On the Computational Simulation of Electronic Equipment and Dynamic Mechanical Environmental Loads

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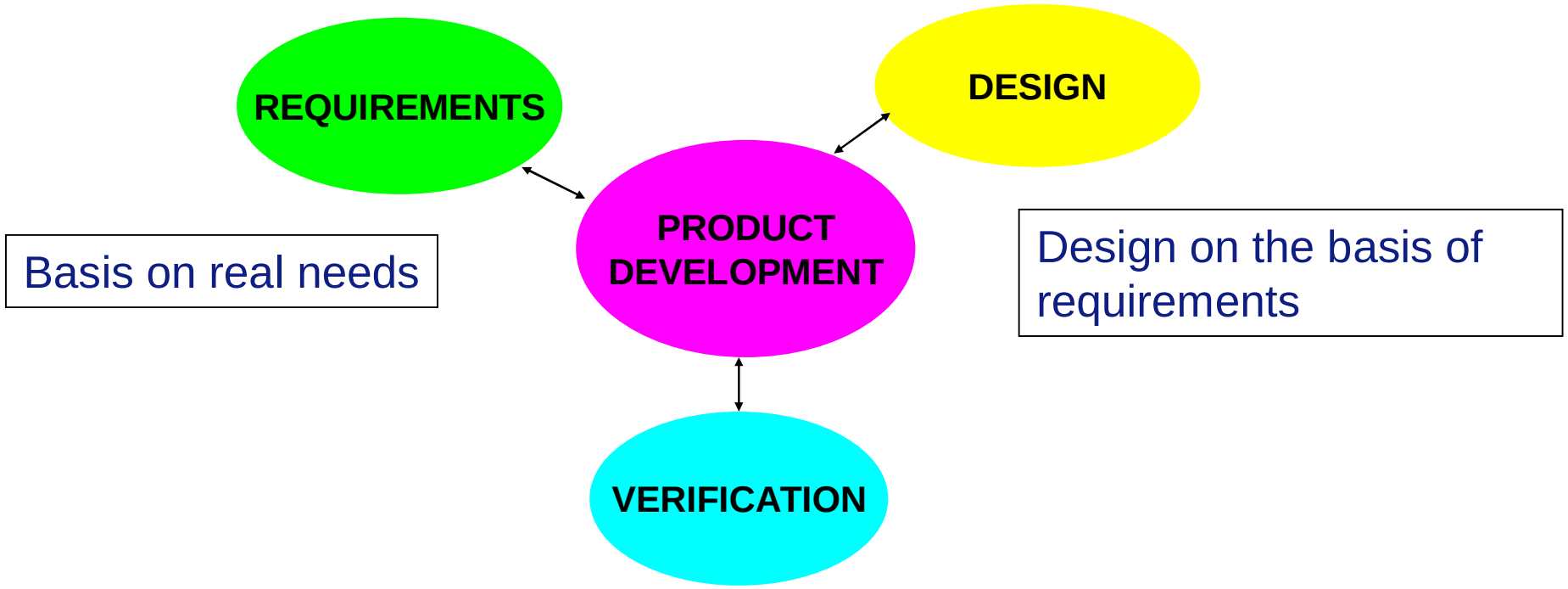
Business from technology

Background

- Design of electronic equipment
- Modelling and simulation in design
- Requirements: mechanical environmental loads
- Verification

Design of electronic equipment



Mechanical environmental loads

- Requirements based e.g. on environmental conditions
- Dynamic mechanical environmental loads:
  - Environmental testing point of view:
    - Manufacturing, transportation, storage, installation, operational
    - Test types: Sine vibration, sine sweep, random vibration, shock, bump, pyroshock, acoustic shock, impact, fall…
  - Signal analysis and numerical simulation point of view:
    - Stationary, non-stationary, deterministic, random, continuous, transient…

Modelling and simulation in design

- Modelling and simulation used increasingly.
- Advances in:
  - mathematical and numerical modeling techniques
  - computer efficiency
  - software usability
- Mature technology in many fields.
  - Numerical methods in mechanical engineering have long tradition
- Advancing into "multiphysical" modeling with various physical phenomena simulated at the same time (e.g. mechanic, temperature, flow, electromagnetic).

Verification

- Verification is the process of conforming that the designed and built product meet the requirements.
- Testing is a typical tool for verification
- There exist various types of testing of various levels and with different goals:
  - Environmental testing
  - Accelerated testing
  - Reliability testing
  - Qualification testing
  - Tailored testing
  - HALT/HASS

Testing

- Manufacturing of prototype, product, subcomponent or component
- Test facilities, equipment and personnel
- Test fixtures
- Possible run-time functionality
- Instrumentation, data collection and signal analysis
- Post test inspection and failure analysis

- Typically several test items needed
- Long testing times for life-time studies
- Often practical limitations: test machine and fixture properties, test time: timetable and test duration, instrumentation, number of channels etc.

VIRTUAL ENVIRONMENTAL TESTING

- Numerical simulation of test items under environmental loads.
- Idea: reduction of cost and physical resources, quality of design and testing, more competitive services and products.
- More than calculation of responses: work process and added value to simulation results.

THE BENEFITS OF SIMULATING ENVIRONMENTAL TESTING - Fast Walk Through

- Fast and versatile support of product design
- Design optimization with fast variation of parameters
- Detailed presentation of the results: stress, strain, field variables…
- No need for time consuming tests
- No need for expensive testing facilities and equipment
- “Multiphysic” simulation of combined environmental loads getting more reliable
- Time acceleration
- Test tailoring
- Test optimization

SOME USES OF VIRTUAL TESTING

- Support of traditional physical testing e.g.
  - Test planning
  - Fixture design
  - Find out the critical ”points”
  - Visualization
- Support for advanced physical testing e.g.
  - Force controlled testing
  - Tailored and accelerated testing
- Development of new tests and test equipment
- Development of test requirements
- Subcomponent requirements and testing
- Fully virtual testing

THE CHALLENGES OF SIMULATING ENVIRONMENTAL TESTING

- Reliable modelling and simulation
- The costs of the modelling and simulation
- Possible need to model whole system test machine, fixture and product
- Critical areas of validation and verification:
  - Experimental methods (dyn. properties, failure limits)
  - Critical failure definition and propagation
  - Tailored and accelerated testing
  - Test equipment dynamics and control systems

Why Is Virtual Environmental Testing Not Used Today?

- Simulation is already widely used, but typically separate to physical testing
    - Different people with different objectives
    - Lack of mutual understanding
    - Missed possibility: exchange of information
- Electronic equipment are considered to be too complicated to be modelled numerically.
    - Geometry, materials, joints, connectors, wires
- Numerical models for testing machines are not available
- The use of simulation tools may be a demanding change: knowledge, working practices and co-operation of experts are needed.

Examples of recent work in Finland

- TUPA – project KOTEL/TEKES
- Mechanical shock and vibration isolation studies
- Full and model scale Finnish Navy simulations

- All projects with physical measurements in laboratory or/and in the field conditions
- Verification a key approach: physical and virtual together for optimal results.

WHAT IS NEEDED TODAY?

- Increase in knowledge and understanding
  - is this a way to go into working practices for “everyday use”?
- Commonly agreed methods and methodologies
  - Work process
  - Modelling practices
    - Different levels of models and simulation
- Company strategy for optimal use of virtual testing
  - Product development process, subcontractors, customers
  - Product model
- Standards
- What else needed or totally not a good idea?

WELLCOME TO JOIN!

Bestproduct TENEEST project:

VPET – VIRTUAL AND PHYSICAL ENVIRONMENTAL TESTING

- Joint European Research Project Of Virtual Environmental Testing
  - Development of Reliable Methodologies
  - Demonstrating the Benefits
  - Initializing Standardization
  - Output proposed:
    - Handbook, Benchmarks, Industrial Cases

ON THE VERGE OF FUTURE AND BEING PART OF IT!