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In the Main Stream of Emerging Engineering

My contribution to the great history of engineering in computer systems

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Introductory remarks

Current powerful engineering modeling is result of d

This is the period of my research a

I organized this talk around th

Computer methods for engineering activities. I
order to establish wide contextua
Representations, their lifecycle managem

Main integration method: ***Driving*** engineering
through contextual connection chains of their s

Developing ideas and strategies for better model ***repres*** capabilities
for ***real product*** and ***experimental structure*** in en ring.

"CATIA Knowledge Engineering ***captures and re-uses*** *all developments for optimization of the product design process.* The discipline covers major topics such as ***design rules and templates, execution knowledge, product optimization knowledge and key performance indicators with the product performance assessment process."***

Dassault Systémes
http://www.3ds.com/products-services/catia/capabilities/knowledge-engineering/

My focus is on global (product) level representation of knowledge applied on the way to decisions

Developing ideas and solutions to meet more and more demands emerged in leading industries

Timeline: 50s- | Early 70s- | Mid 70s- | 80s- | 90s- | 2000- | 2010-

Advanced surfaces on products

Control of production equipment

"Developers need an ***integrated systems engineering approach*** that enables them to manage the complete development process. ***Requirements engineering***, systems architecture definition, detailed modeling and simulation of complex systems and the development of embedded software all ***need to be mastered in the context of the complete product***."

Dassault Systémes
http://www.3ds.com/products-services/3dexperience/on-premise/

Integrated knowledge

Integrated information handling for

Multidisciplinary, cyber-physical product (consistent)

Modeling high level interacting systems which keep product running

Customer a … elfront

industries

Geometry driven equipment control

Early surface and solid shape models

Ma… pro… system planning

…ated monitoring

…ated object model

Self instancing generic model objects

Multidisciplinary concept and physical (RFLP) representation

Organizing job floor level processes

Speeding job floor level processes

Automatic handling of materials

Integrated mfg. systems

Customer demand

Speeding engineering processes

Handling high volume structured information

Integrated research

Multiphysics analysis

Connecting intelligent devices

Cross-disciplinary collaboration

Main milestones of global history of engineering in computer systems (50s-)

Timeline	50s-	Early 70s-	Mid 70s-	80s-	90s-	2000-	2010-
	Geometry driven equipment control	Early surface and solid shape models	Manufacturing process and system planning	Quality assurance and system monitoring	Resource driven integrated object model	Self instancing generic Model objects	Multidisciplinary concept and physical (RFLP) representation

Assembly operation parameters

Interfacing manufacturing process

Integrated model object (IMO)

Virtual engineering processes.

Configurable mfg. process

Petri net process representations

Environment adaptive objects

Configurable mfg. system structure

Human intent representations

Virtual engineering space (VES)

Content behind model information

Multilevel content structure driving for RFLP structured model

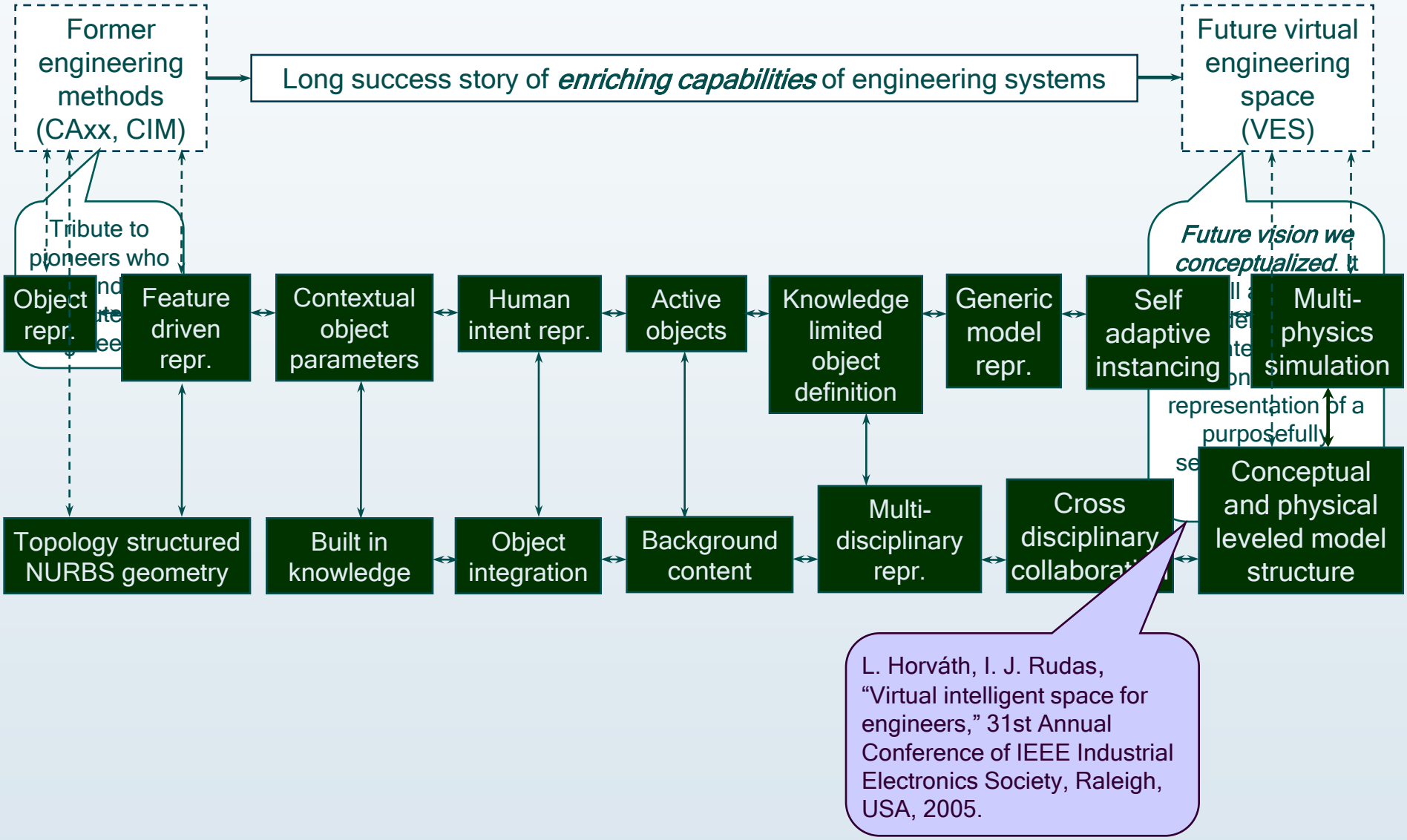
Product behavior representation

Representation of design intent in product model and ***collaborative*** information exchange (1998- 2002, OTKA T 026090)

Theoretical grounding and development of intelligent, ***environment adaptive objects in highly integrated product models*** (2002-2005, OTKA T037304)

Theoretical analysis and grounding of selected ***virtual engineering processes*** in novel approach (2008-2011, OTKA K68029).

My contributions (1976-)


Former engineering methods (CAxx, CIM)
Long success story of *enriching capabilities* of engineering systems
Future virtual engineering space (VES)
Tribute to pioneers who
Future vision we conceptualized.
representation of a purposefully
Object repr.
Feature driven repr.
Contextual object parameters
Human intent repr.
Active objects
Knowledge limited object definition
Generic model repr.
Self adaptive instancing
Multi-physics simulation
Topology structured NURBS geometry
Built in knowledge
Object integration
Background content
Multi-disciplinary repr.
Cross disciplinary collaborat
Conceptual and physical leveled model structure
L. Horváth, I. J. Rudas, "Virtual intelligent space for engineers," 31st Annual Conference of IEEE Industrial Electronics Society, Raleigh, USA, 2005.

Former engineering methods (CAxx, CIM)

Long success story of enriching capabilities of engineering systems

Future virtual engineering space (VES)

First thematic group
1976 - 1992

Conditions organized for process, product, expert, and mfg. system resources

Predefined QA entities

Configurable mfg. system description

Mixed generative-variant process plan creation

Generative definition

Variant definition

Algorithms Decisions at branches Calculation of process entity parameters

Predefined generic process structure

Mátyás Horváth, "Semi-generative process planning for part manufacturing," Ann Arbor, USA, 1979.

L Horváth, J Fodor, I J Rudas, "Manufacturing Aspect of the IBCA Structure for Active Knowledge Content Representation in Product Model," in IFAC-Papers Online, Elsevier, Vol 48, No. 3, 2015.

Content structure driven RFLP and PR structures

Requirements (R)
Functional (F)
Logical (L)
Physical (P)

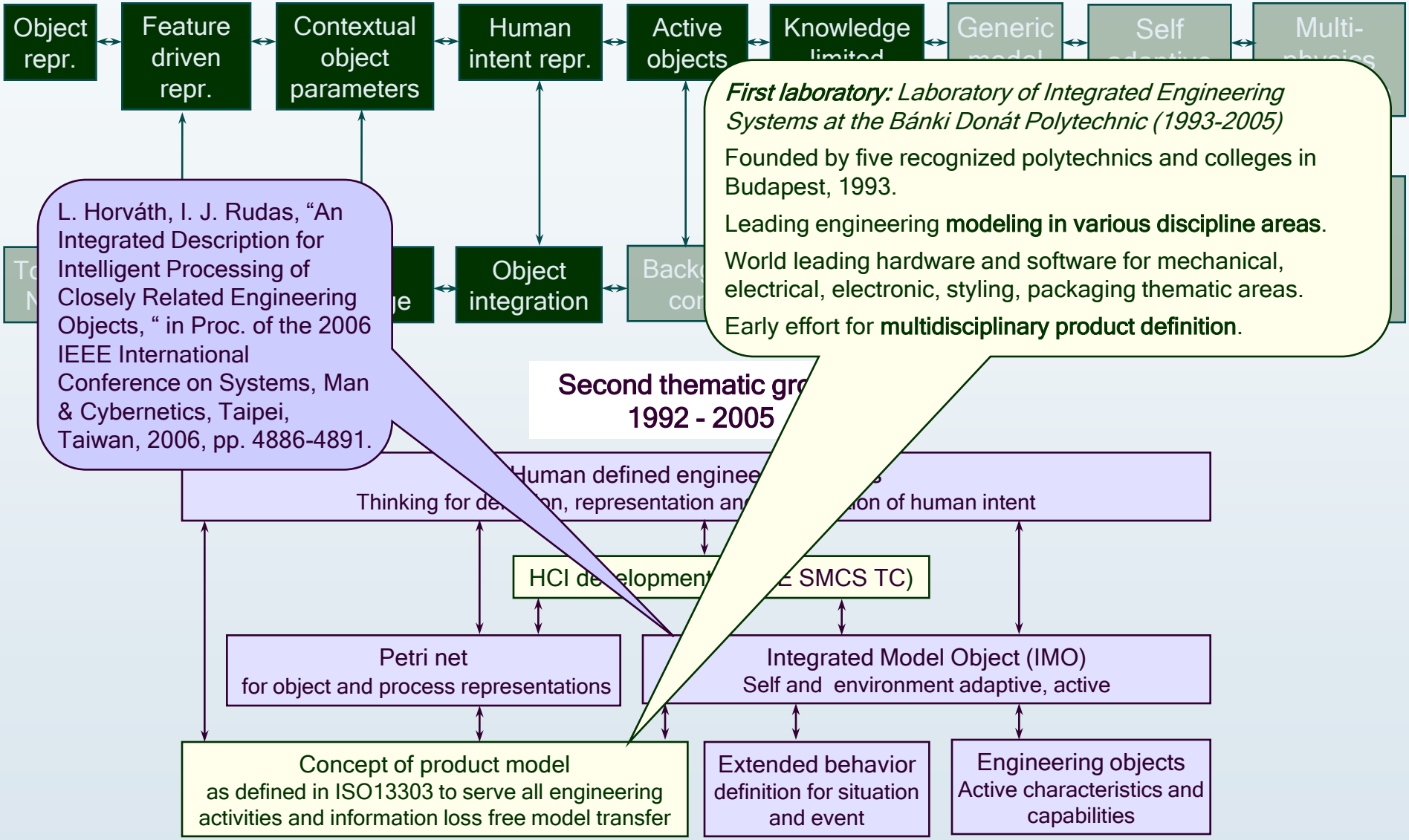
Conceptual and physical leveled model structure

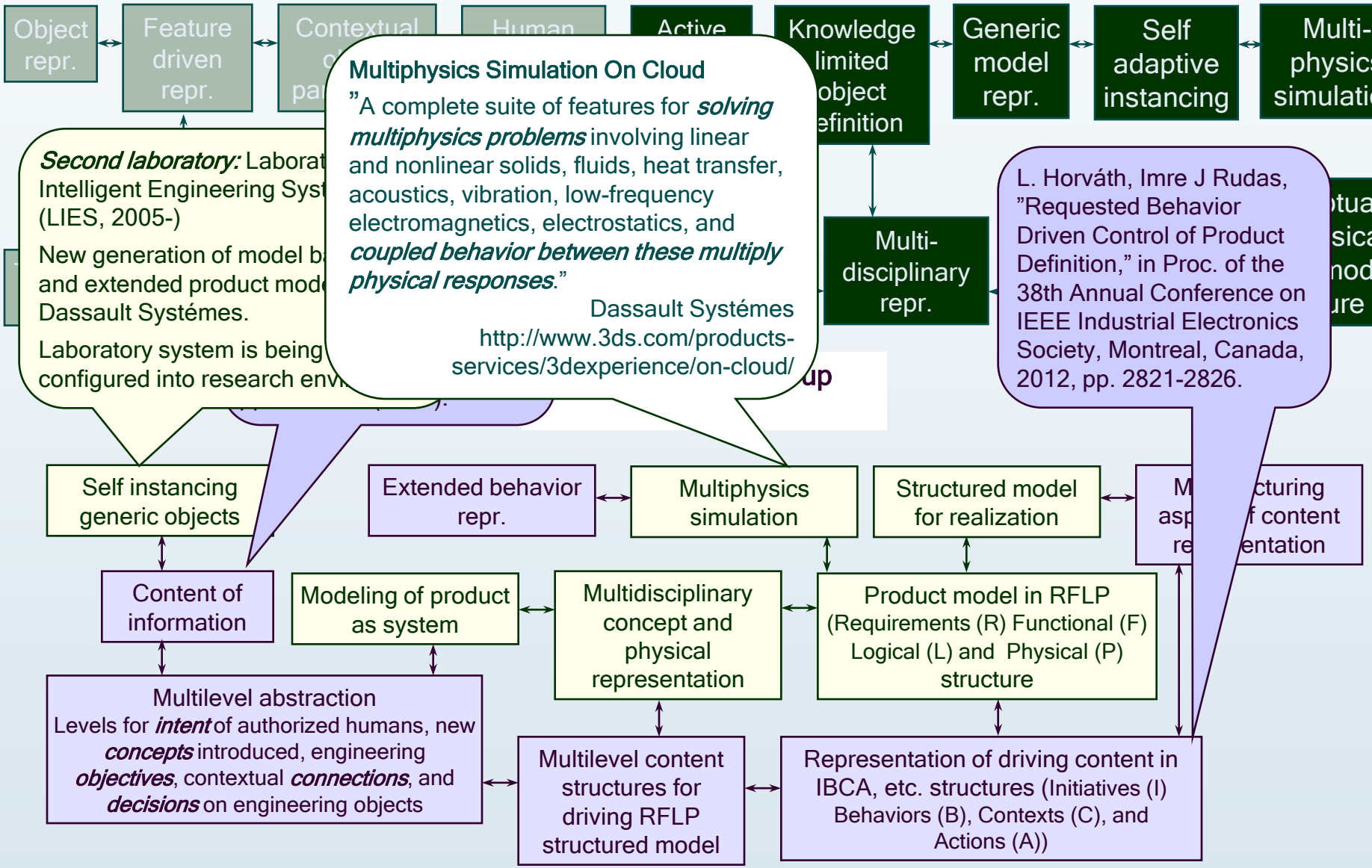
Process structure
Manufacturing system structure
Resource structure

Future research
Concept: INCOM 2015, Ottawa

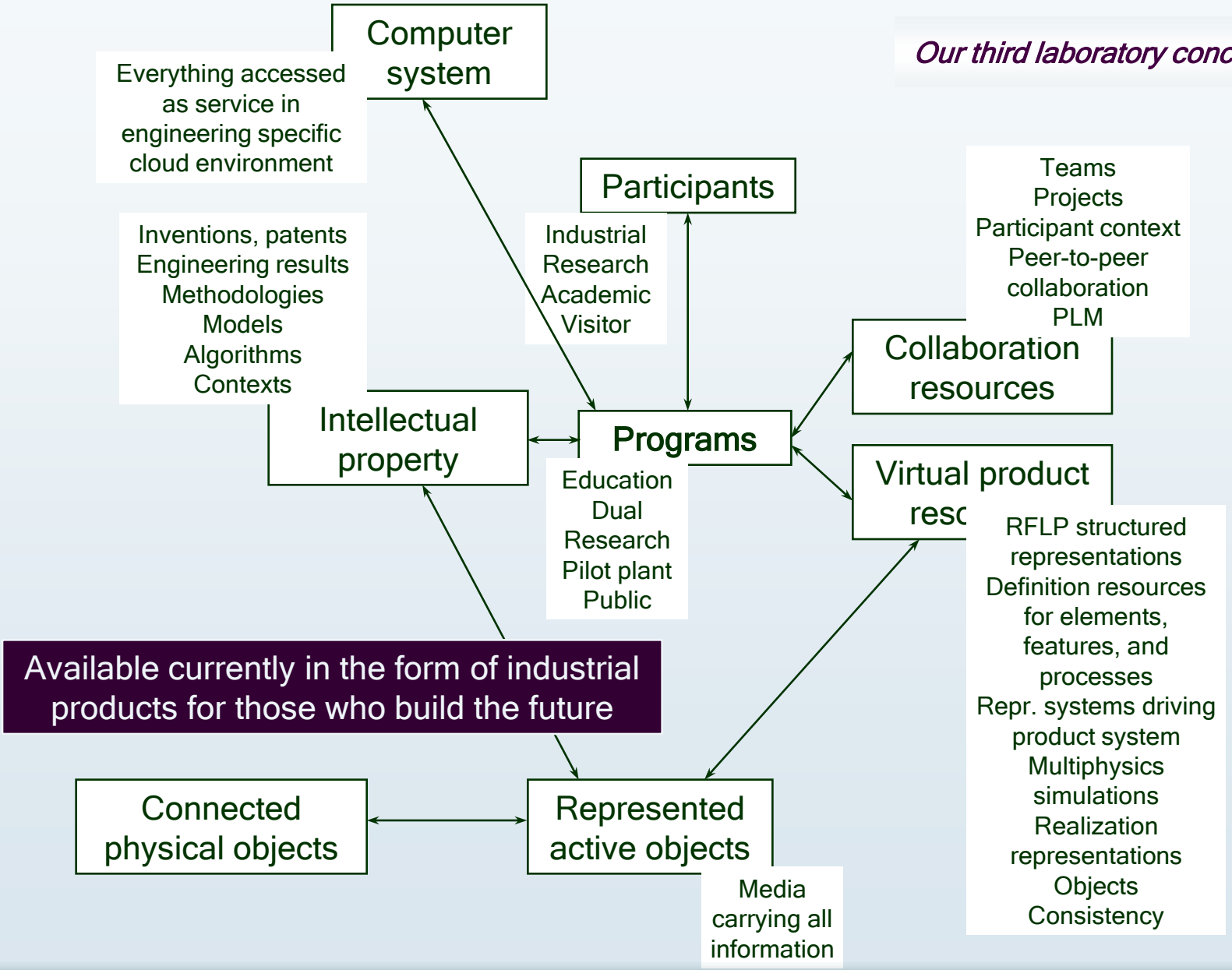
Horváth, L., Szabó, K., GLEDA, A computer - aided Manufacturing Process Planning System ..." APMS-COMPCONTROL' 85 Budapest, 1985.

PLM 2 (Dassault Systémes)


Object repr.
Feature driven repr.
Contextual object parameters
Human intent repr.
Active objects
Knowledge
Generic
Self
Multi-
Object integration
L. Horváth, I. J. Rudas, “An Integrated Description for Intelligent Processing of Closely Related Engineering Objects, “ in Proc. of the 2006 IEEE International Conference on Systems, Man & Cybernetics, Taipei, Taiwan, 2006, pp. 4886-4891.
First laboratory: Laboratory of Integrated Engineering Systems at the Bánki Donát Polytechnic (1993-2005)
Founded by five recognized polytechnics and colleges in Budapest, 1993.
Leading engineering modeling in various discipline areas.
World leading hardware and software for mechanical, electrical, electronic, styling, packaging thematic areas.
Early effort for multidisciplinary product definition.
Second thematic gr
1992 - 2005
Human defined enginee
Thinking for de on, representation an ion of human intent
HCI de elopment E SMCS TC)
Petri net
for object and process representations
Integrated Model Object (IMO)
Self and environment adaptive, active
Concept of product model
as defined in ISO13303 to serve all engineering activities and information loss free model transfer
Extended behavior
definition for situation and event
Engineering objects
Active characteristics and capabilities


Object repr.
Feature driven repr.
Knowledge limited object definition
Generic model repr.
Self adaptive instancing
Multi-physics simulation
Multi-disciplinary repr.
Second laboratory: Laborat
Intelligent Engineering Syst
(LIES, 2005-)
New generation of model b
and extended product mod
Dassault Systémes.
Laboratory system is being
configured into research envi
Multiphysics Simulation On Cloud
"A complete suite of features for solving multiphysics problems involving linear and nonlinear solids, fluids, heat transfer, acoustics, vibration, low-frequency electromagnetics, electrostatics, and coupled behavior between these multiply physical responses."
Dassault Systémes
http://www.3ds.com/products-services/3dexperience/on-cloud/
L. Horváth, Imre J Rudas, "Requested Behavior Driven Control of Product Definition," in Proc. of the 38th Annual Conference on IEEE Industrial Electronics Society, Montreal, Canada, 2012, pp. 2821-2826.
Self instancing generic objects
Extended behavior repr.
Multiphysics simulation
Structured model for realization
Content of information
Modeling of product as system
Multidisciplinary concept and physical representation
Product model in RFLP (Requirements (R) Functional (F) Logical (L) and Physical (P) structure
Multilevel abstraction
Levels for intent of authorized humans, new concepts introduced, engineering objectives, contextual connections, and decisions on engineering objects
Multilevel content structures for driving RFLP structured model
Representation of driving content in IBCA, etc. structures (Initiatives (I) Behaviors (B), Contexts (C), and Actions (A))

Our third laboratory concept



Conclusions

We are on long way to virtual engineering

From individual component representation to modeling product as systems

Integration of fundamental, problem and product oriented research into engineering modeling

Practice demanded and verified intellectual property is active in model