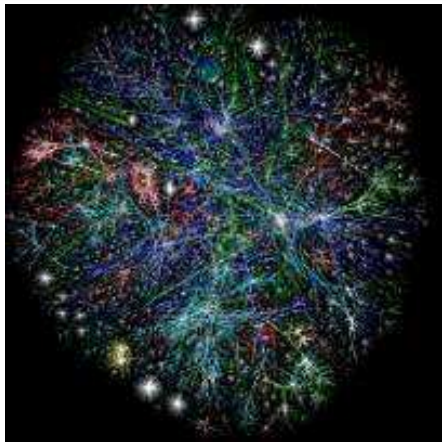
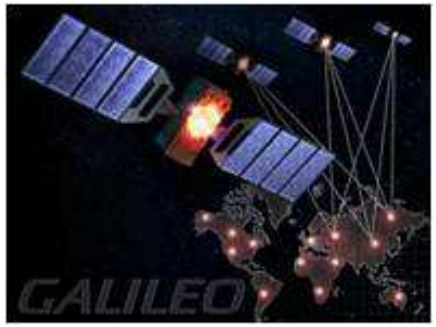



Systems Engineering

AFIS Vision for the 2020s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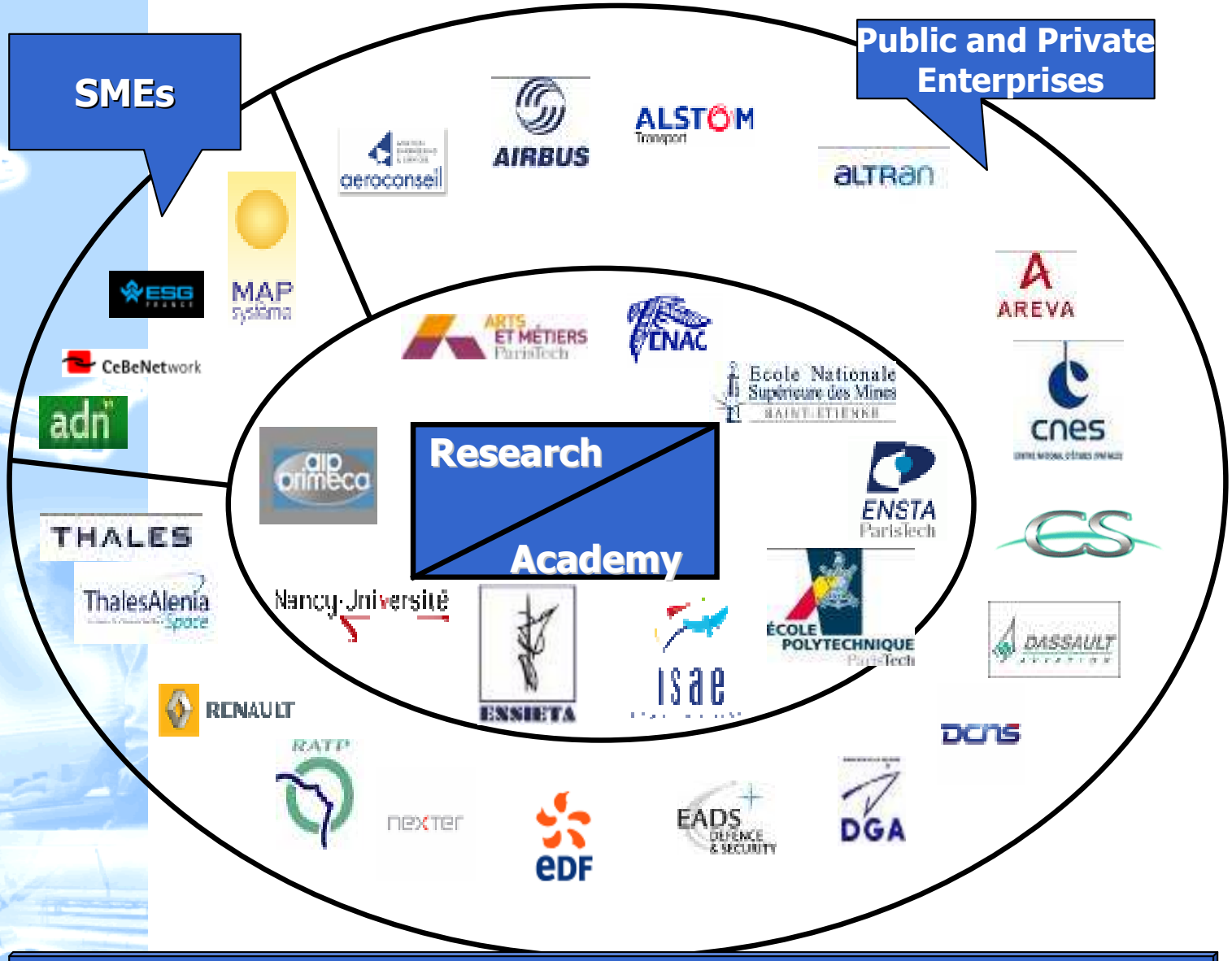
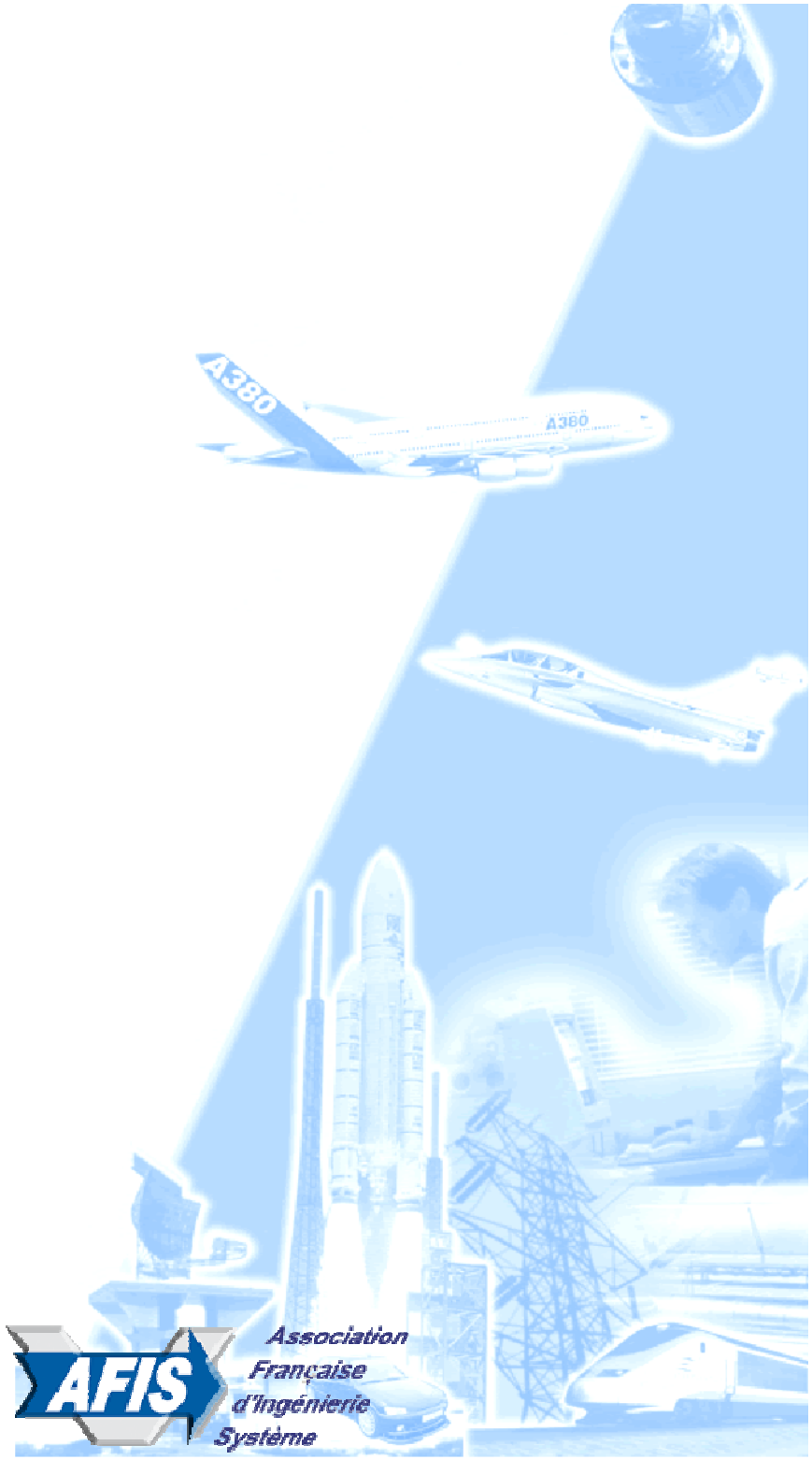
AFIS (French Council for System Engineering)

AFIS

"Association loi 1901" (non-commercial):

- created 1999,
- around 500 *individual members*,
- exclusive representative of the INCOSE in France,
- fosters SE within industry and academy,
- fosters exchange around best practices and drafts standards,
- organizes workshops and conferences.





2010… Where do we start from?

SE to avoid this!

Association Française d'Ingénierie Système

and this…


MICHAEL LONG
TRUCK & CRANE HIRE

No comment …

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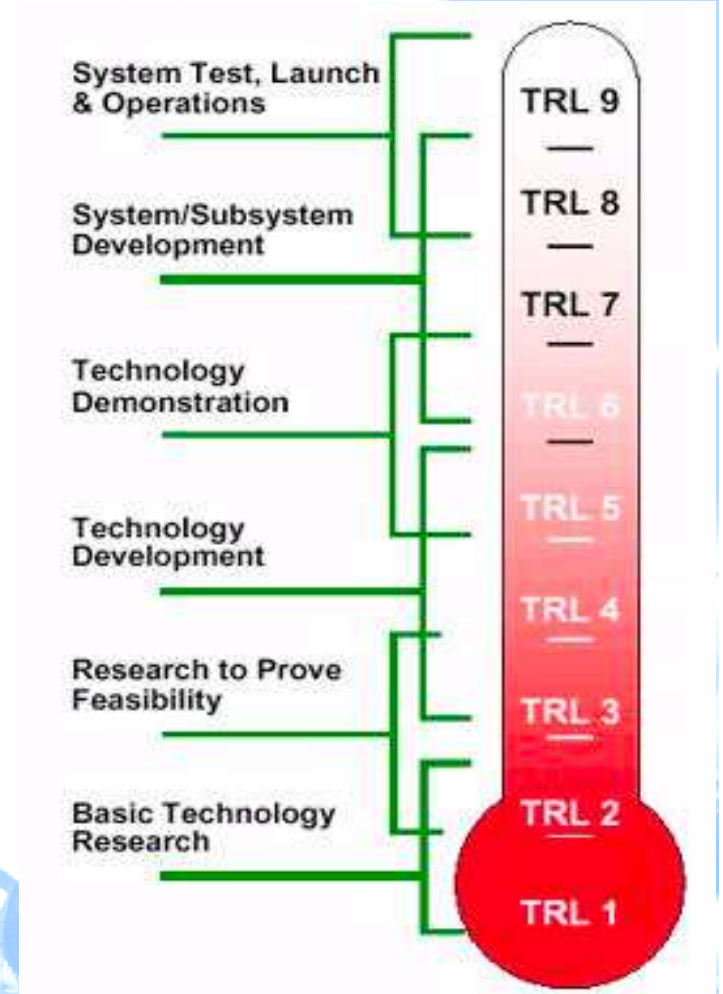
Bridging Research and Industry …
SE at the rescue !

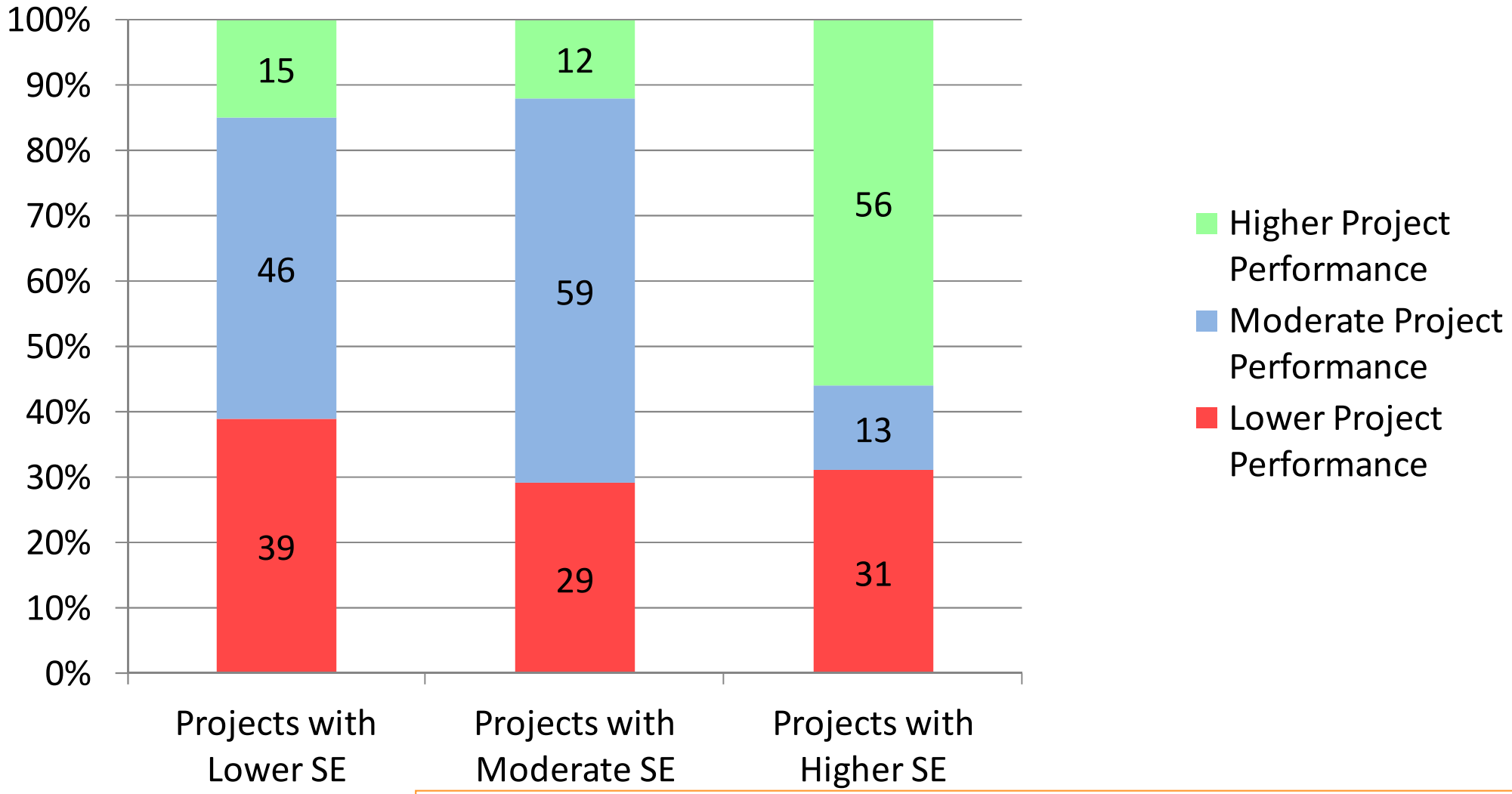
Technology readiness levels scale



Research ⇄ Industry

Excellence is mandatory

Project Performances vs Systems Engineering Capability*



*A Survey of Systems Engineering Effectiveness, SEI et National Defense Industrial Association (Systems Engineering Effectiveness Committee), December 2008, based on 46 + 18 projects
Assessment of SE Capability based on CMMI maturity. Project Performances based on Earn Value Management Model: Cost Performance Index, Schedule Performance Index, % Key Performance Parameters satisfied

Systems Engineering Workforce

(France vision)

- ✓ **Systems engineering manpower: 3% to 5% of the global manpower in major companies**
- ✓ **A need for 3000* new SE engineers for the next 5 years in France (2009 System@tic survey)**
- ✓ **A discipline recently addressed by universities: less than 100 new SE engineers per year**
- ✓ **SE research not yet recognized as such: strong need for industry/academia cooperation**

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System@tic survey identify a need of 12000 new systems engineers for the next 5 years in France including Information Systems. Hypothesis: 25% are devoted to SE only, including SWE

Systems Engineering Processes

The Generic SE approach is already available

- ✓ **Most mature part of SE stated in existing documents**
  - **ISO 15288**
  - **IEEE 1220**
  - **CMMI**
  - **INCOSE SE Handbook**
  - **AFIS DCIS** *(Découvrir et connaître l'ingénierie système)*

… But further improvements are required

- ✓ **SE methodology not fully actually applied**
- ✓ **Human factors and large-scale complex systems not enough taken into account**
- ✓ **Need for :**
  - Business tailoring: SMEs-Small projects, Lean
  - Management involvement
  - Detailed guidelines adapted to business domain areas

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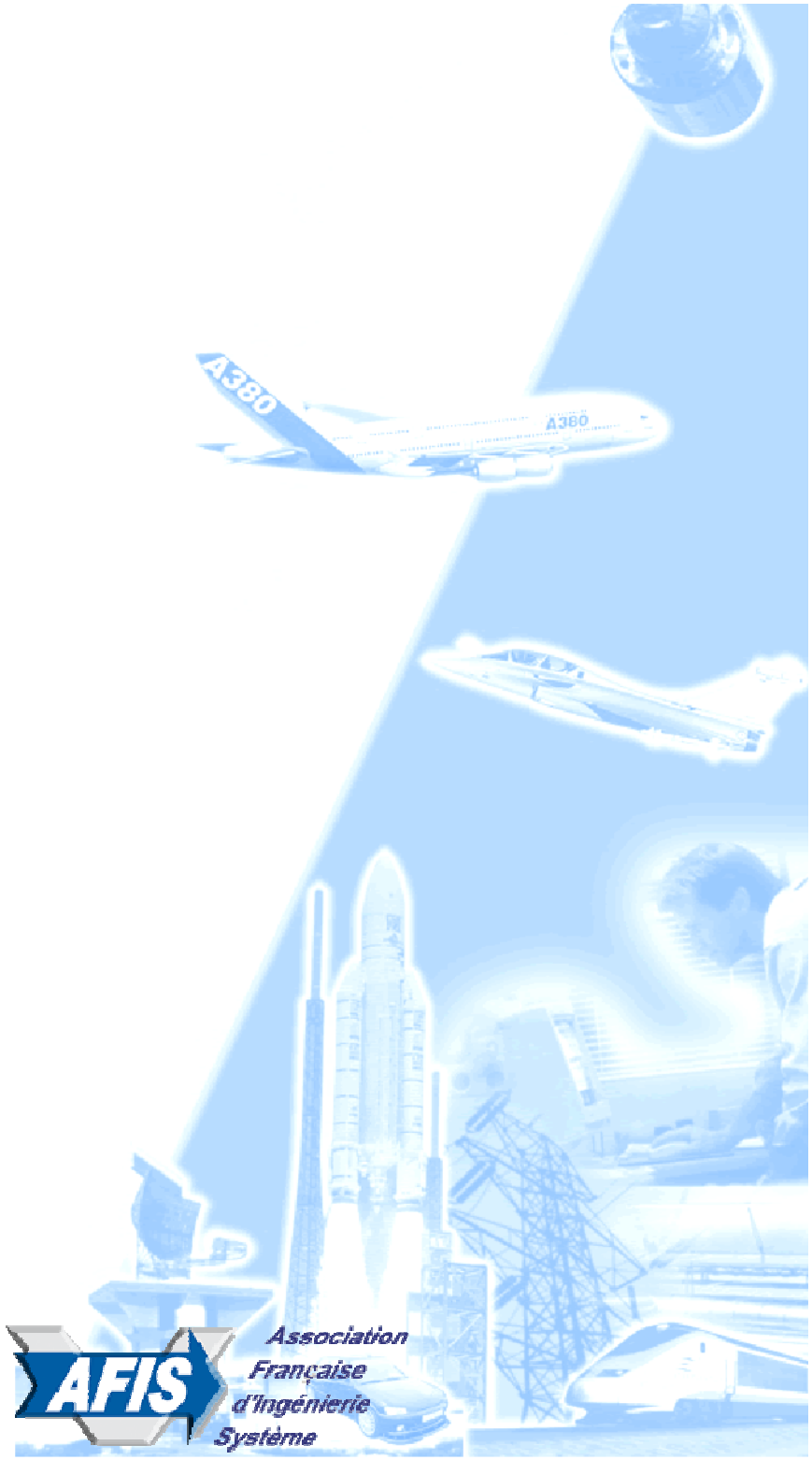


EXTERNAL DRIVERS FOR CHANGE

Business globalization

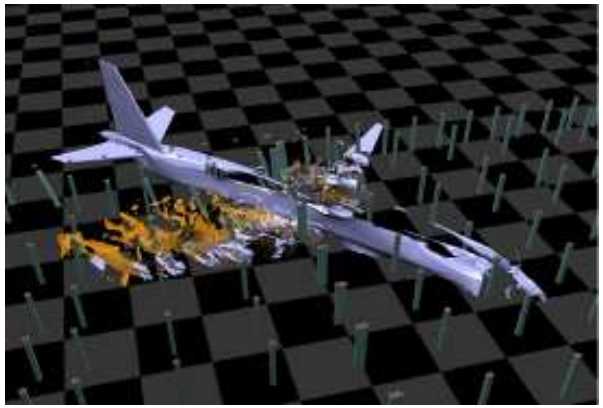
- ✓ New competitors expected from emerging countries even in complex systems (space, nuclear, aeronautics…) in the next 10 years
- ✓ International provisioning and offshore > 60% outside Europe
- ✓ Technology transfer becomes mandatory
- ✓ Cultural diversity management
- ✓ Still different nationwide policies

Never ending technological evolution

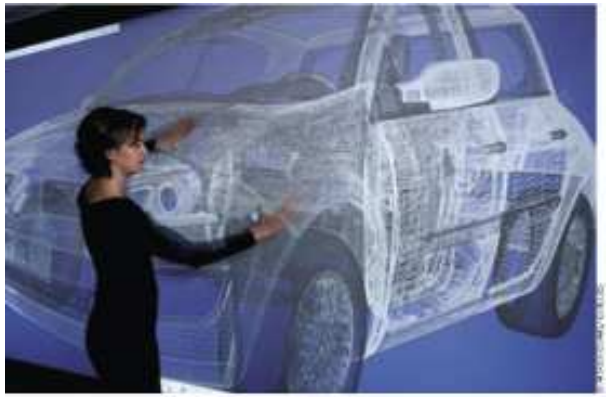
- ✓ High Performance Computing
- ✓ High Performance materials
- ✓ Grid computing
- ✓ Nanotechnologies
- ✓ Biotechnologies and BioInformation

- ✓ *Innovate or die…*

BLUE GENE/L, IBM, over 100 Teraflops

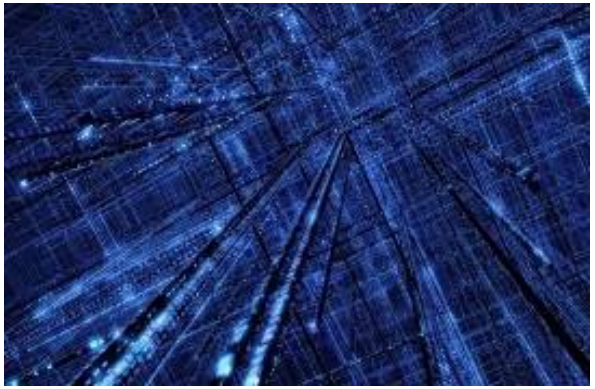


Integrating Modeling, Simulation, and Visualization - Purdue University



Virtual Reality, Renault

NBIC (nanotechnology – biology – information science convergence)



Bio Grid computing

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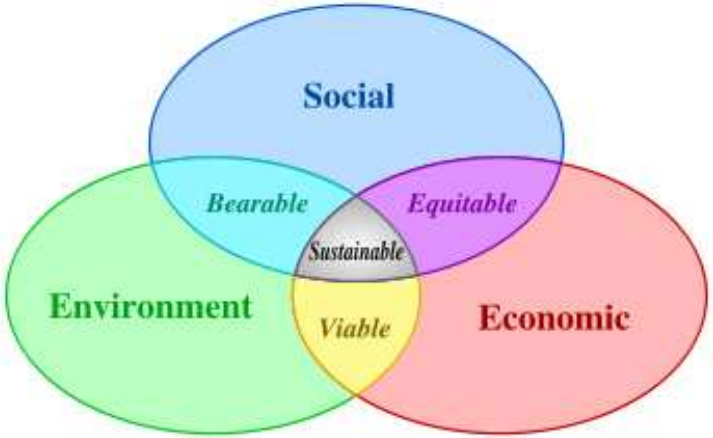
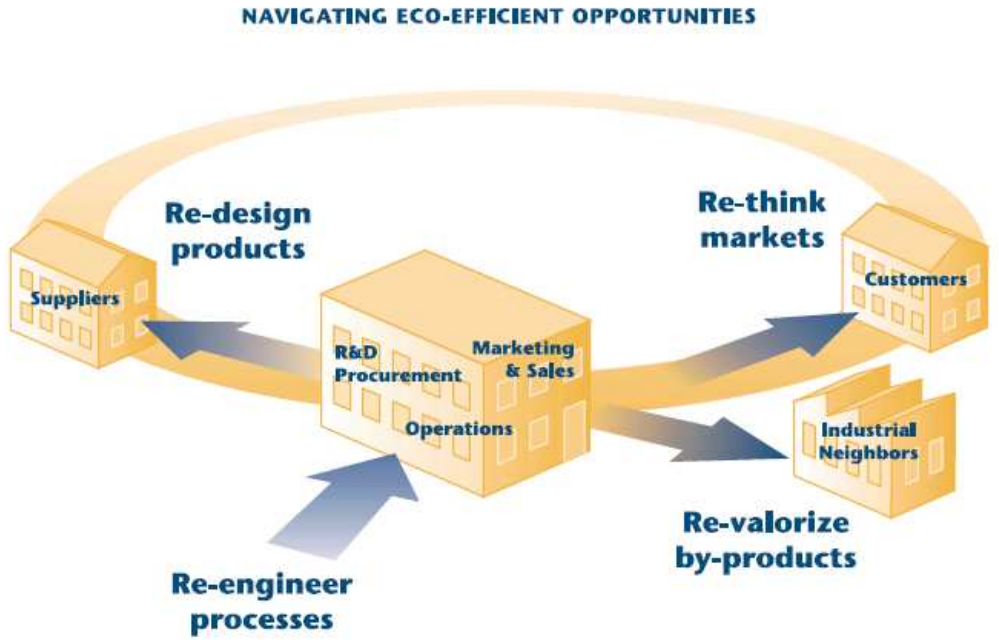
Clean, Cost effective,
… Sustainable processes

- ✓ Scarcity of raw material
- ✓ Production costs increase
- ✓ New markets are emerging
- ✓ New value creation - “Eco-efficiency”
  - Reduce material intensity
  - Reduce energy intensity
  - Reduce dispersion of toxic substanc
  - Enhance recyclability
  - Maximize use of renewables
  - Extend product durability
  - Increase service intensity

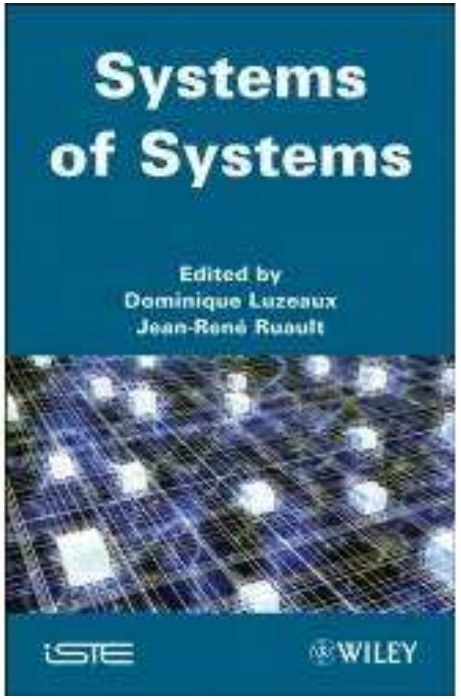




Eco-efficiency: creating more value with less impact.
World Business Council for sustainable Development.

SE : Exploration of new dimensions

- ✓Global, integrated, “system of systems”
- ✓Quick, complex and non predicted changes
- ✓Focused on people, services, organizations
- ✓Applied to new industrial and societal problems



SE Trends & Challenges: the way to do it!

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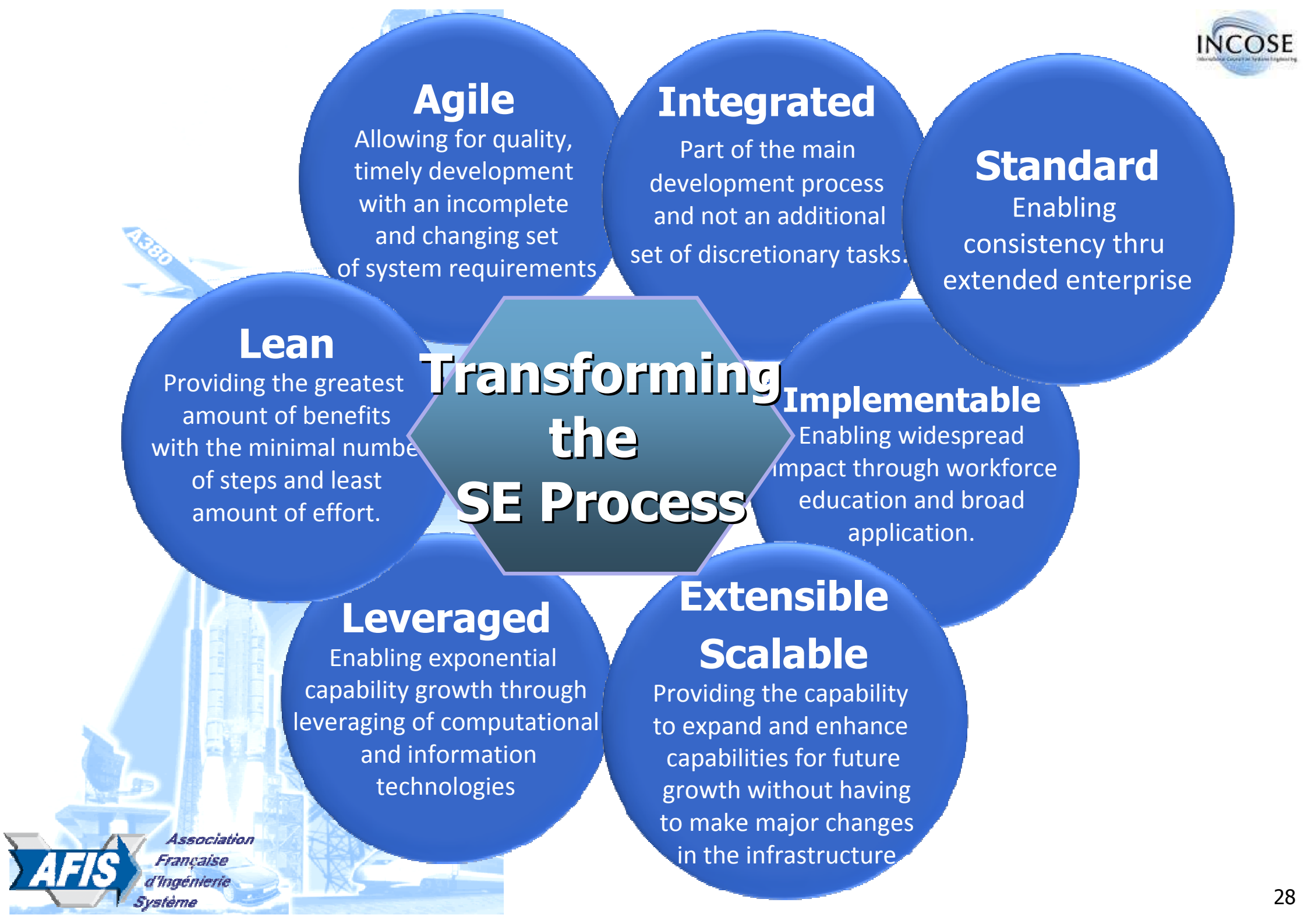
Complexity
adaptive, dynamic & emergent
Legacy
unplanned, ill-suited
Criticality
essential to day to day life, disponibility
increase
Workforce
great cultural diversity, Internet generation
Vulnerability
increasingly valuable, fragile and potential targets of malicious attacks
Time Compression
we're all on Internet time

The 7 main challenges for SE

- ✓ **Very large heterogeneous systems** (legacy, technology opportunities, resilience, complexity management, connections of in-use systems, system-of-systems) .
- ✓ **Very large autonomous systems** (autonomous decision-making, real-time control, reconfiguration, security-privacy-trust).
- ✓ **Verification, validation and qualification of systems** (legacy, international contexts, aggregation of complex systems).
- ✓ **Modeling and simulation covering total system representation** (performance, human factor, model granularity).
- ✓ **Through-life knowledge management** (long systems versus short technology lifecycles, information access in large distributed bases, reuse).
- ✓ **Agile human-centered design** (co-creative process).
- ✓ **Large-scale virtual prototyping.**


Agile
Allowing for quality, timely development with an incomplete and changing set of system requirements
Integrated
Part of the main development process and not an additional set of discretionary tasks.
Standard
Enabling consistency thru extended enterprise
Lean
Providing the greatest amount of benefits with the minimal numbe of steps and least amount of effort.
Transforming the SE Process
Implementable
Enabling widespread impact through workforce education and broad application.
Leveraged
Enabling exponential capability growth through leveraging of computational and information technologies
Extensible Scalable
Providing the capability to expand and enhance capabilities for future growth without having to make major changes in the infrastructure
INCOSE
AFIS
Association Française d'Ingénierie Système

A new culture: Risk sharing among the partners within a business domain

Risk Sharing Partners

Excellence of production

- Trust
- Sharing
- Preservation of knowledge and know-how

Strategic Alliances

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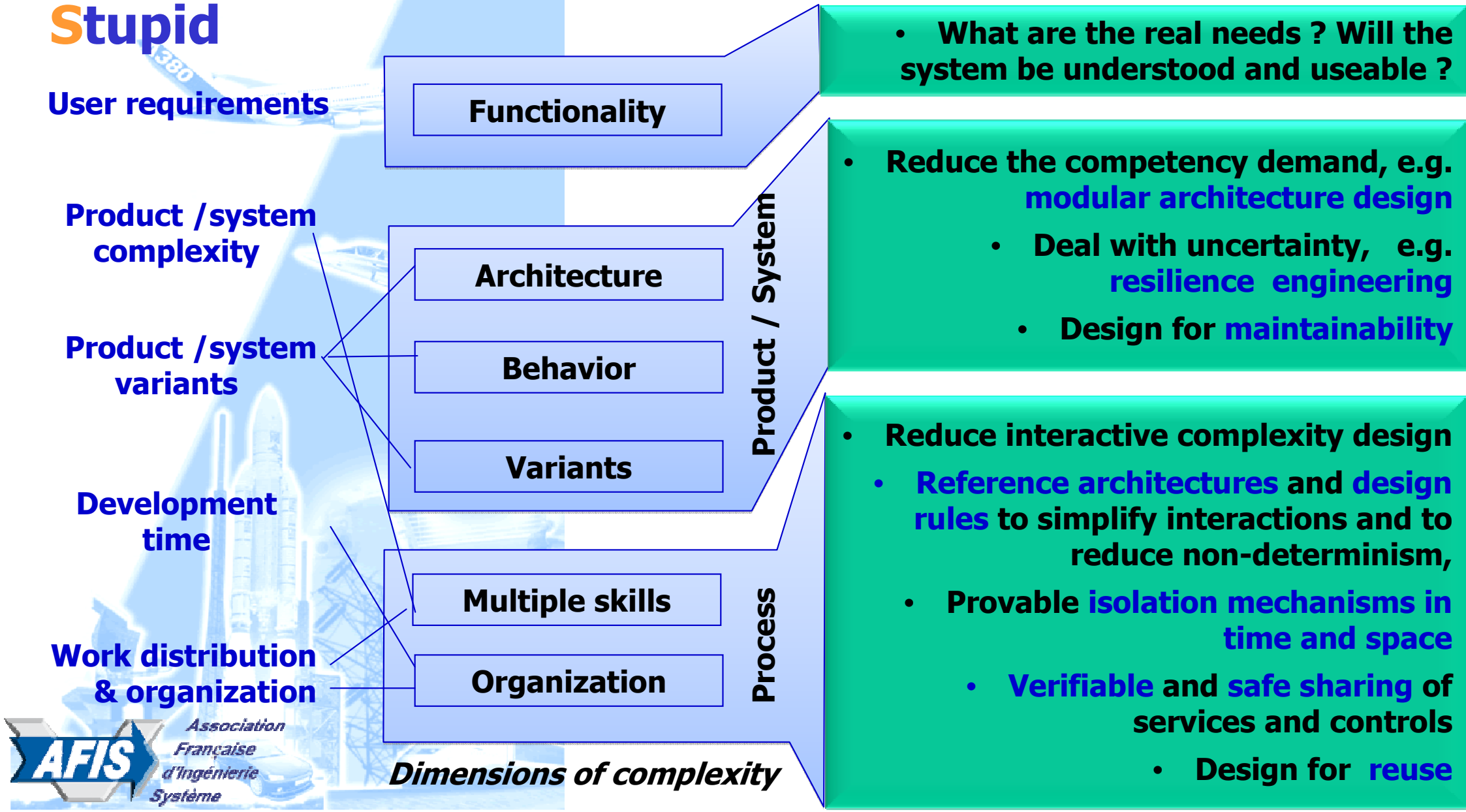
Keep It Simple Stupid

The KISS principle : a universal and interdisciplinary challenge



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INCOSE

Seamless SE Education & Research

- System Engineering Education :
  - Pre-recruitment
  - Agreements Academy-Industry on SE training, certification and curriculum
  - Individual certification
  - *E.g.: GRCSE (Graduate Reference Curriculum in Systems Engineering under development) by INCOSE*
- A way of recognition and a mobility asset
  - SE as a bridge between Technical and Non Technical disciplines; seen more and more as a key factor for wider job opportunities
- SE Company Certification :
  - Manage competitiveness and address new markets
- Upper-stream and applied research :
  - Academy-Industry link

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R&T to address the 7 SE challenges	Very large heterogeneous systems	Very large autonomous systems	V V & A	M&S covering total system	Thru-life KM	Agile human-centered design	Large-scale virtual prototyping
Modeling (synthesis, analysis and inversion) –DES, hybrid systems, game theory with local feedback –Multi-scale, discrete/continuous, stochastic/deterministic, micro/meso/macro, pattern formation, morphogenesis –Systemics: coalgebras, category theory, topoi (algebraic+logic) –Parametric analysis, reverse modeling	X	X	/	X			
Automatic proof –Theories with many axioms (simplifying theories), dealing with potential inconsistencies –Parallel theorem proving –Stochastic automatic proving systems –Algorithmic complexity			X		X		
SWE: design of large-scale SW with HF –Store & search large heterogeneous databases, visualization tools –Design, architecture description languages, simulation –MDA, design patterns –MMI, models of human interaction, human stress models –Security of distributed SW: confidentiality, authentification, protection against reverse engineering	/	/			X	X	X
HW-SW co-design –Adaptive optimal allocation –Reconfigurable architectures, intensive computing	/	X		/			X

To conclude

SE is an Art and a Science

INCOSE
International Council on Systems Engineering

Sharing a vision
... and working together to make it a reality !

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