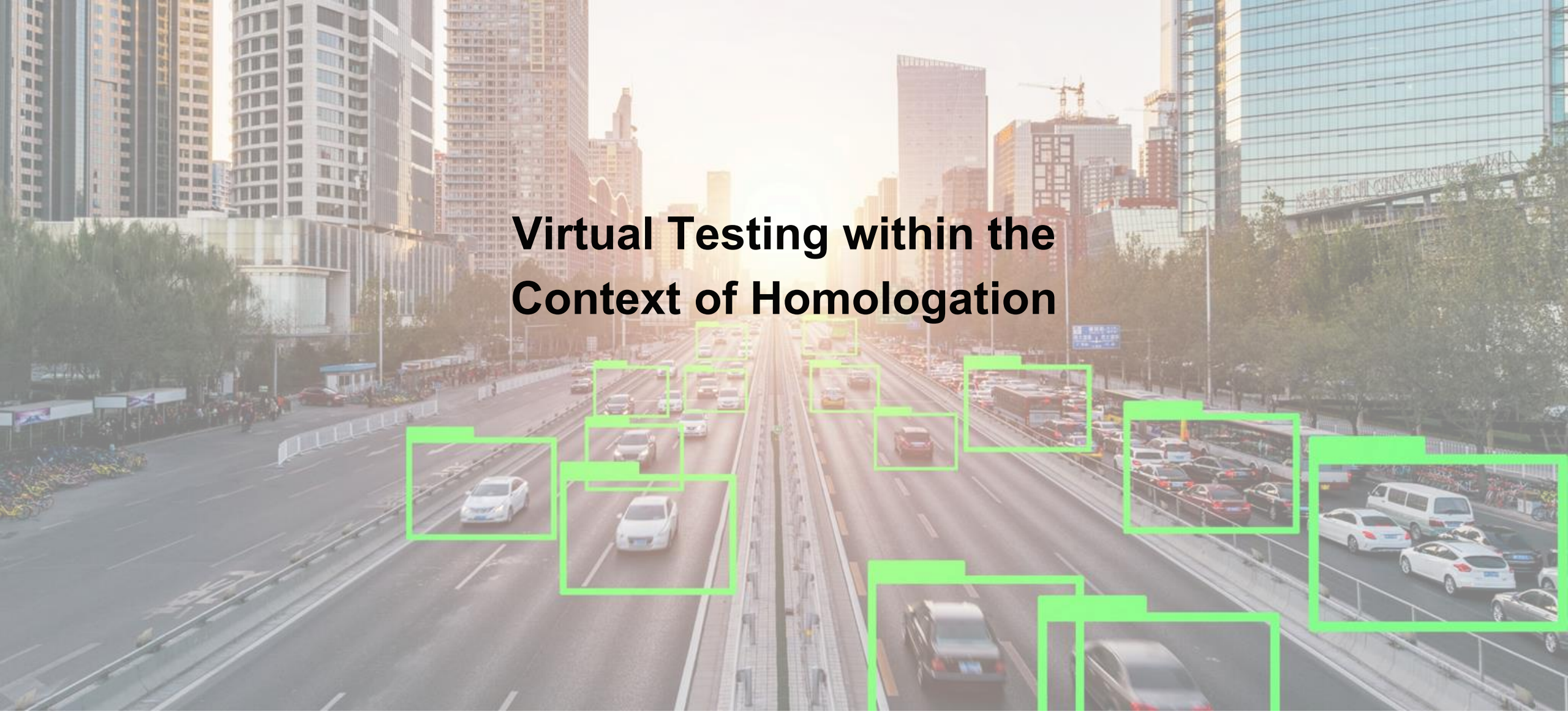

Virtual Testing within the Context of Homologation

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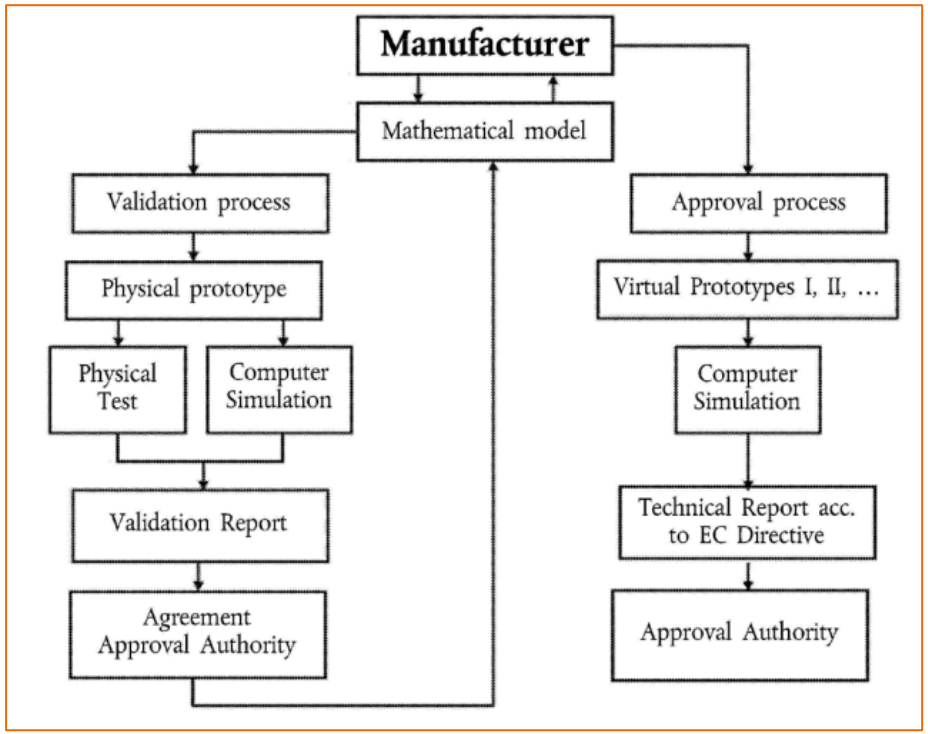
November 14th 2023

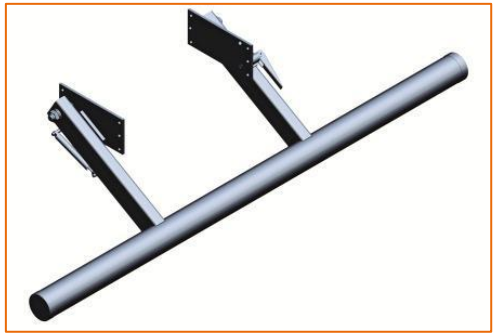
LEGAL BASICS FOR VIRTUAL TESTING

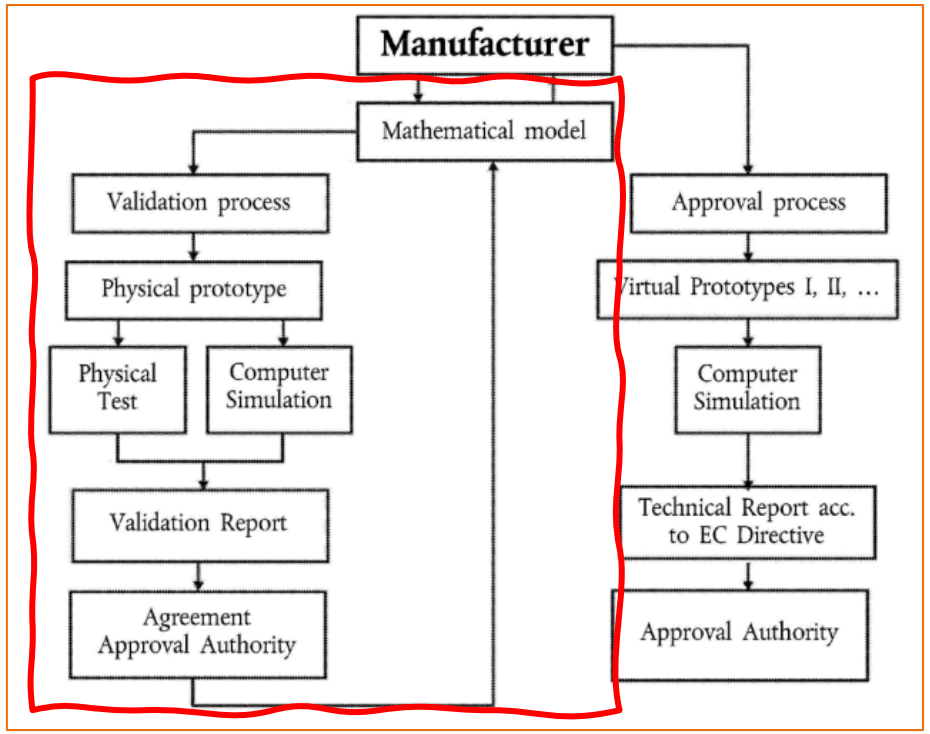
- Process for the virtual testing - overview:
  - One-time validation of a specific calculation method
  - Unlimited re-calculations of different models (as long no differences within the frame of the validation occur)
  - Similar process between the EU and UN
  - Within EU separate approval by the authority needed (only in combination with KBA and only within the EU)



LEGAL BASICS FOR VIRTUAL TESTING

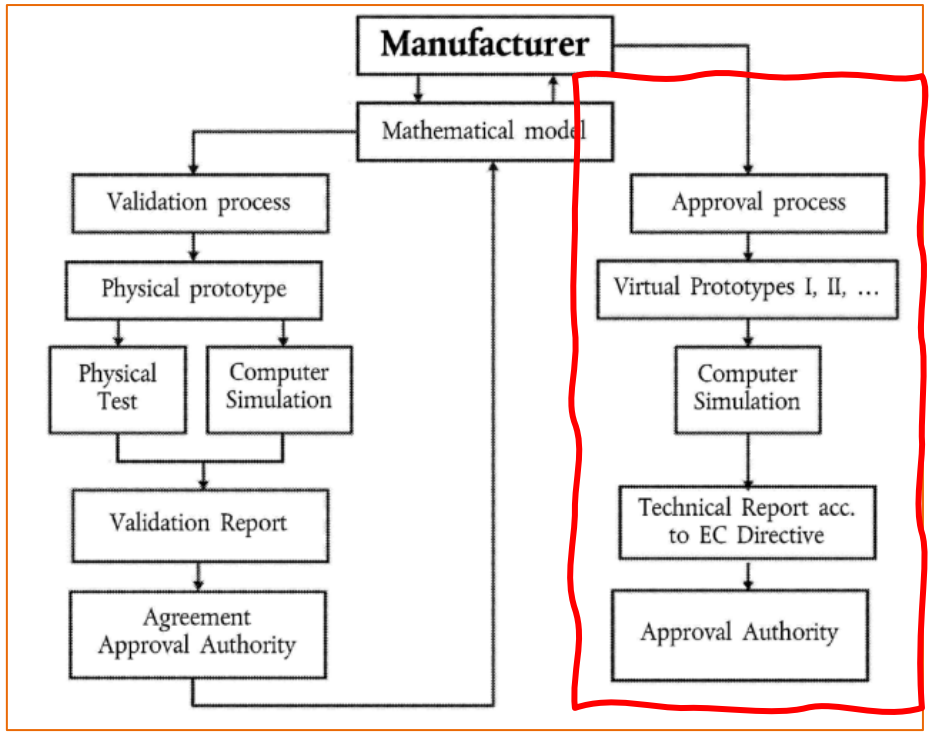
- Process validation in detail:
  - Manufacturer or calculation lab is requesting the validation for a specific method (e.g. mechanical strength; dimensional testing)
  - Based on the initial idea a physical model is to be prepared which is equivalent to the model to be used for simulation (e.g. rear underrun protection)
  - Practical (physical) test is needed
  - Calculation will be performed with identical load cases
  - Results will be compared to each other; differences in deformation will be verified
  - Validation report will be created considering the most important input values used for the calculation (e.g. model structure, …)
  - Deviations on the result to be considered





LEGAL BASICS FOR VIRTUAL TESTING

- Process for approval granting:
  - Manufacturer is requesting a new calculation for a new device or system
  - The owner of the validation report (manufacturer or lab) will perform the new calculation
  - No addition physical testing is needed
  - Results will be “corrected” by the deviations provided during the validation process
  - Approval for the device / system will be applied and granted by the authority
  - Changes on the calculation model or process will automatically lead to an update of the validation



CHALLENGES

- Today’s state of the art for virtual testing
  - More simple requirements are considered for virtual testing also by today:
    - Wheel covers
    - Direct vision evaluation
    - Indirect vision evaluation
    - …
  - Mechanical strength calculations are done, but during the validation a couple of question occur every time:
    - How to simulate material properties
    - How to create the model itself
    - How to create boundaries (welding, screwing connections, …)

→ **simple requirements are simulated today without any big problems; validation process is being used**

→ **Mechanical strength simulations are also be used today but a couple of questions occur very often where no clear way is being defined**

CHALLENGES

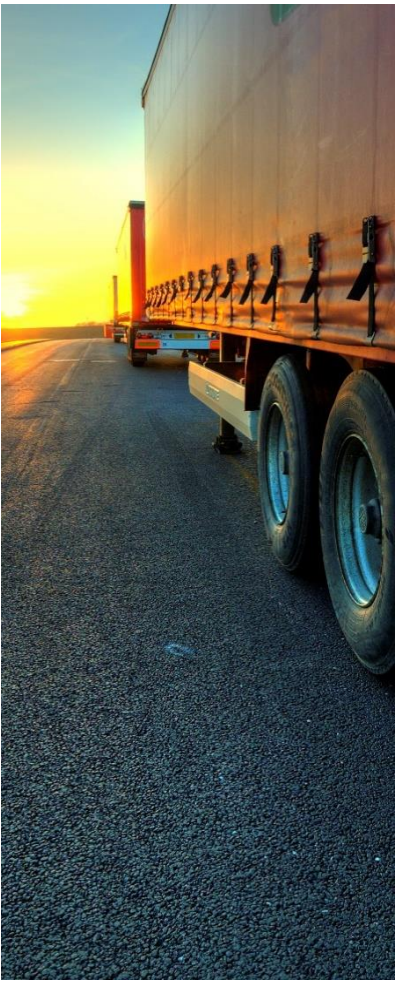
- When do the before mentioned rules also apply?
  - Certain regulations are mentioned within the annex VIII to CR(EU)2018/858
  - Additional information are given within the separate legal acts, e.g. at the UN-R42 (slow speed crash testing for front and rear bumper):

> **4. EQUIVALENT TEST METHODS**
>
> **4.1.** Other equivalent test methods are permitted provided that the conditions referred to in this Regulation can be observed and that their equivalence can be demonstrated.

  - Such a kind of remark / hint can be found in several regulations
  - Manufacturer would need to follow the official validation process by issuing the CAD model of the vehicle / structure

→ **Even in case the manufacturer would like to use it, the validation method is not sufficient for more complex testing**

VIEW OF THE FUTURE



Industry is requesting more ways of simulations

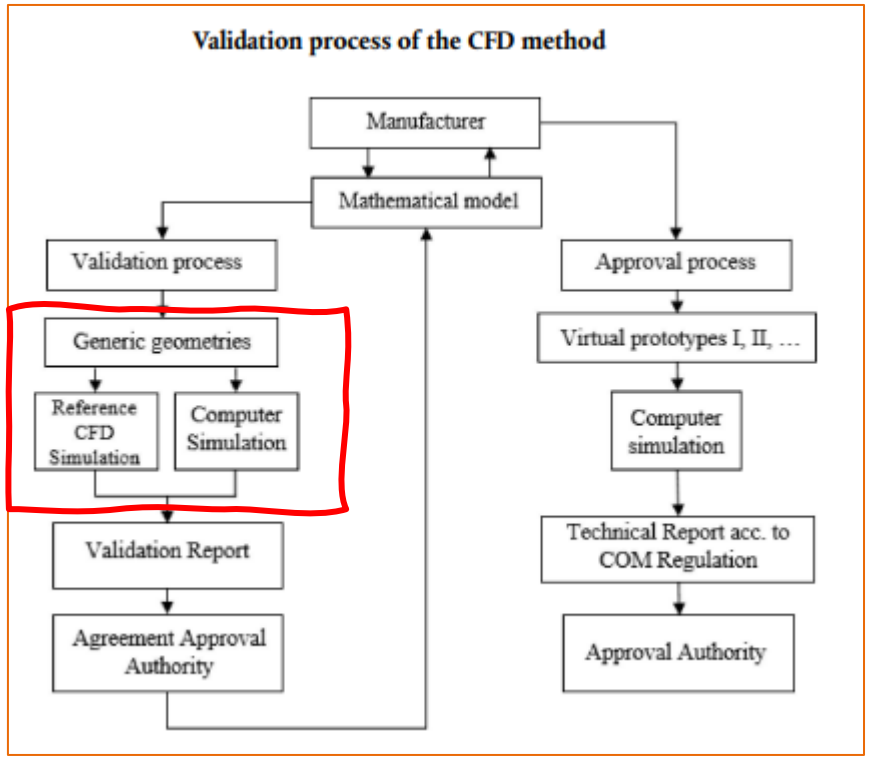
Homologation process in general need to speed up

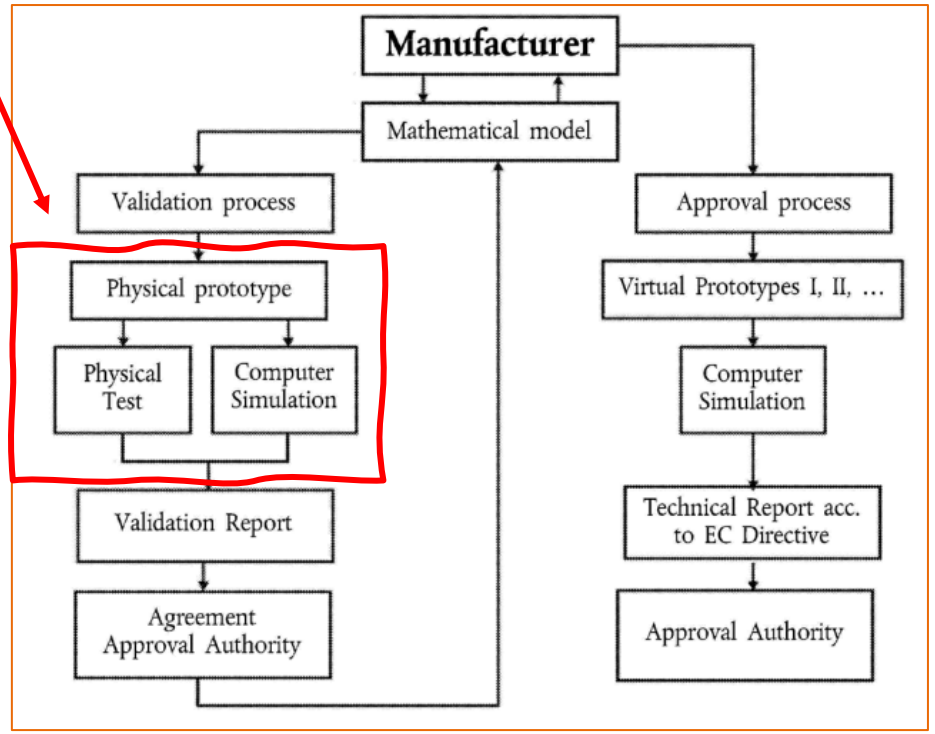
Additional ways for simulations are slowly upcoming; general implementation needed

VIEW OF THE FUTURE

How to deal with complex simulation in the future?

- Main question: is the current way practicable?
- CO2 simulation requirement did the first approach to change the way to following:





VIEW OF THE FUTURE

- While having the today's need for a practical test following update might be useful for the future:
  - Having a generic model not allocated to a specific manufacturer
  - This generic model will be set up physically for only one time
  - Validation with the physical model will be done only one time
  - Analysis of the factors influencing the calculation results
  - Defining of limits for the calculation to be expected
  - Manufacturer / labs (application owner) finally showing their competence for being able processing calculation by re-calculating the generic model
  - Evidence whether it's acceptable or not will be given by fulfilling the limit values (e.g. limit deformation, limit acceleration, …)

→ **This might be a proposal for future virtual testing within having the need that manufacturer will publish their CAD models**

→ **This might end in a higher acceptance for virtual certifications**

THANK YOU!

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