Collaborative Product Lifecycle Management (PLM) for continuous Improvement - Unified Modelling Approach for PLM

by

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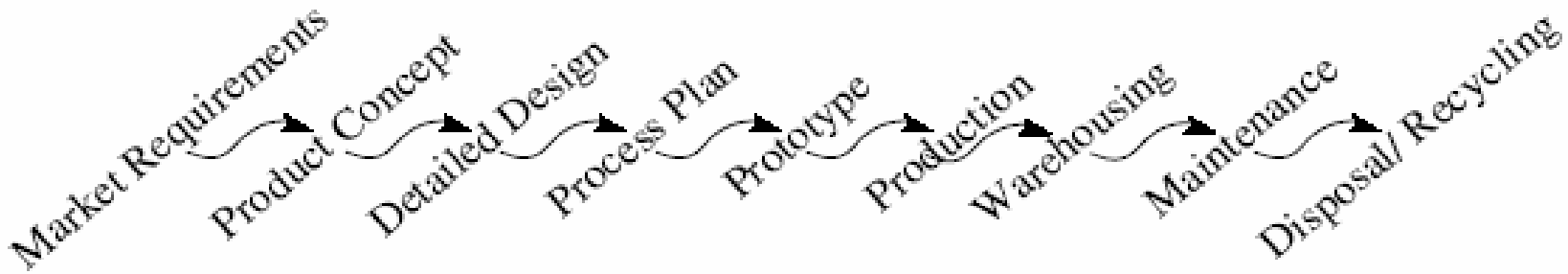
Unified Feature-based Modeling Framework for Product Lifecycle Management

Introduction

- Product life cycle management has been emerging as a very critical aspect for a global company. To effective work in a distributed collaborative environment, every company demands coherent and consistent product and process models.

- With the current information integration trend and easy accessibility with the Internet technology, there is an urgent need to share the common consistent information with minimum transactions.



Research Issues

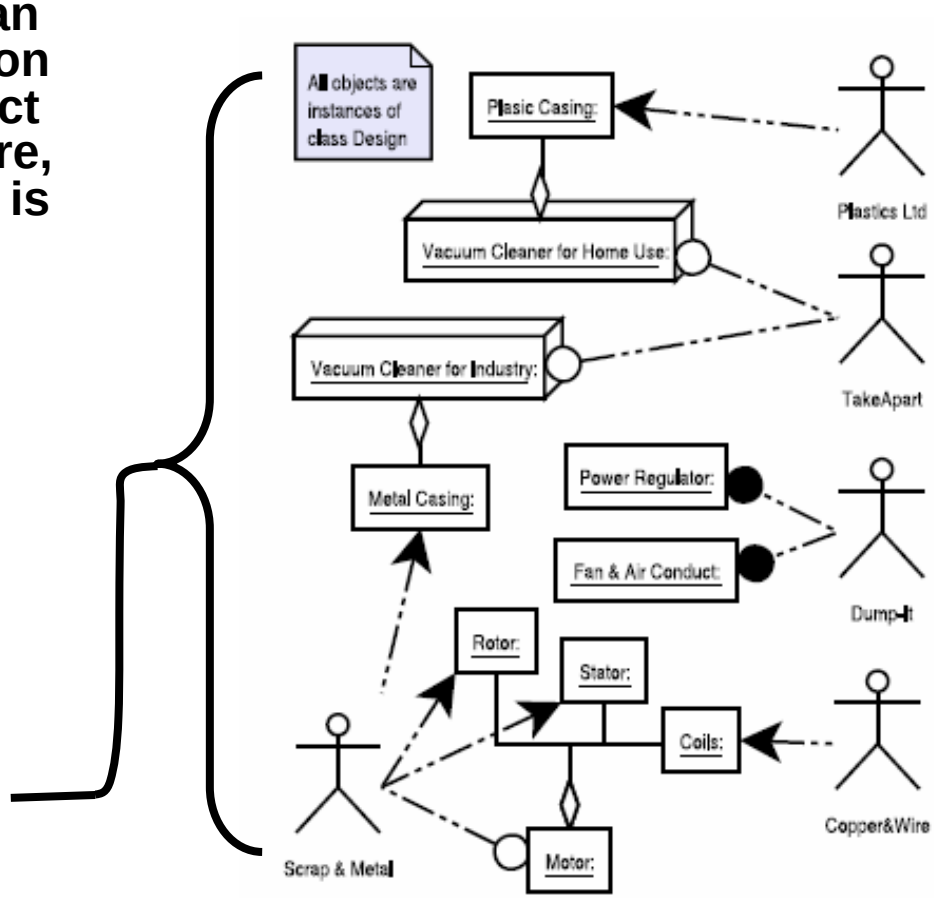
- **We need to develop a deeper understanding of the *structure* of the PLM information graph**
  - **Which concepts? → Ontologies**
  - **Which relationships? → Knowledge about product, process**
  - **Reusable patterns? → Knowledge Repositories**
  - **How to represent information and knowledge? → uncertainty, context, …**
  - **How to reconcile multiple ontologies? → interoperability**
  - **…**
- **We need *methods for managing* the PLM information graph (creating, sharing, modifying,…)**
  - **Which tools to create and modify info? → maps to stakeholders**
  - **In which order to build the graph? → concurrent eng.**
  - **How to coordinate among multiple stakeholders?**
  - **How to maintain consistency?**
  - **How to propagate changes?**
  - **…**

Research Issues

Basically, the PLM challenges lay in the area of implementing *a unified product and process model* that can automatically provide all information required in order to support product development, analysis, manufacture, management, marketing and sales is required.

A few burning issues:

- ❑ **Information sharing and management in collaborations**
- ❑ **Unified product and process models for SMEs and PLCs**
- ❑ **Increased innovation and upgrading in IP contents – R&D**
- ❑ **Environmental impact analysis, evaluation, qualification in PLM**
- ❑ **E-engineering and e-business**
- ❑ **E-manufacturing and services**



Agenda

Unified Feature-based Modeling Framework for Product Lifecycle Management

- Why does it have to be feature-based?
- The state of art in feature-based engineering
- Enterprise product oriented system architecture
- Four-layer Information model
  - Unified feature model
    - Geometrical representation
    - Associative feature concept and approach
  - Applications of unified features
    - Components and libraries
    - Assemblies, and libraries
    - CAD-CAE integration
    - Unified feature modeling language
- NTU unified approach for PLM modeling
- On-going research in NTU
- New collaborative research project with SIMTech
- Looking ahead … a major PLM research effort
- PLM CRP roadmap for industry partners

Why does it have to be feature-based?

Feature is important as

- Information carrier –feature objects Modular building block in product and process information model
- Validation and reasoning agents
- Feature model provides interfaces, upward to applications' reasoning processes, downward to geometric models.
- Scalable associations

The State of Art

Currently, features are not interoperable among different applications. Most of the current CAD features are based on the classification of machining approach or designing functions.

Different features need to be modeled for process planning, CAE analysis, assembly design, MRP/ERP integration and many other purposes.

Clearly, features are not the same for different purposes.

Product-oriented System Architecture

- **Framework of a product oriented system**

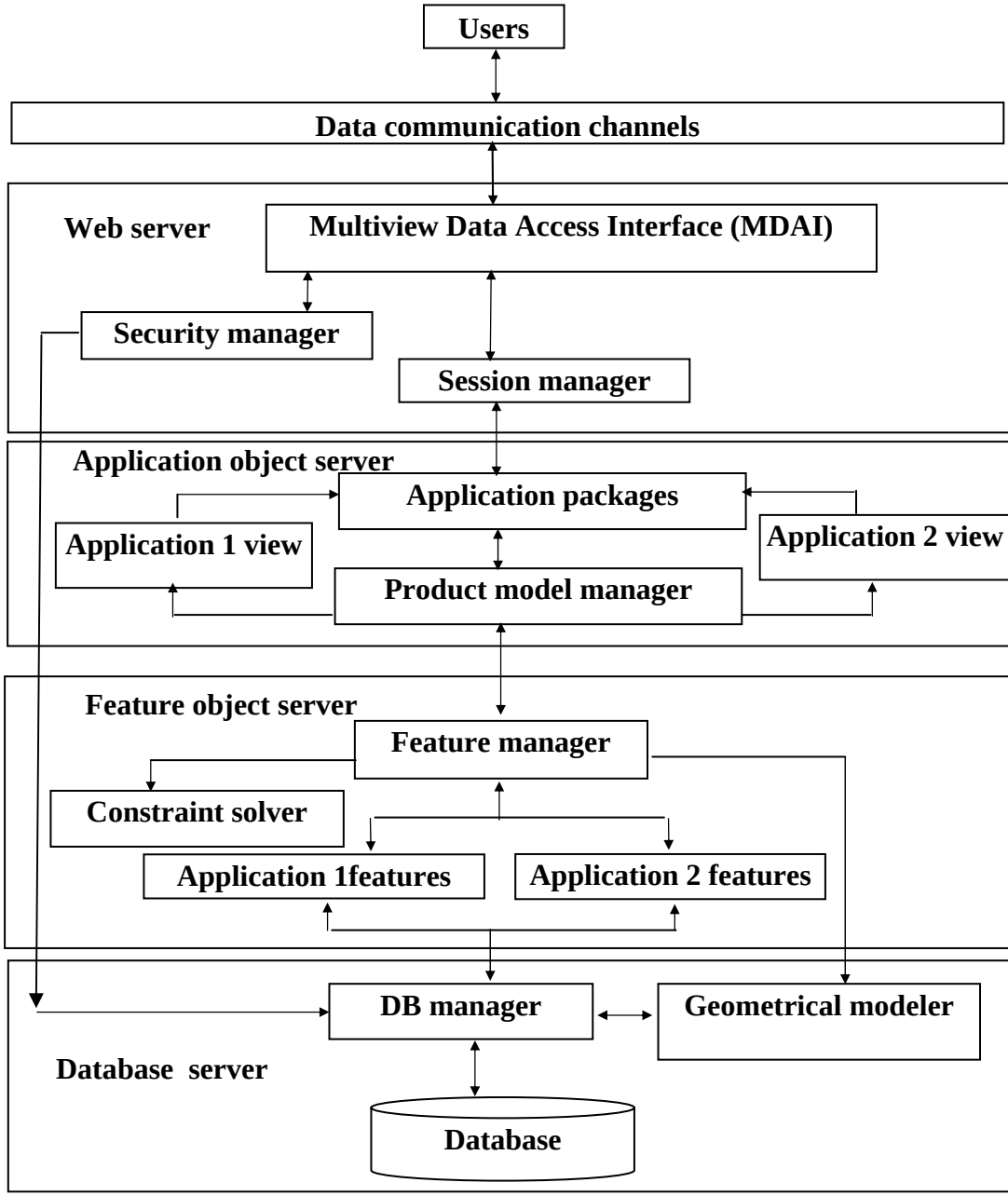
✓ Web server

✓ Application object server

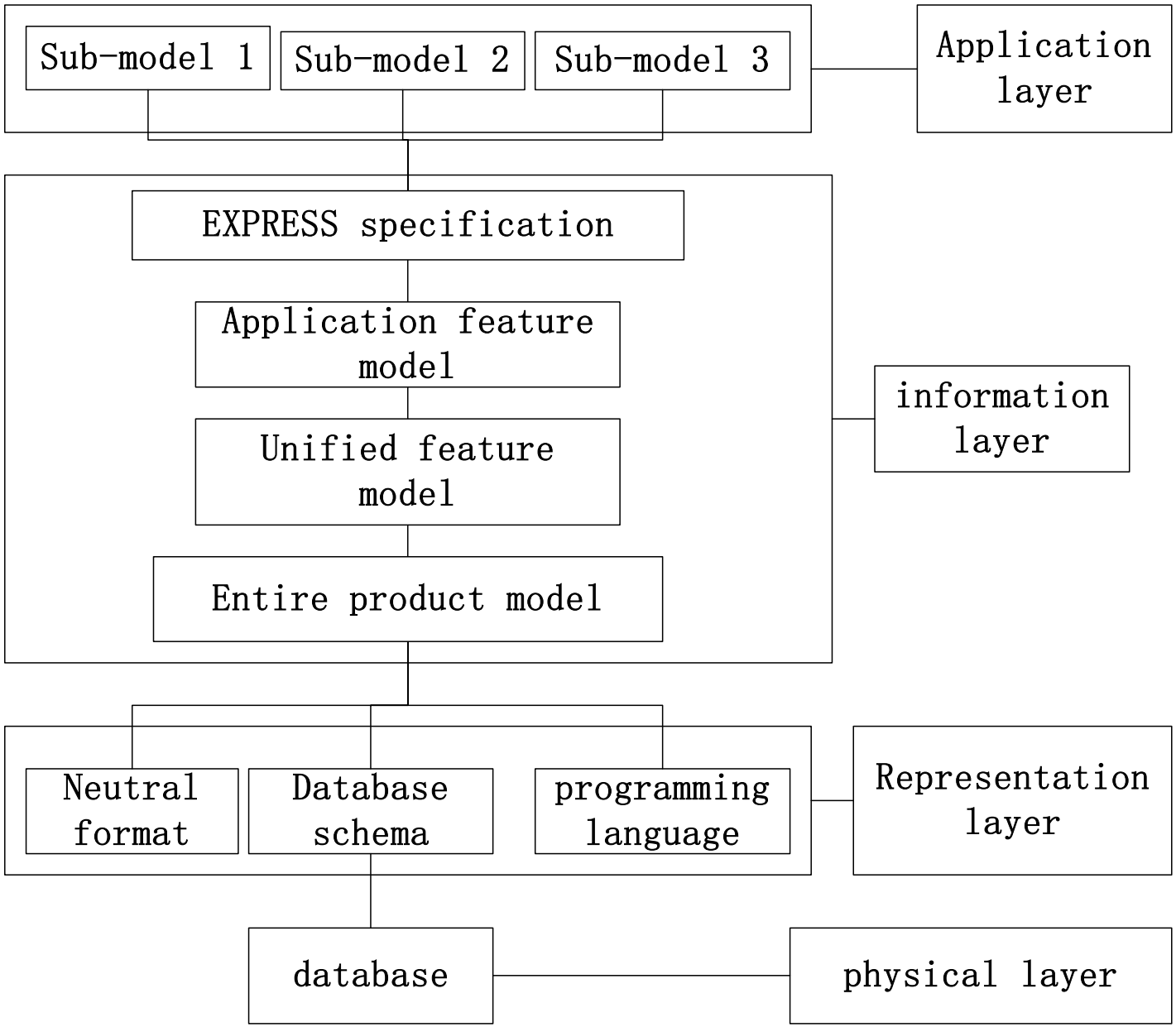
✓ Database server

✓ Feature object server

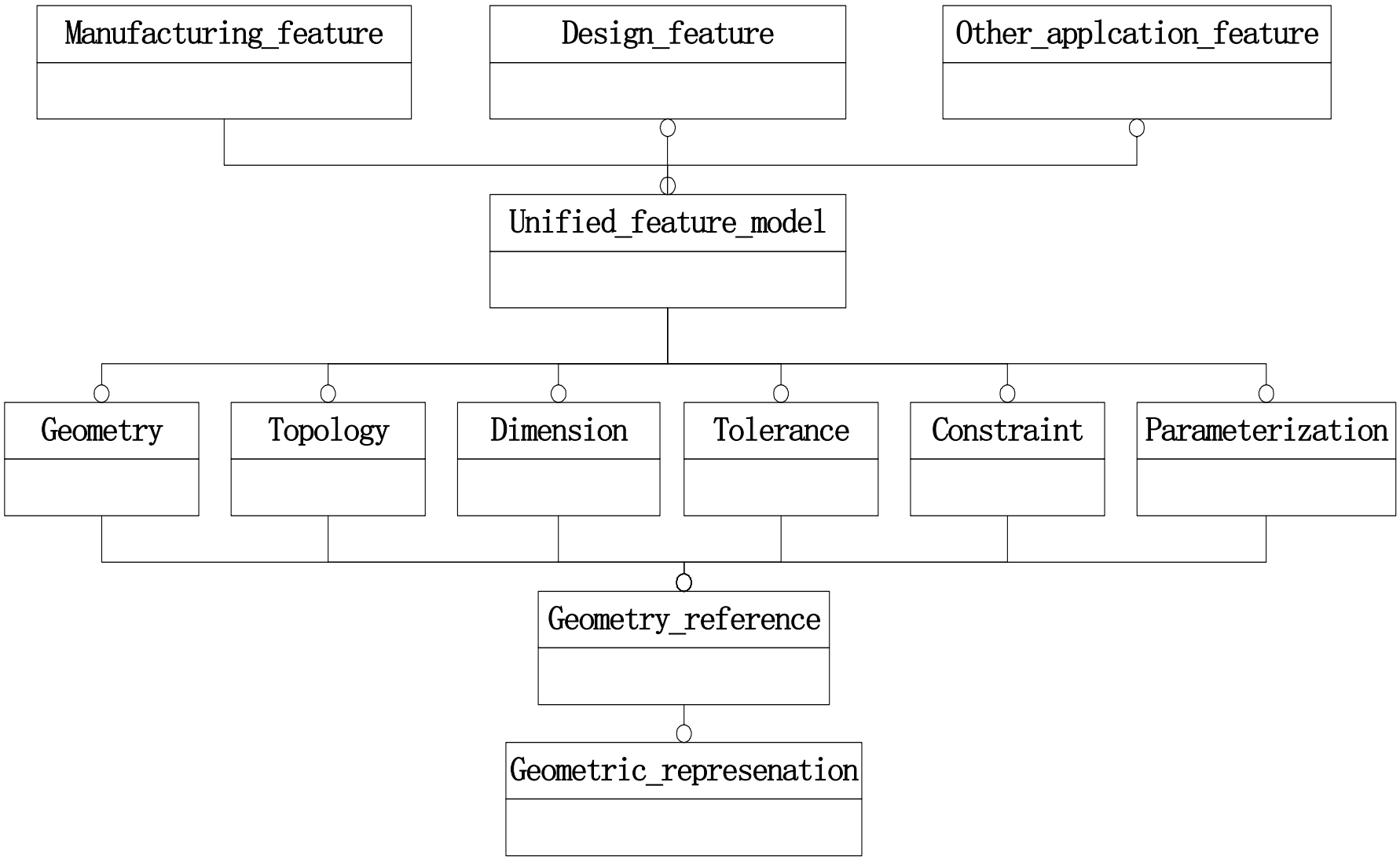
✓ Geometrical modeler



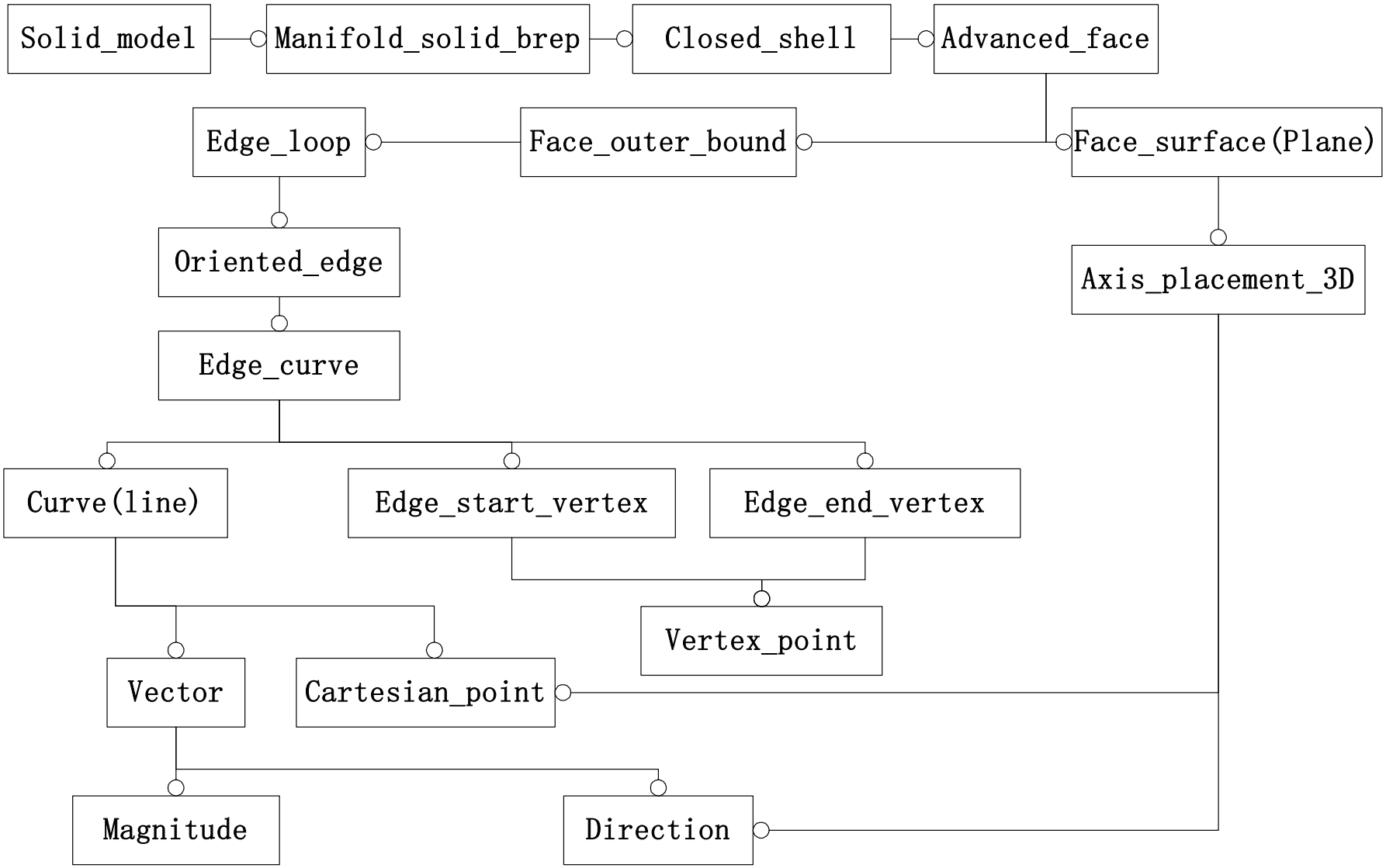
Four-layer Information Model



Unified feature model



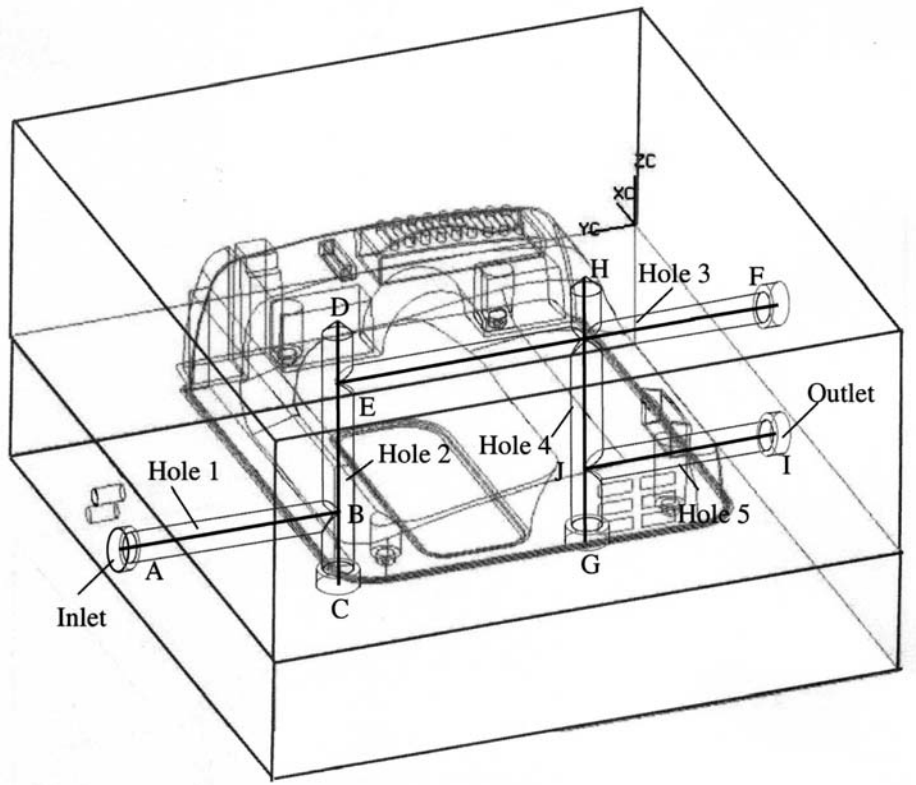
Geometrical representation



Associative Feature Concept and Approach

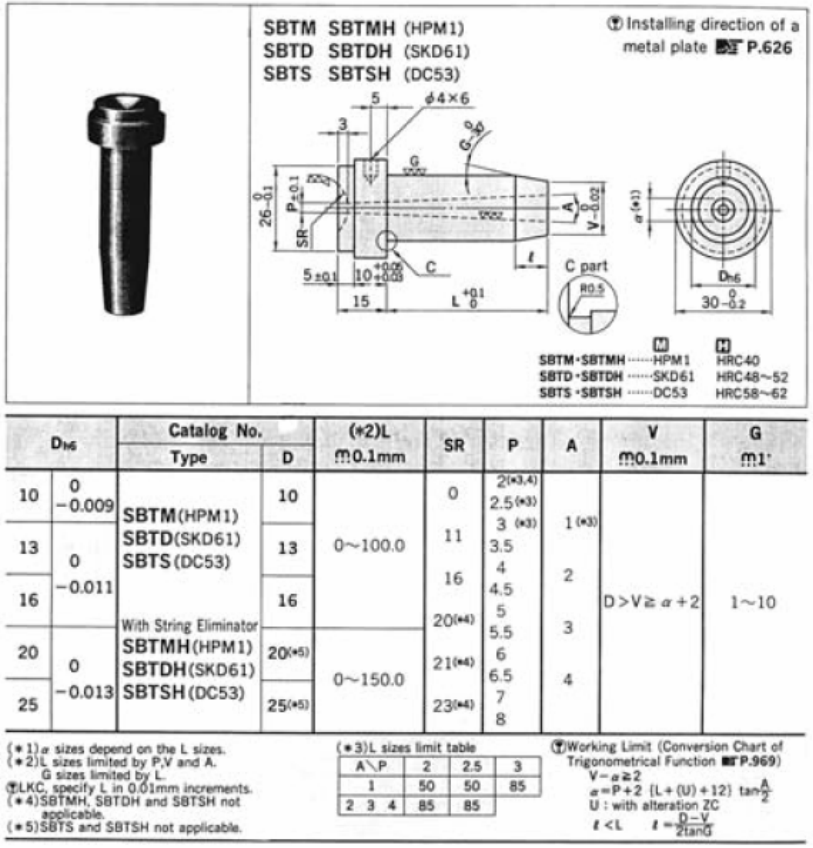
Go beyond traditional features …

Associative features have to be recognized-self contained and well defined in a uniform type hierarchy and semantic structure



Feature-object technology will be widely accepted as the potential solution for flexible, scalable and multi-facet engineering repositories, such as product life cycle management, catalogues, collaboration portal support.

Standard component library – an application of unified feature models



SBTM SBTMH (HPM1)
SBTD SBTDH (SKD61)
SBTS SBTSH (DC53)

Installing direction of a metal plate P.626

	M	H
SBTM・SBTMH	HPM1	HRC40
SBTD・SBTDH	SKD61	HRC48~52
SBTS・SBTSH	DC53	HRC58~62

Dh6		Catalog No. Type	D	(*2)L m0.1mm	SR	P	A	V m0.1mm	G m1°
10	0 −0.009	SBTM(HPM1) SBTD(SKD61) SBTS(DC53)	10	0~100.0	0	2(*3,4)	1(*3)	D>V≧a+2	1~10
13	0 −0.011		13		11	2.5(*3) 3(*3) 3.5			
16			16		16	4 4.5	2		
		With String Eliminator			20(*4)	5			
20	0 −0.013	SBTMH(HPM1) SBTDH(SKD61) SBTSH(DC53)	20(*5)	0~150.0	21(*4)	5.5 6	3		
25			25(*5)		23(*4)	6.5 7 8	4		

(*1) a sizes depend on the L sizes.
(*2) L sizes limited by P,V and A. G sizes limited by L.
LKC, specify L in 0.01mm increments.
(*4) SBTMH, SBTDH and SBTSH not applicable.
(*5) SBTS and SBTSH not applicable.

(*3) L sizes limit table

A \ P	2	2.5	3
1	50	50	85
2 3 4	85	85	

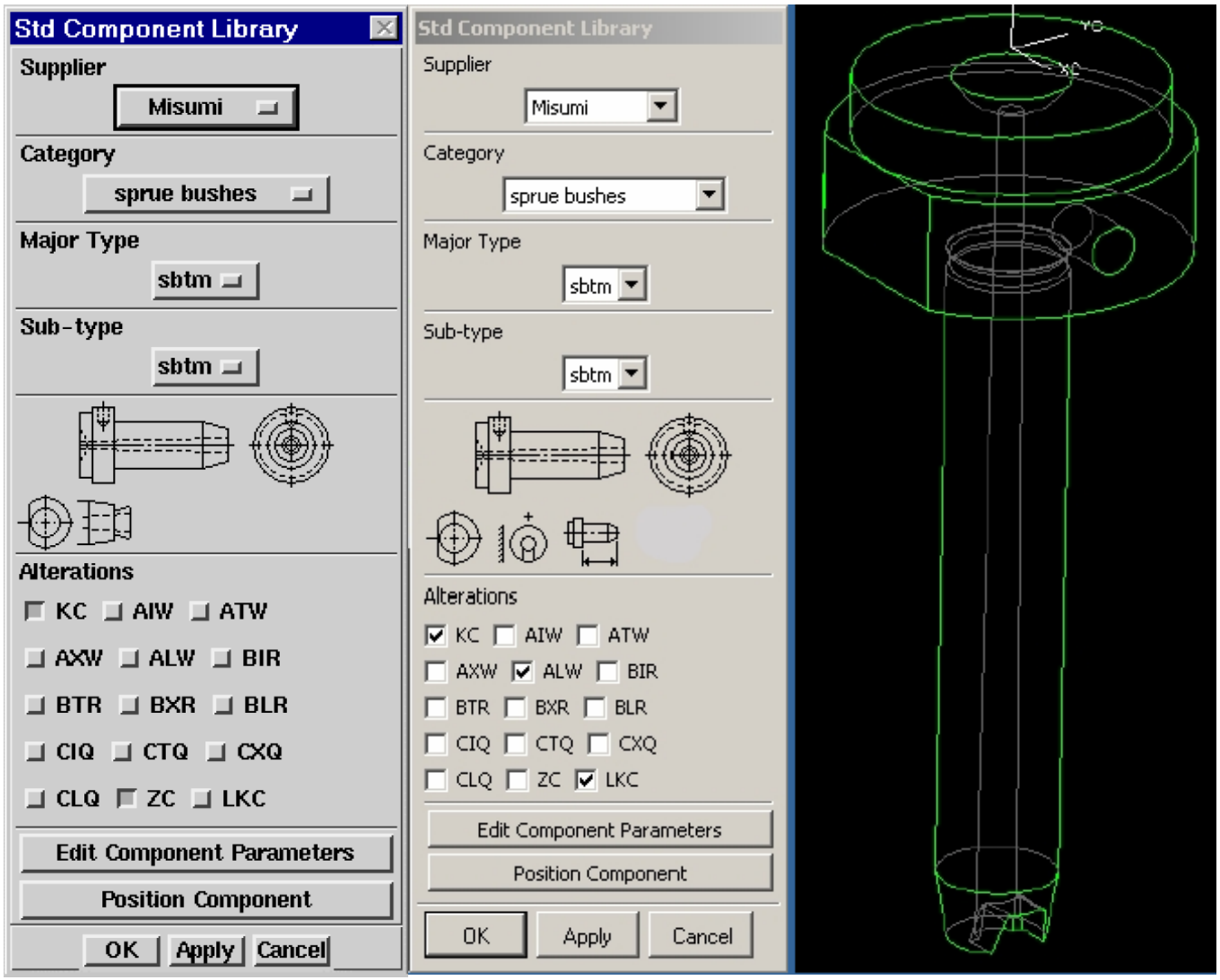
Working Limit (Conversion Chart of Trigonometrical Function P.969)
$V - a \geq 2$
$a = P + 2\ (L + (U) + 12)\ \tan\frac{A}{2}$
U : with alteration ZC
$\ell < L \quad \ell = \frac{D - V}{2\tan G}$

Alteration Details P.627

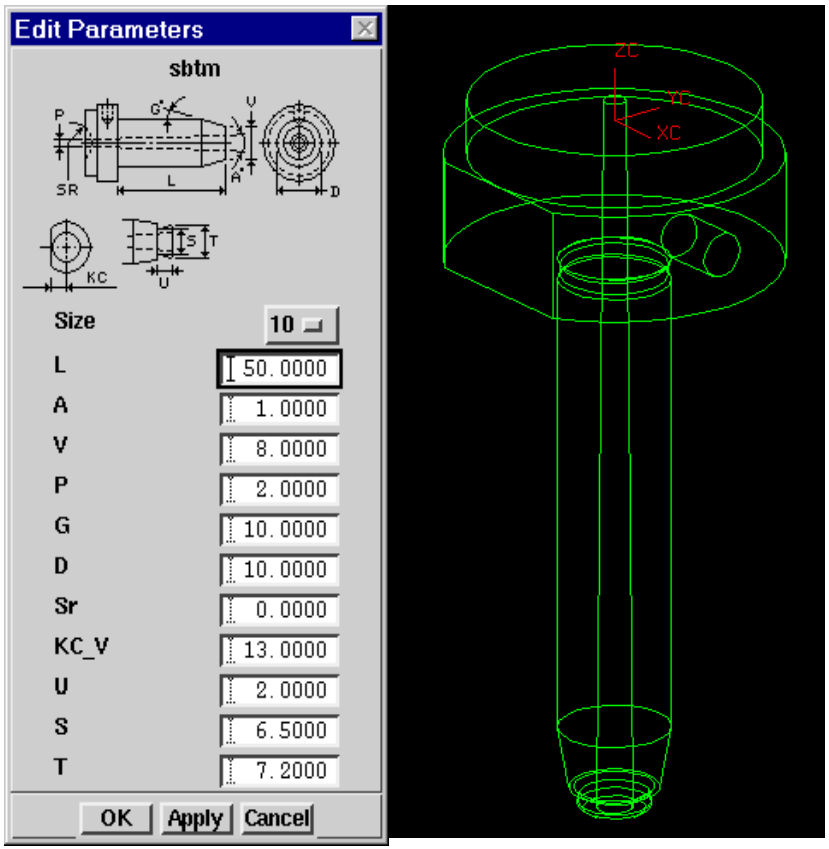
Alterations	Code	Spec.	Code	Spec.	Spec.	@/1 Code
	AIW	(*)	ATW	(*)	Shape A (trapezoid) R0.5 10° W t ⊗Combination with ZC not available ●W sizes W 1 / 3 2.5 / 4 3 / 5 3.5 / 6 4 / 8 5.5 / 10 7 AIW10	AIW 1000
	AXW	(*)	ALW	(*)		AXW 1800 ATW 2000 ALW 1500
	BIR	(*)	BTR	(*)	Shape B (semi-circle) R ⊗Combination with ZC not available ●R sizes 1.5 2 2.5 3 4 BXR2	BIR 1000
	BXR	(*)	BLR	(*)		BXR 1800 BTR 2000 BLR 1500
	CIQ	(*)	CTQ	(*)	Shape C (an arc and tangents) 5° ⊗Combination with ZC not available Q ●Q sizes 2 4 / 2.5 5 / 3 6 / 3.5 8 CTQ5	CIQ 1000
	CXQ	(*)	CLQ	(*)		CXQ 1800 CTQ 2000 CLQ 1500
	KC	13				200
	ZC	R0.5 R0.5 L U±0.1			S,T,U : m0.1mm S≧a+2 a+2≦T≦D 2≦U≦5 Lmax≧L+U ZC-S3.5-T4.0-U2.0	1000
LKC	LKC	LKC = m0.01mm $L^{+0.1}_{0}$...$L^{0}_{-0.02}$ ⊗Combination with ZC not available				600

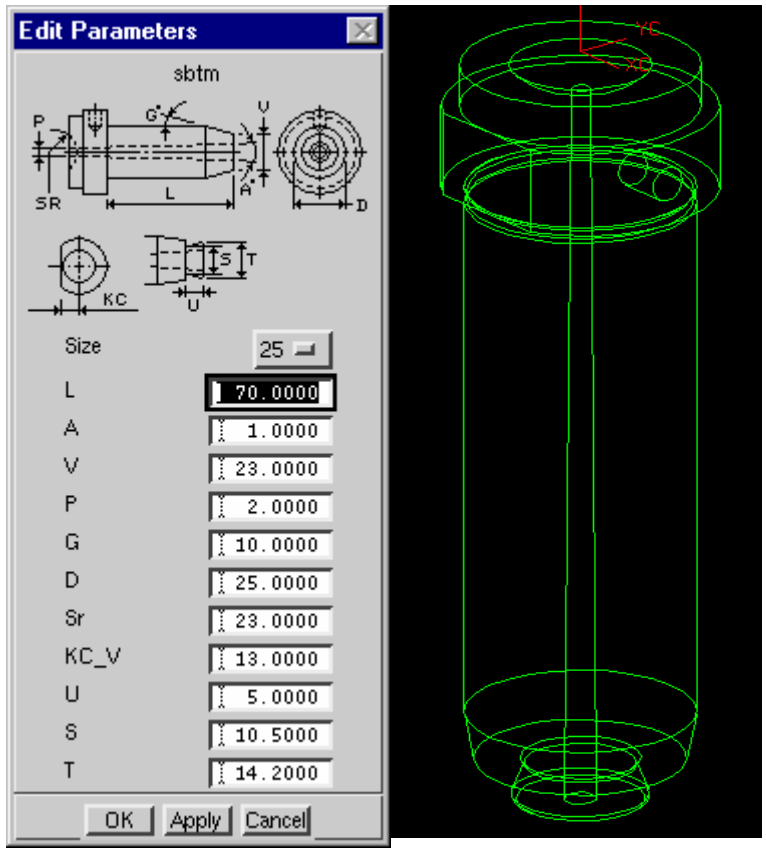
(*) Cut the flange at ////// part when KC is also taken.

Unified feature-based components and libraries

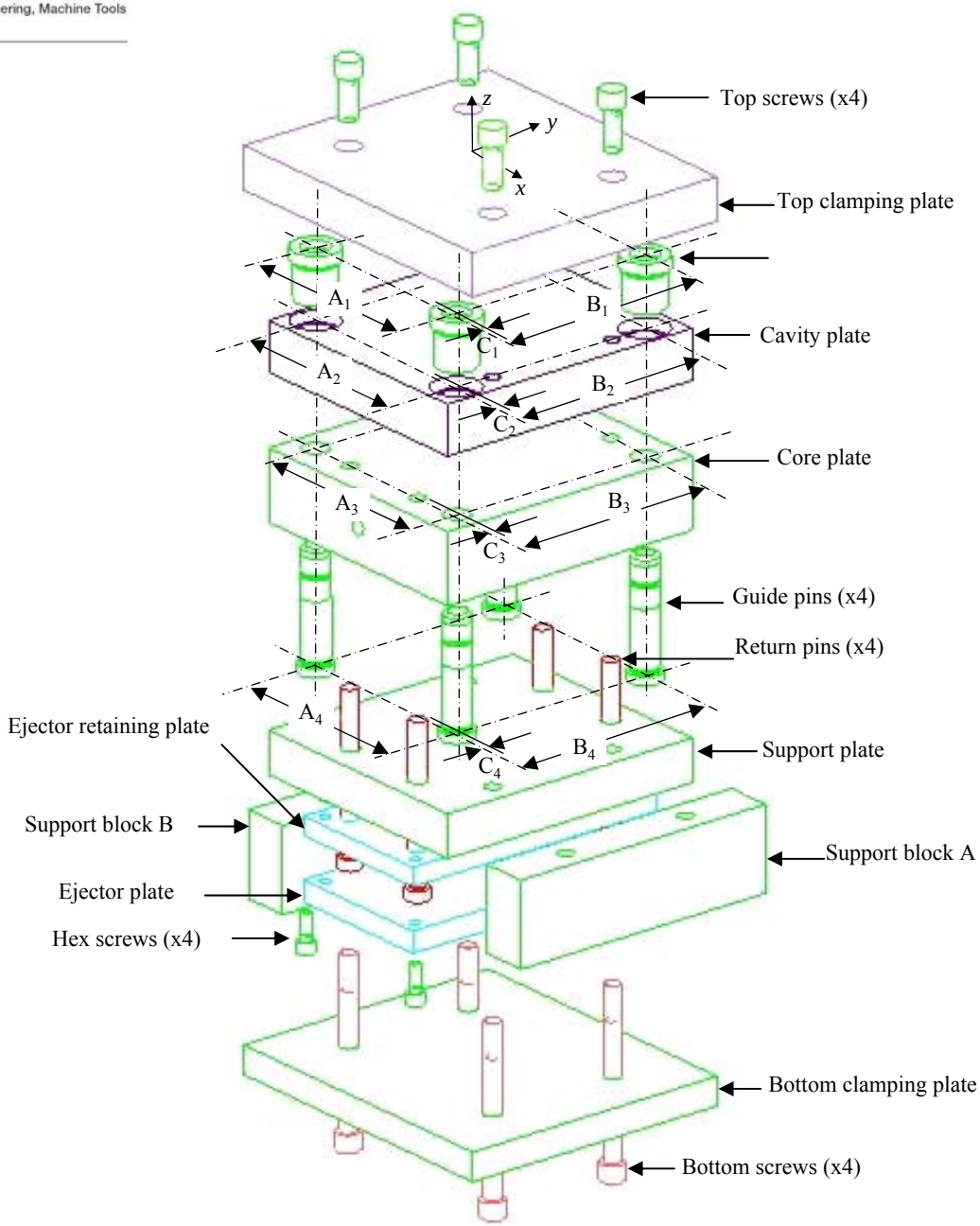


Unified feature-based components and libraries

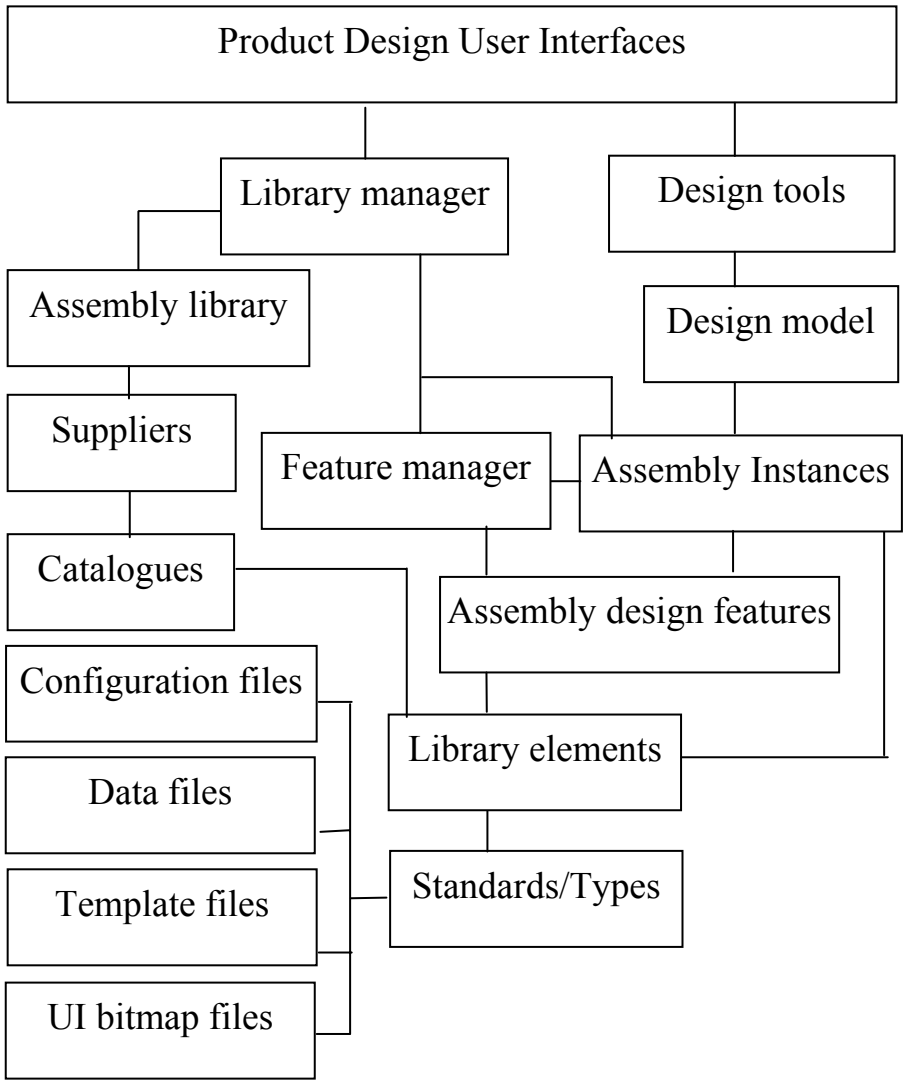


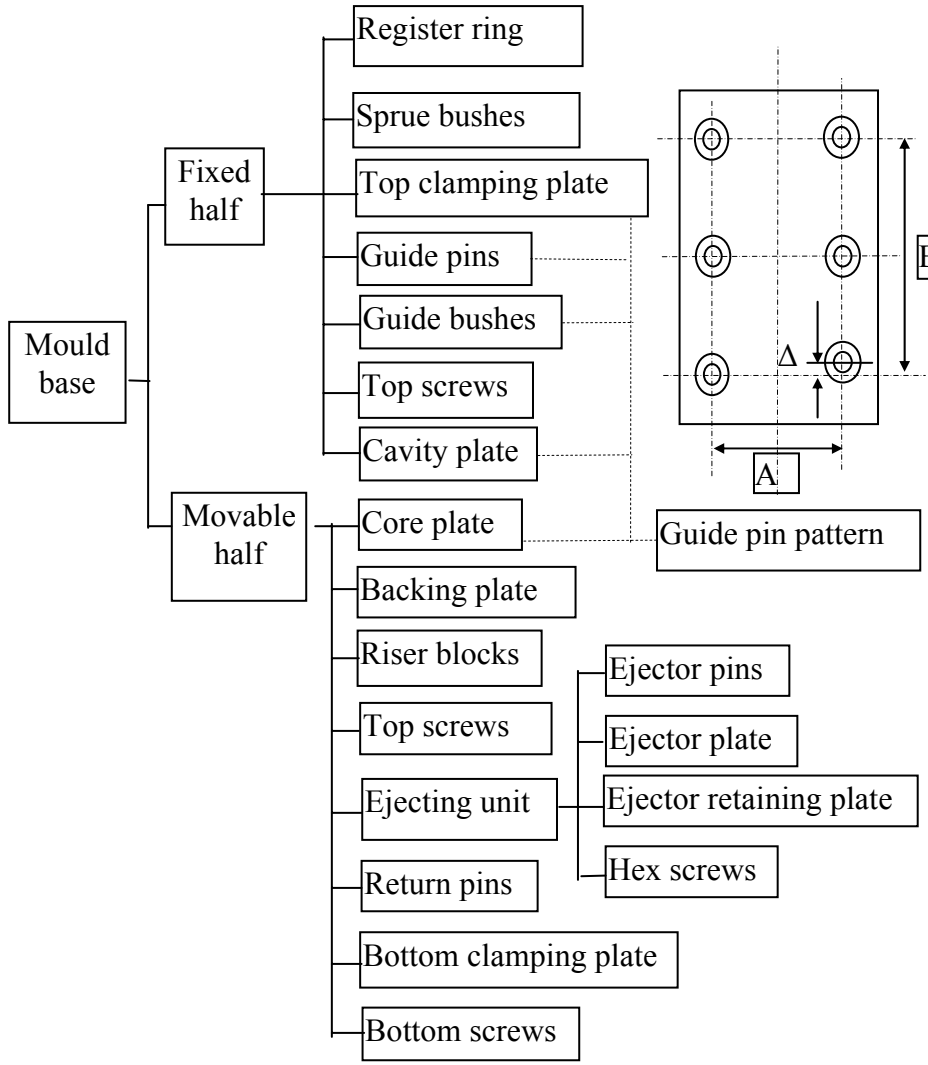


Modular assembly & mechanism libraries

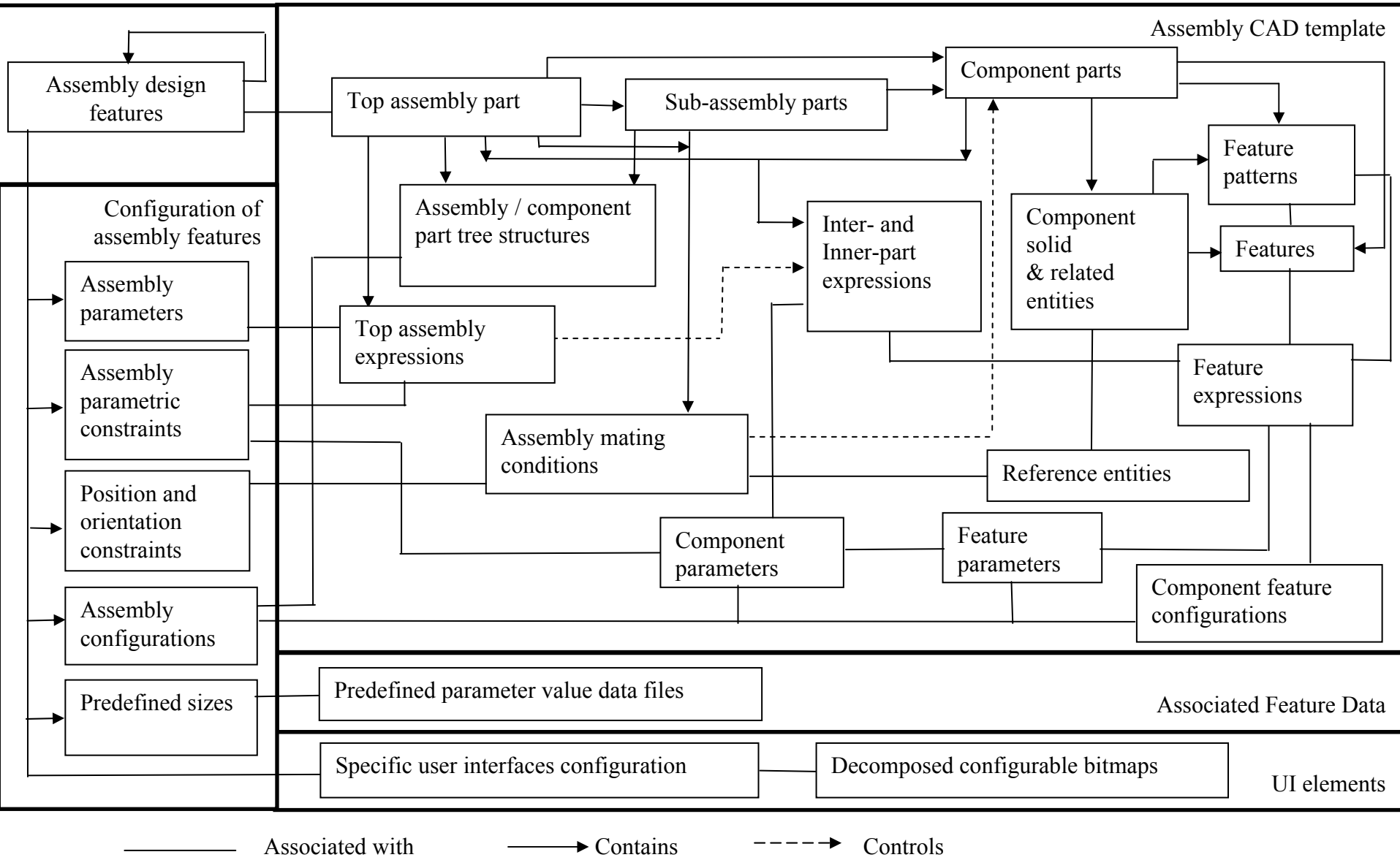


Smart design patterns in mechanism libraries

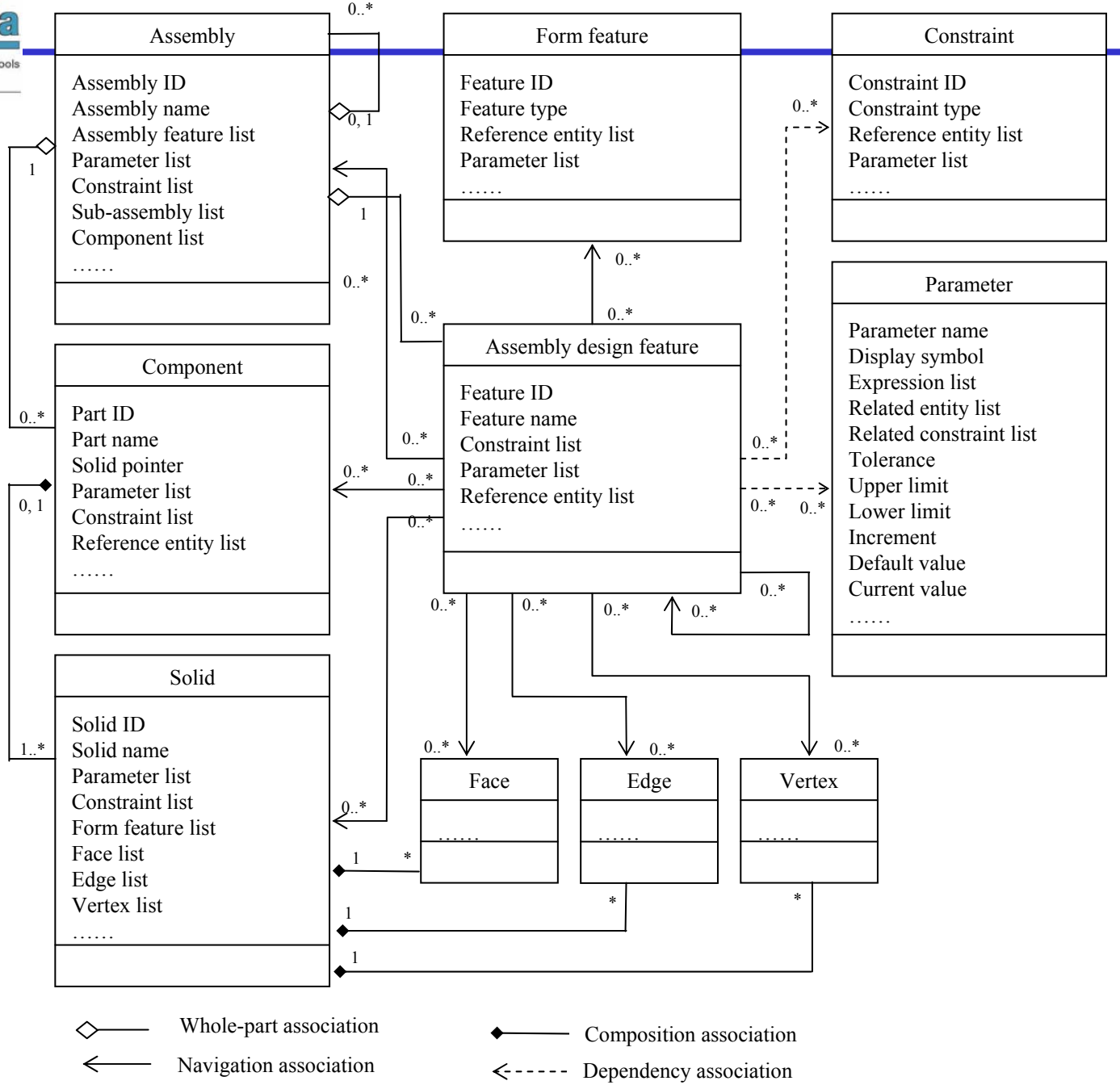




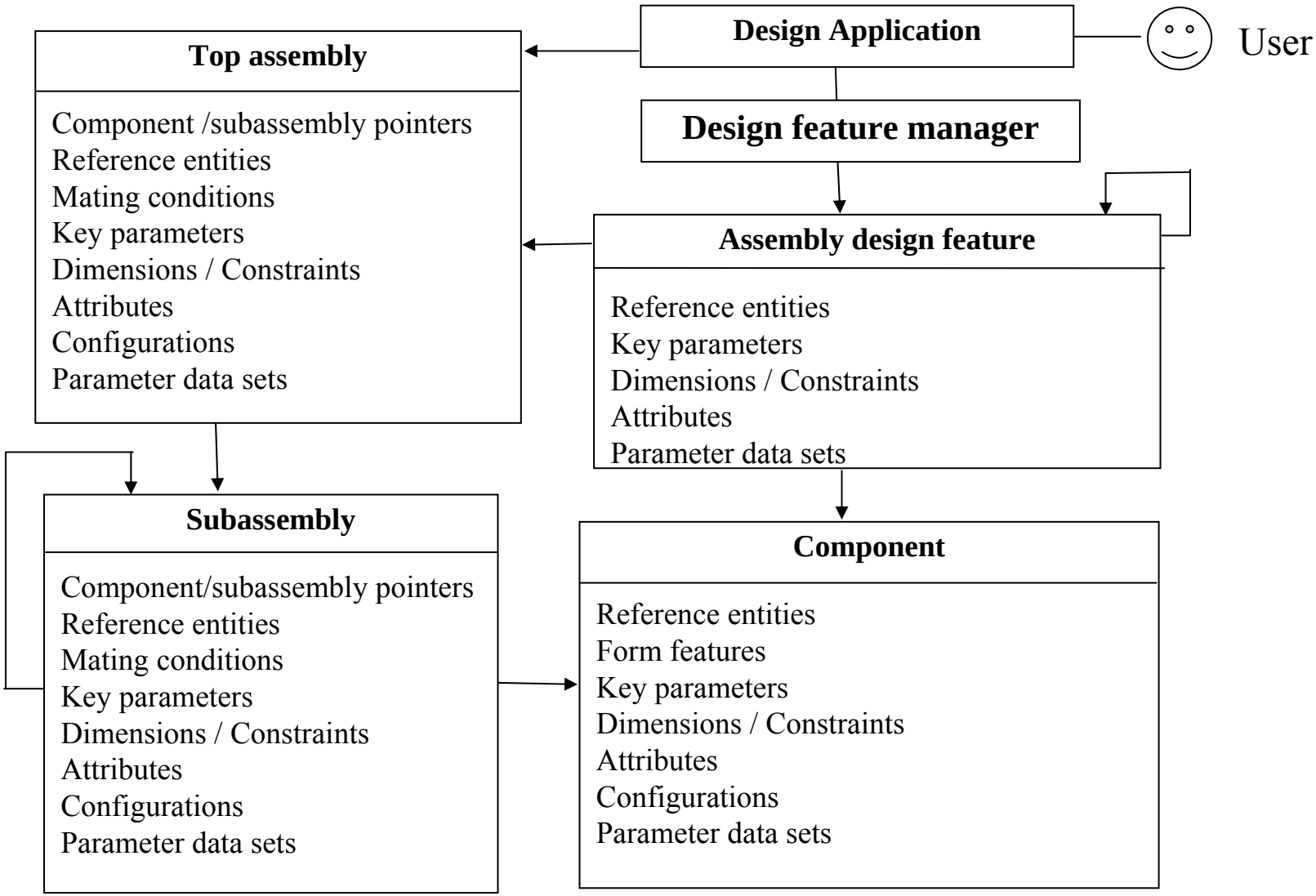
Unified feature-based assembly model



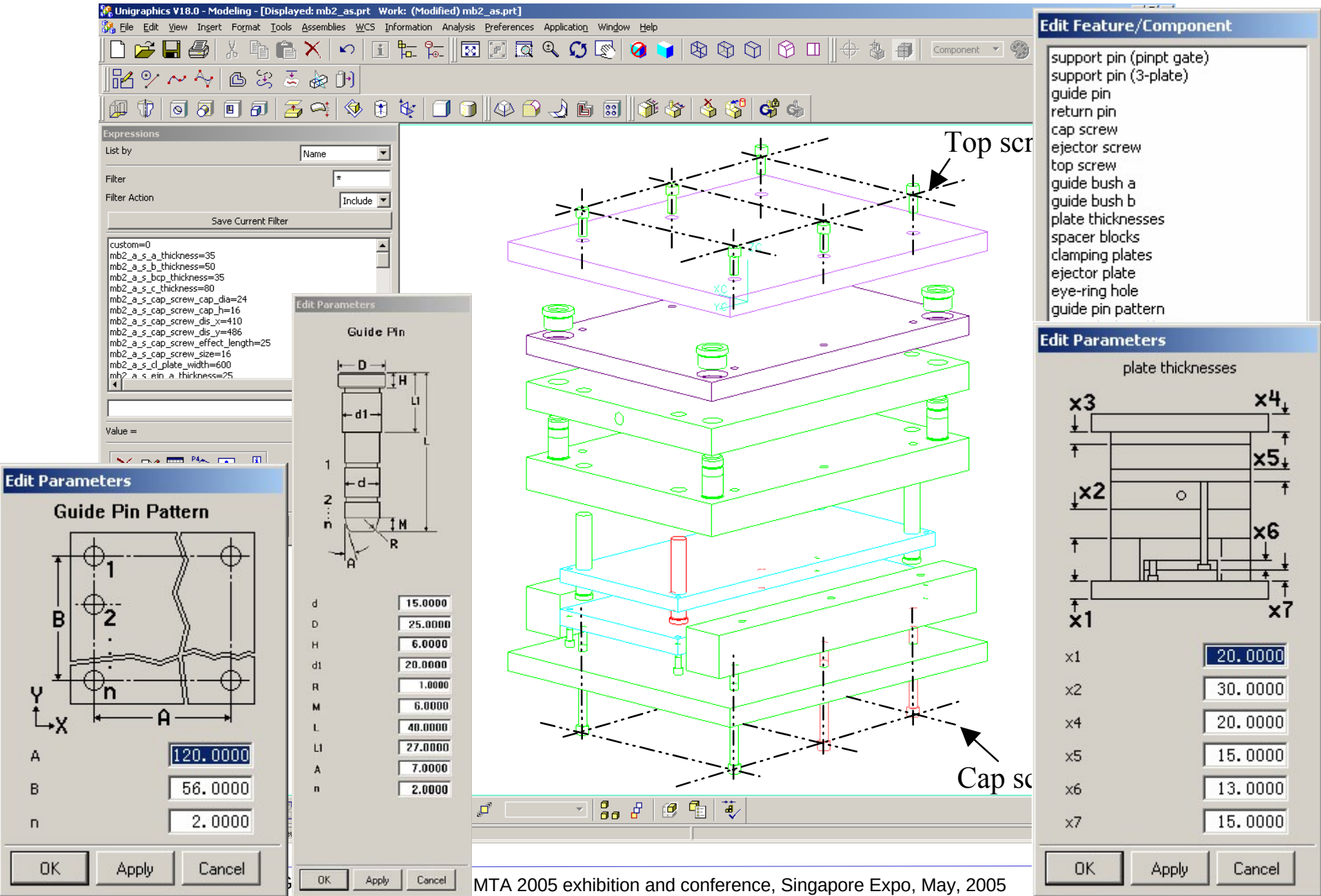
Unified assembly model



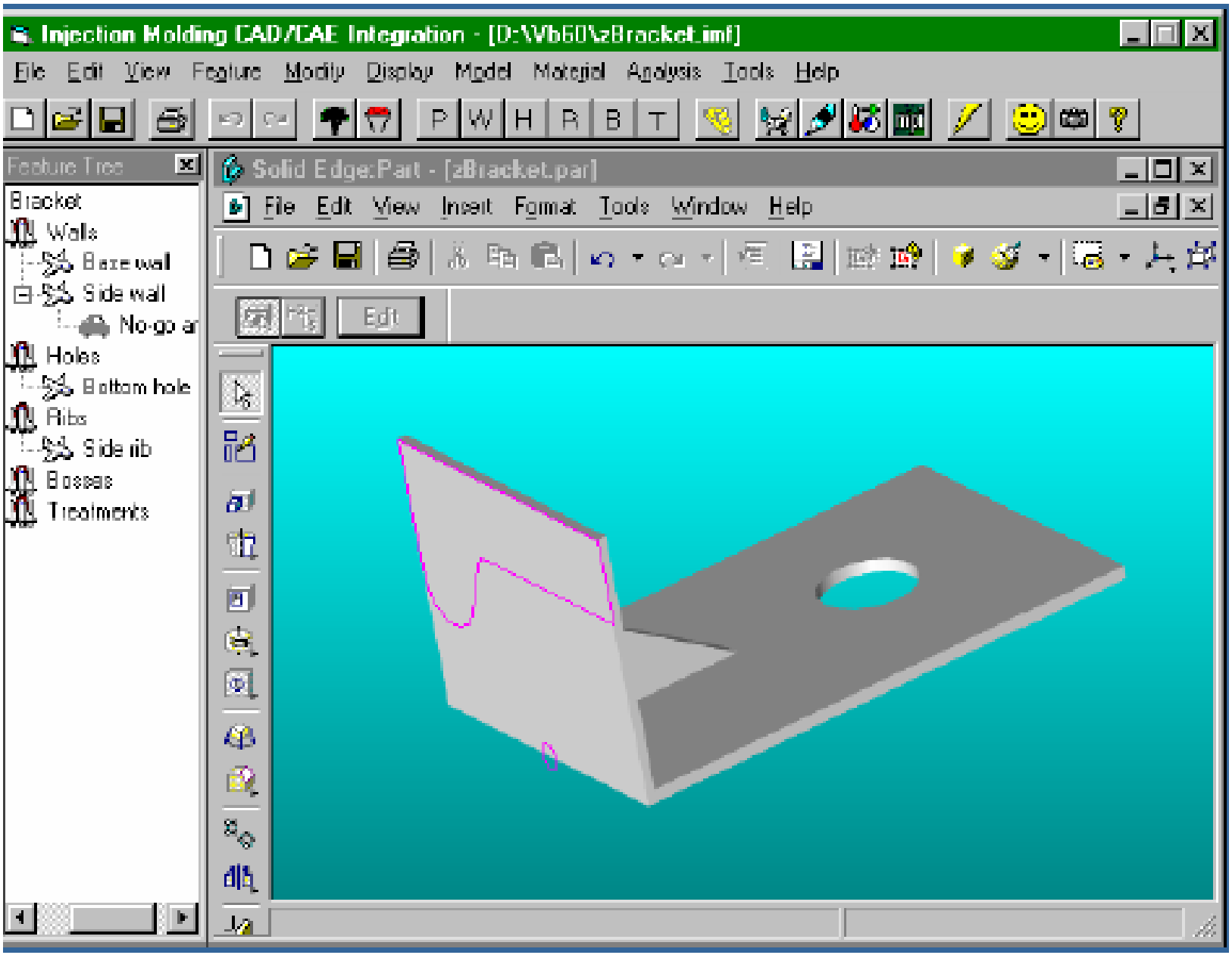
Semantic relations in a product model for assembly feature-based design



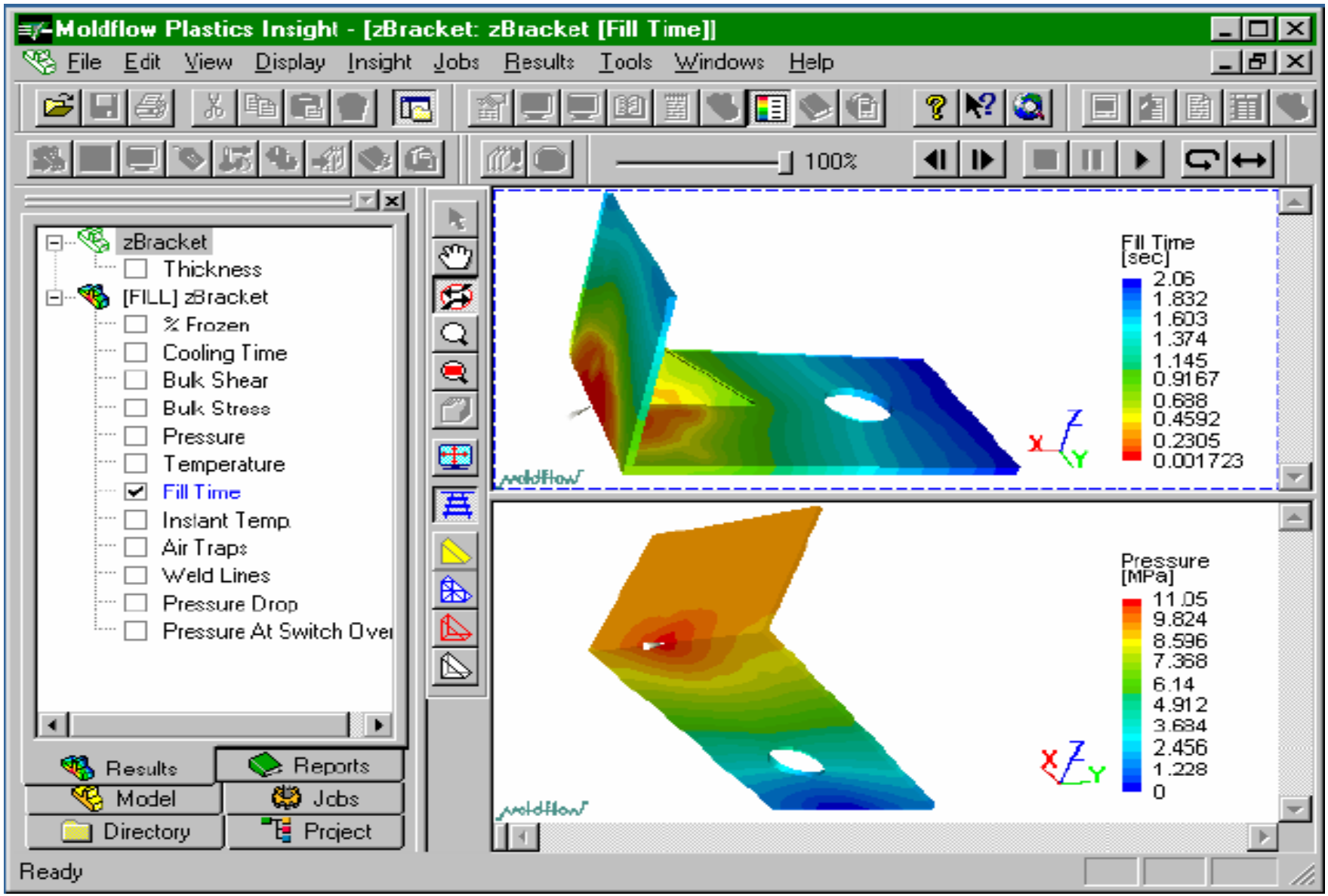
Unified Associative Feature: Mechanism Patterns



Unified Feature-Based CAD-CAE Integration Model

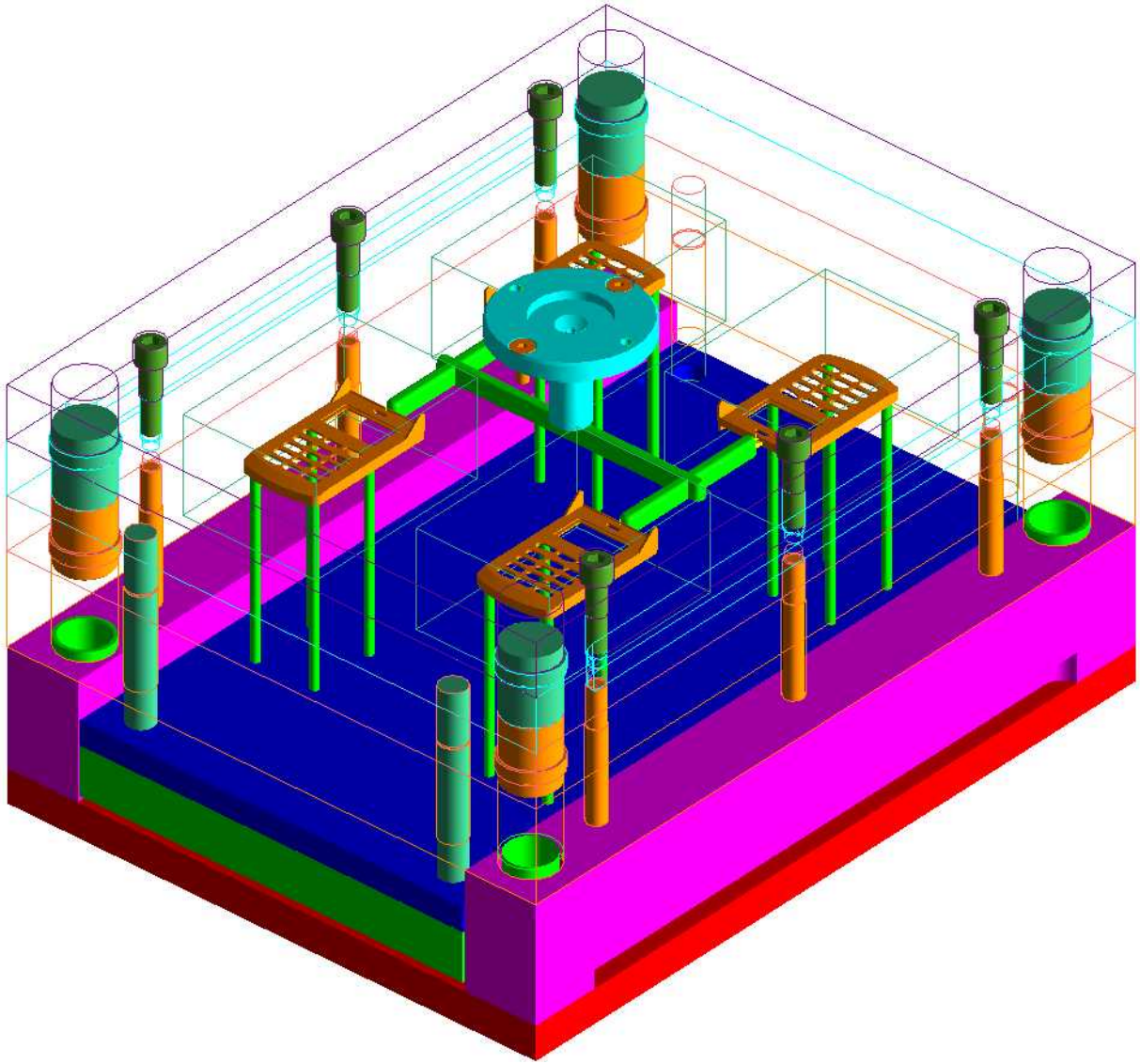


Unified Feature-Based CAD-CAE Integration Model



Unified feature-based language for product and process models

- **XML for communication**
- **UML based modeling descriptions at macro/process level**
- **Unified features at the application level**
- **Associative features at the modular data structure level**
- **Extended solid model entities for geometry level**
- **Web-services for project management and collaboration**



NTU unified approach for PLM modeling

Feature-object technology developed in NTU in recent years has been proven to be effective to bridge the information gap among different application features for different purposes.

- **Investigation and development of an XML-based product data translator and extended active engineering database specifications (feature-based PLM repository)**

- **Unified feature model for the integration of CAD and Cax applications**

On-going research in NTU

- Unified feature semantics and ontology
- Self-contained, well defined and flexible feature data structure modeling and generic schemas in database
- Geometric and non-geometric entity types and their representations in a scalable database
- Associated feature-oriented database constraints management mechanisms
- Dynamic updating and validation methods
- Unified feature communication packaging and interactions
- Unified feature modeling language specifications and its application methods, such as parsing, binding and validating
- Generic interfaces between a KBE system and the flexible feature-oriented database
- Deep reasoning of engineering knowledge with the proposed feature oriented database
- Meta-knowledge generation and updating
- Unified modeling for product life cycle management processes

New Collaborative Research Project with SIMTech - Objectives

- **To investigate the unified feature-object modeling technology to be applied in the application integration of PLM.**

- **To support e-Engineering PLM framework, which covers unified feature modeling, product information repository, communication and sharing across the Web, especially with both geometric and non-geometric contents, for multi-discipline applications.**

- **To enable new generation generic Application Service Provider (ASP) portal-based engineering services with flexible knowledge encapsulation and deep intelligent reasoning, e.g.**
  - **Mass Customization,**
  - **Quality Engineering, and**
  - **Green Product Development and Manufacturing.**

- **To provide the foundational common platform for the software packages ranging from CAD/CAx systems, shop floor management systems, MRP tools, to enterprise and supply-chain management solutions.**

LOOKING AHEAD …
A MAJOR PLM RESEARCH EFFORT

It can be envisaged that many research works are necessary in order to live up the proposed new generation industrial IT infrastructure. Here are some of the immediate ones:

- **Research and development of a unified feature-oriented scalable engineering database**
- **Research on the collaboration of distributed manufacturing systems**
- **Research and development of a Feature Modeling Language (FML) and its relevant evaluators and parsers**
- **Feature object interaction protocols**
- **Feature object-brooking service infrastructure**
- **Research on a multi-facet product model for concurrent/collaborative engineering**
- **Research on enterprise level information management mechanisms**
- **Engineering data banking transactions and supporting system modeling**

SIMTech, NTU and Industry Partners PLM CRP Roadmap

S: Public Symposium IPs: Industrial Partners, CRP: Collaborative Research Project

Theoretic Research

NTU individual academic research projects (Unified PLM modeling & knowledge synthesis)

SIMTech applied research projects (Mass customization, PLM modeling & Industrial projects)

SIMTech/NTU CRP (System framework & enabling technologies)

Applied Research

SIMTech/NTU/IPs CRP (Research on reference model)

SIMTech/NTU/IPs A*Star public research grant (Development of the reference model)

Technology Dev

Industry partners

S

Industrial development consortium

Training courses for executives & engineers

Vendo

Industrial Application Tests

Pilot Consultancy projects

Consultancy projects

Implementation projects

Customized solutions for industry sectors

Turn-key projects & marketable system solution

Industry Partners

1 2 3 4 5 6 7 8 9 10 11 12

2005

2006

2007

Aerospace & military

Equipment & automation

CM, ODM & OEM