Industrie 4.0

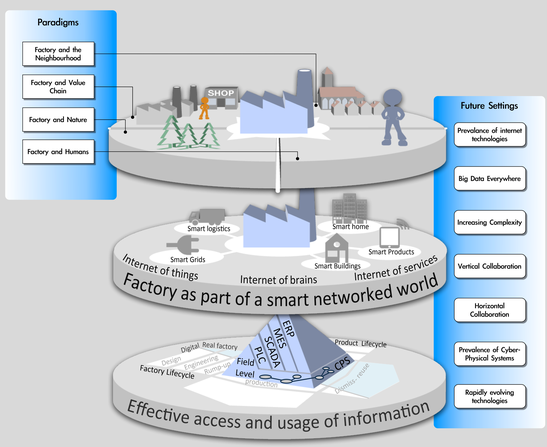
FoF2020

Trends

ActionPlanT

IMS2020

PATHFINDER VISION



S&FT STATE OF PRACTICE

RESEARCH AREA 1 — Open and cloud-based S&FT for High-Performance Computing

- Only early adoption stage of cloud-computing IaaS Paradigm;
- High-performance simulations requires high-performance CPU;
- Applications run only single device;

RESEARCH AREA 2 — Multi-Disciplinary and Multi-domain integrated S&FT

- Only dedicated application object libraries for fast and efficient modeling of typical scenarios;
- Incremental model building allowing in-process debugging;
- Limited product data exchange or across different domains;
- Many domains specific models;
- Many tools available for specific functions or resources;
- Few/No common standards or integrated framework;

RESEARCH AREA 3 — S&FT for Life-Cycle Management

- Poor modeling simulation of life-cycle issue;
- Limited, specialized de-manufacture applications for specific product type;
- Few applications consider product life cycle cost and environmental issues;
- Existing process modeling applications used to evaluate remanufacturability of design (non-tailored for de-manufacturing)

RESEARCH AREA 4 — Multi-level S&FT integration

- Object-oriented, hierarchical model of plants, encompassing business, logistic and production processes exist;
- Direct interface with CAD, DBMS (ORACLE, SQL Server, Access, etc.) direct spreadsheet link in/out, XML save format, HTML reports;

RESEARCH AREA 5 — S&FT for Real-Time Factory Controlling and Monitoring

- Expensive data collection;
- Expensive and time-consuming systems for factory operations;
- Early adoption of virtual factory models;

RESEARCH AREA 6 — Smart, Intelligent and Self-Learning S&FT

- Integrated neural networks and experiment handling;
- Inbuilt algorithms for automated optimization of system parameters;
- Many custom models used;
- Some knowledge-based advisory system in use;
- Excellent analytical simulation and forecasting capabilities in continuous processing industries;
- Application based on empirical or past data;

RESEARCH AREA 7 — Human-centred Simulation-based Learning & Training

- Used in the aviation and automotive sectors for special training;
- Expensive and time consuming;
- Many-domain specific tools;

RESEARCH AREA 8 — Crowdsourcing-based S&FT

- Existing crowdsource-source frameworks used in the design phases;
- Complex tools require high-skill & long processing time;

S&FT TRENDS & FUTURE STATE

RESEARCH AREA 1 — Open and cloud-based S&FT for High-Performance Computing

- Exploit IaaS in cloud infrastructure for high-performance and complex simulation, forecasting and analytics;
- Facilitating SMEs to access high-performance and complex simulation, forecasting and analytics through a manufacturing app store;

RESEARCH AREA 2 — Multi-Disciplinary and Multi-domain integrated S&FT

- Develop multidisciplinary models and tools for designing flexible and easily reconfigurable systems, integrating models from different domains able to monitor consumption of energy and other resources and prevent unforeseen and undesired reactive maintenance
- Development of closed loop simulation tools to be used in the design phase;
- Use simulation for the sustainable supply chain design;

RESEARCH AREA 3 — S&FT for Life-Cycle Management

- Simulation tools for the de-manufacturing phase (dismantling, repairing and rebuilding);

RESEARCH AREA 4 — Multi-level S&FT integration

- Multi-level simulation applications that support usability at different levels aimed at providing different representations of relevant information (multi-level access features, aggregation of data with different granularity, zoom in and out functionalities);
- Simulation tools enhancing data integration across the process chain
- Advanced visualization tools for better human understanding

RESEARCH AREA 5 — S&FT for Real-Time Factory Controlling and Monitoring

- Real-time data collection from all the factory resources and synchronization of real-world and virtual resources;
- Knowledge-based and intelligent simulation tools able to assess performance at both factory level (energy consumption, productivity, production processes and quality) and supply chain level;
- Performance assessment in real-time and predictive considering varying environmental conditions and phenomena;
- Product-life cycle simulation tools that could support the decisional process providing KPIs;
- Integrating simulation tools with MES
- Real-time data collection from all the factory resources and synchronization of real world and virtual resources;
- Developing digital mock ups of product and services in their environment to improve the control done by simulation tool;
- Simulation tools used to guarantee production systems delivering "zero defect" parts;

RESEARCH AREA 6 — Smart, Intelligent and Self-Learning S&FT

- Self-learning systems to enable self-adaptation of simulation attributes from historical and real-time data;
- Development of predictive data analytics techniques and forecasting capabilities to process the massive amount of data

RESEARCH AREA 7 — Human-centred Simulation-based Learning & Training

- Virtual and simulation environment for role game-based learning and training;
- Tools to support the decision-making on the basis of worker capabilities;

RESEARCH AREA 8 — Crowdsourcing-based S&FT

- Simulation tools interacting with social networks and HMI supporting the comparison between models and allowing a what-if analysis (interaction with customers);

GAPS

RESEARCH AREA 1 — Open and cloud-based S&FT for High-Performance Computing

- **G1.1** - Poor maturity level of use of cloud computing in S&FT;
- **G1.2** - Missing of multi-device application;

RESEARCH AREA 2 — Multi-Disciplinary and Multi-domain integrated S&FT

- **G2.1** - Missing of multi-disciplinary and multi-domain models;
- **G2.2** - Lack of integration from different domain/discipline models;
- **G2.3** - Few standards for multi-domain models building & integration;
- **G2.4** - No integration between tools;

RESEARCH AREA 3 — S&FT for Life-Cycle Management

- **G3.1** - Poor modelling simulation of life-cycle issues;
- **G3.2** -Limited modelling of product life-cycle costs;
- **G3.3** - Environmental issues are barely considered;
- **G3.4** - De-manufacturing not completely assessed and only for specialized product type;

RESEARCH AREA 4 — Multi-level S&FT integration

- **G4.1** - Shortage of multi-level S&FT models;
- **G4.2** - Limited integration and interoperability across the process and product chain;

RESEARCH AREA 5 — S&FT for Real-Time Factory Controlling and Monitoring

- **G5.1** - Real-time data collection barely used;
- **G5.2** -Limited linkage to actual and real-time data;
- **G5.3** - Poor maturity level of use of virtual factory models;

RESEARCH AREA 6 — Smart, Intelligent and Self-Learning S&FT

- **G6.1** - Missing of self-optimizing and self-learning models;
- **G6.2** - Poor use of knowledge-based systems;
- **G6.3** - Poor maturity level of use of smart objects utilization;

RESEARCH AREA 7 — Human-centred Simulation-based Learning & Training

- **G7.1** - Limited use on large-scale;
- **G7.2** - Lack of generic tools for human-centred simulation-based learning and training;

RESEARCH AREA 8 — Crowdsourcing-based S&FT

- **G8.1** - Missing of crowdsource-based framework for simulation and forecasting tools;
- **G8.2** - Lack of integration with social networks;

CHALLENGES

S&FT and Digital Continuity

Interoperable simulation and forecasting systems; Digital continuity across product and factory lifecycle of engineering information; seamless use and reuse of engineering data; Modelling; Standardization.

S&FT and Scalability

Step-by-step integration and adoption of simulation and forecasting techs; S&FT solution scalable on different devices; SF&T that runs from single device to Cloud-based.

S&FT and Synch. of digital and Real World

Self-adjustment of digital models triggered by smart objects (embedded intelligence); Co-Simulation in Real-time; Handling of big-data.

S&FT and Advanced HMI

Intuitive, mobile, context-sensitive, ergonomic, collaborative user-interfaces.

S&FT and Digital Consistency & Security

Provision of consistent data, data safety and privacy.

S&FT and Knowledge

Relevant knowledge capture and reuse, also for training and education.

RESEARCH PRIORITIES