PLM WORLD™

The role of Academia in the PLM Industry

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2003 Annual Conference

Business Environment

TECHNICAL
DOW JONES 30 INDUSTRIALS
Source: BusinessWeek online

Business Response

- Growth through quality
  - Lean management
  - Just in Time
- Growth through acquisitions and consolidations
  - EDS-UG-SDRC
  - HP-Compaq-DEC
- Throwing technology at problem
  - E-commerce (remember the Dot Coms?)
  - ERP implementations
- Outsourcing
  - Collaborative Product Development

Why Outsource?

- Concentrate on core business functions "do what you do best"
- Cheaper talent markets
- Experienced talent pools
- Penetrate foreign markets

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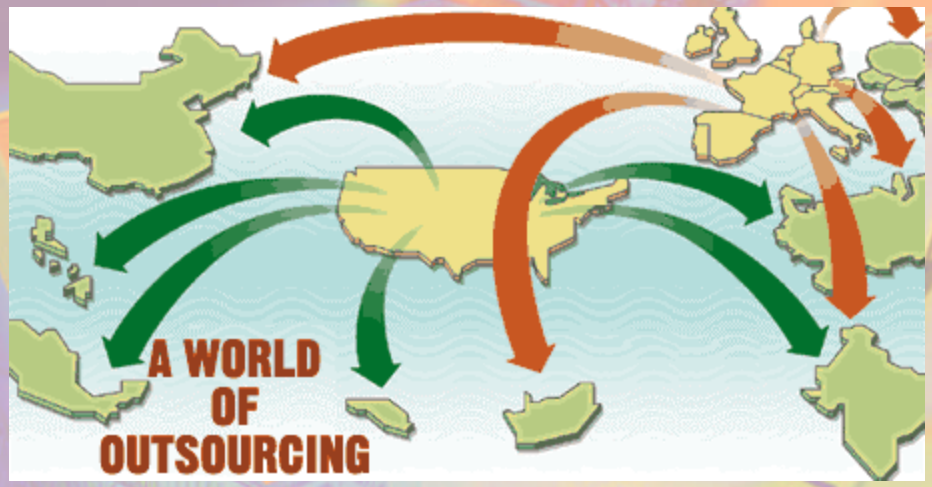
Outsourcing Service [1]



Source: BusinessWeek Feb 2003

Outsourcing Service [2]

GLOBALIZATION GOES WHITE COLLAR

A global pool of skilled workers . . .

NUMBER OF NATURAL-SCIENCE AND ENGINEERING COLLEGE GRADUATES

	BAs		MAs and PhDs	
	1989	1999	1989	1999
CHINA	127,000	322,000	19,000	41,000
INDIA	165,000	251,000	64,000	63,000
PHILIPPINES	40,000	66,000	255	937
MEXICO	32,000	57,000	340	63,000
U.S.	196,000	220,000	61,000	77,000

Data: National Science Foundation, *BusinessWeek*

. . . is drawing more Western companies

COMPANY	NO. OF WORKERS AND COUNTRY	TYPE OF WORK MOVING
ACCENTURE	2,000 in the Philippines by 2004	Accounting, software, back-office work
CONSECO	1,700 in India, 3 more centers planned	Insurance claim processing
DELTA AIR LINES	6,000 contract workers in India, Philippines	Airline reservations, customer service
FLUOR	700 in the Philippines	Architectural blueprints
GENERAL ELECTRIC	20,000 in India alone by yearend; big China R&D center	Finance, IT support, R&D for medical, lighting, aircraft

. . . that are eager to cut costs . . .

COMPANY	NO. OF WORKERS AND COUNTRY	TYPE OF WORK MOVING
HSBC	4,000 in China, India	Credit-card, loan processing
INTEL	3,000 in India by 2005	Chip design, tech support
MICROSOFT	500 in India, China by year end	Software design, IT support
ORACLE	Doubling India staff to 4,000	Software design, customer support, accounting
PHILIPS	700 Chinese engineers in China	Consumer electronics R&D
PROCTER & GAMBLE	650 in Philippines, 150 in China	Tech support, accounting

Data: Gartner Inc., McKinsey & Co., Forrester Research Inc., *BusinessWeek*

. . . a trend that's likely to grow

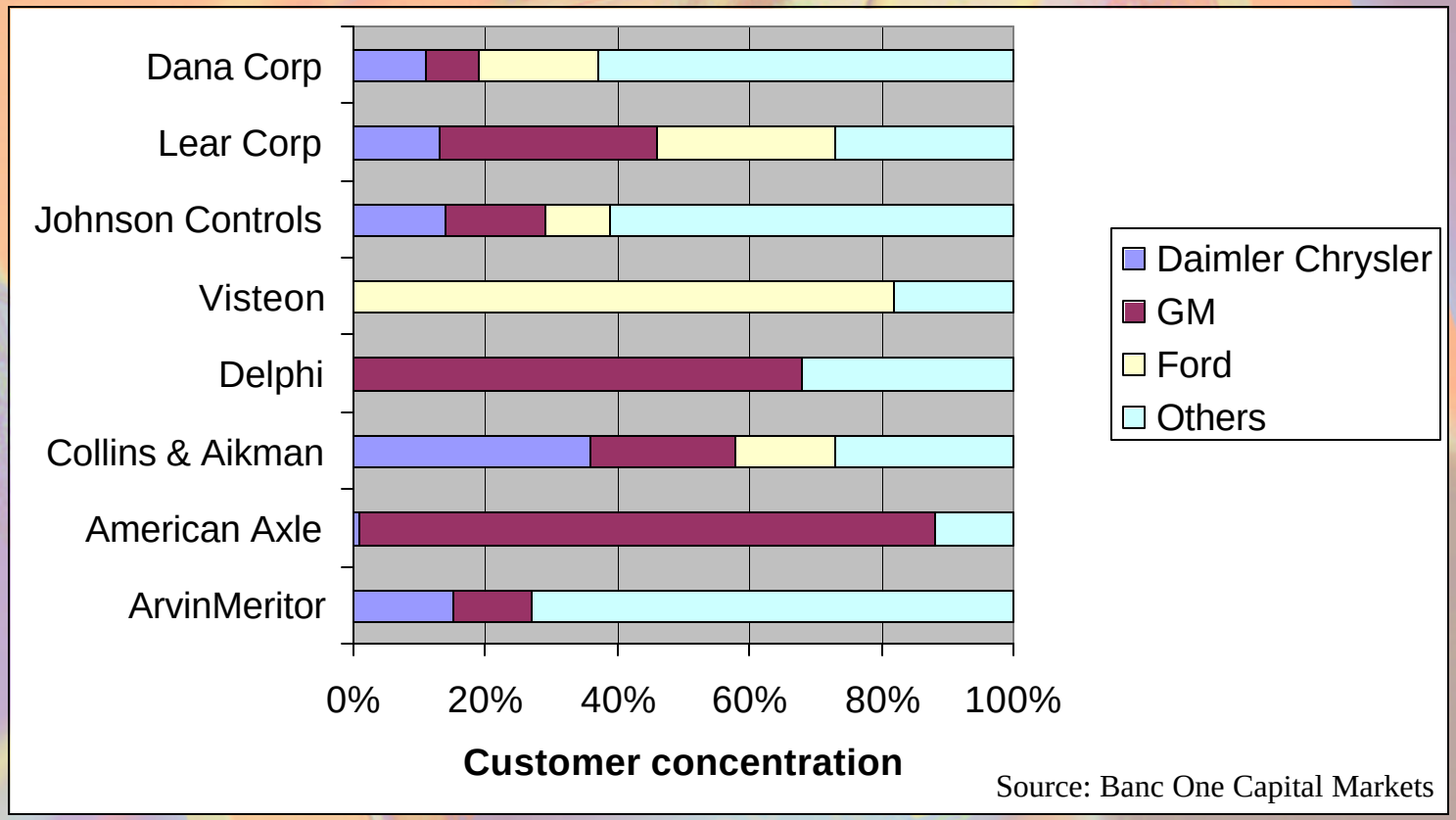
NUMBER OF U.S. JOBS MOVING OFFSHORE*

	2005	2010	2015
LIFE SCIENCES	3,700	14,000	37,000
LEGAL	14,000	35,000	75,000
ART, DESIGN	6,000	14,000	30,000
MANAGEMENT	37,000	118,000	288,000
BUSINESS OPERATIONS	61,000	162,000	348,000
COMPUTER	109,000	277,000	473,000
ARCHITECTURE	32,000	83,000	184,000
SALES	29,000	97,000	227,000
OFFICE SUPPORT	295,000	791,000	1,700,000
TOTAL	588,00		

*To low-wage countries such as India, China, Mexico

Source: BusinessWeek Feb 2003

Where the principal US parts suppliers derive their revenues



Current Trends in Industry

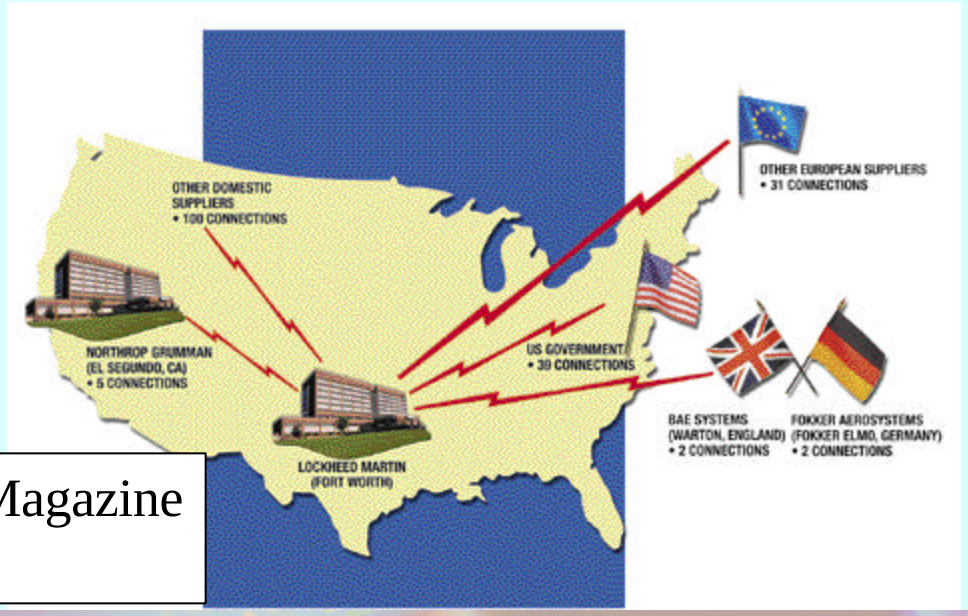
X-35
Joint Strike Fighter

COLLABORATIVE DEVELOPMENT ACROSS 11 TIME ZONES

Uniform tools give Lockheed, its partners, and suppliers the same view of product development

• PDM software • CATIA for 3D design

• 1 master database, mirrored at partners, synchronized in real time



Source: Desktop Engineering Magazine
Dec 2002

What is PLM?

"Product lifecycle management enables you to marshal the skills, expertise, knowledge, and experience of your entire extended enterprise and apply them to every major stage in your product lifecycle to achieve competitive excellence."

- How do you manage the design process?
- What needs to be managed?
- What data formats need to be managed?
- How does information flow? Bi-directional? Unidirectional?

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Engineering education of today

Must Set or Reflect Industry Trends!

- Multidisciplinary Teamwork
- Project Management Skills
- Practical Experience and Industry Contact
- Distributed
- Students focused on Product and Process

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Role of PLM in education

- Manage information in the design process
- Enhance collaboration
- Foster multidisciplinary environment
- Enhance processes not automate
- Preserve knowledge for reuse

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ME4041 - Lecture [1]

Topics:

- Introduction to Computer Aided design
  - Cartesian Coordinate Systems
  - Introduction to Parameterization
    - Cubic Spline formulation
    - Bezier Curves
    - B-Splines
    - Patches
  - Solids and Boolean operations

The cubic splines take the form:

$$x(t) = [T][M][x] = \begin{bmatrix} 1 & t & t^2 & t^3 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -3 & 3 & -2 & -1 \\ 2 & -2 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_0 \\ x_1 \\ x_0' \\ x_1' \end{bmatrix}$$

$y(t)=[T][M][y]$
$z(t)=[T][M][z]$

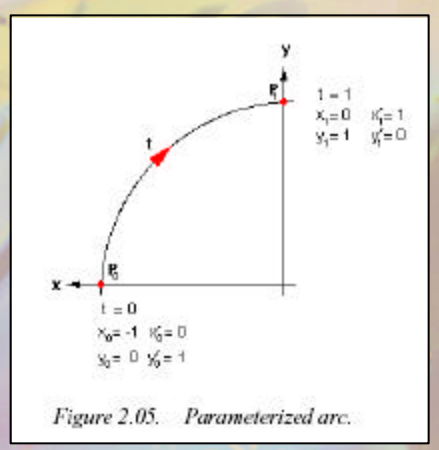
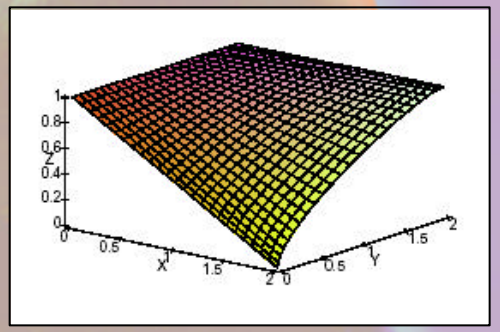


Figure 2.05. Parameterized arc.



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ME4041 - Lecture [2]

Topics (cont.):

- Introduction to Finite Element Analysis
  - Stiffness matrix formulation
    - One dimensional elements
    - Two dimensional elements
    - Three dimensional elements

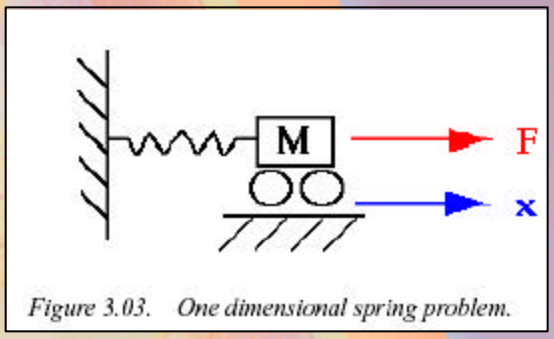


Figure 3.03. One dimensional spring problem.

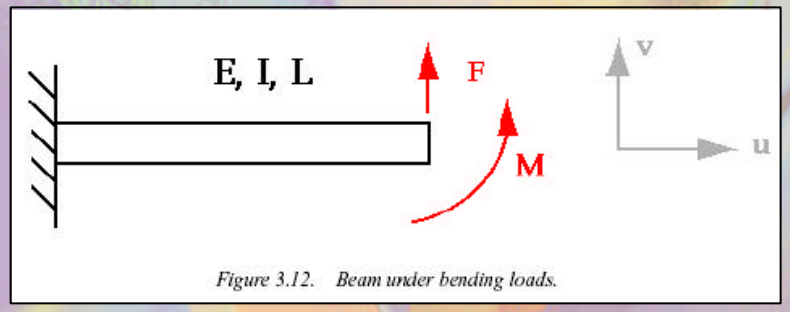
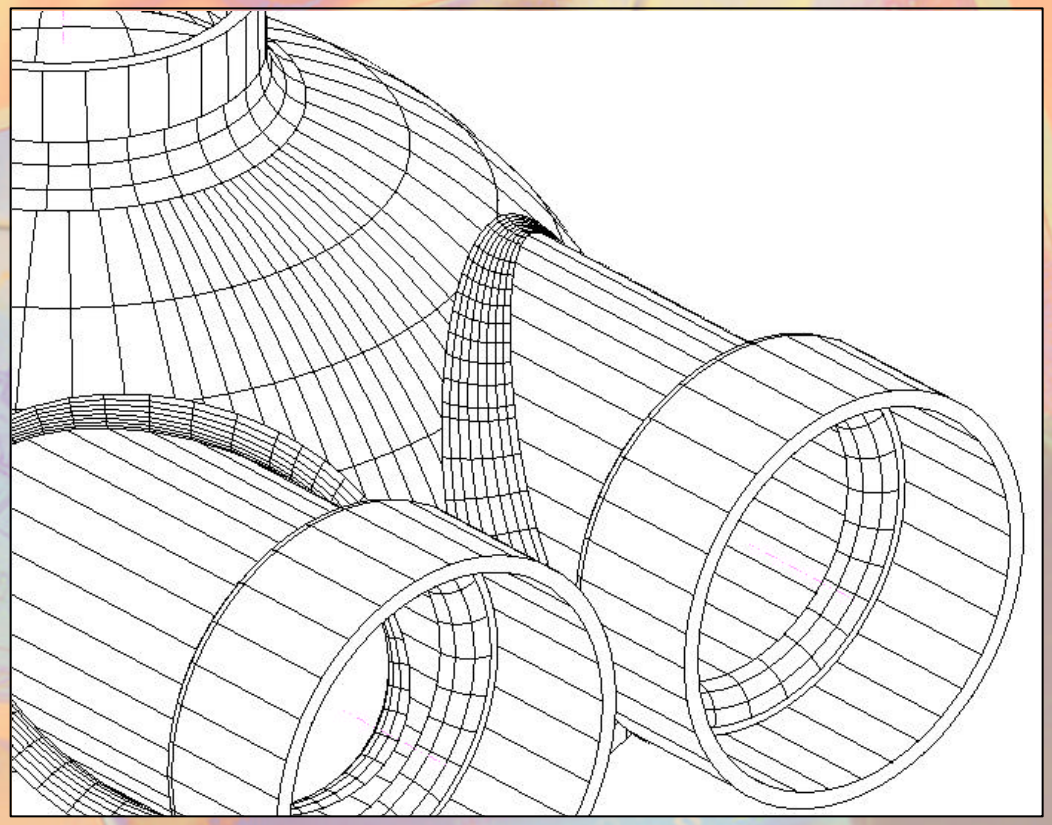


Figure 3.12. Beam under bending loads.

$$\frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & 6L & 0 & 0 \\ 6L & 4L^2 & -6L & 2L^2 & 0 & 0 \\ -12 & -6L & 12+12 & -6L+6L & -12 & 6L \\ 6L & 2L^2 & -6L+6L & 4L^2+4L^2 & -6L & 2L^2 \\ 0 & 0 & -12 & -6L & 12 & -6L \\ 0 & 0 & 6L & 2L^2 & -6L & 4L^2 \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \end{Bmatrix} = \begin{Bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \\ Q_5 \\ Q_6 \end{Bmatrix}$$

Looking under the hood [1]



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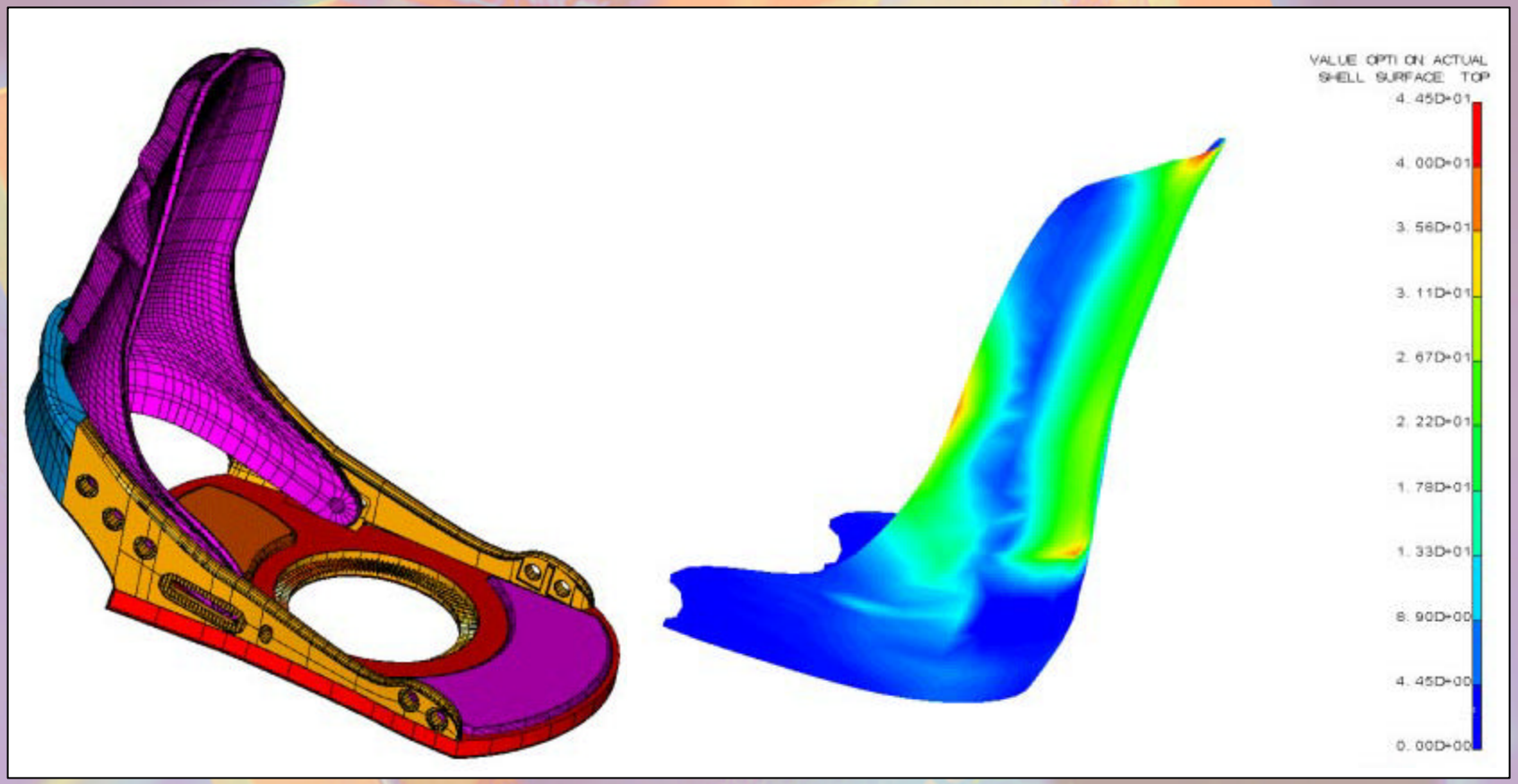
Looking under the hood [2]



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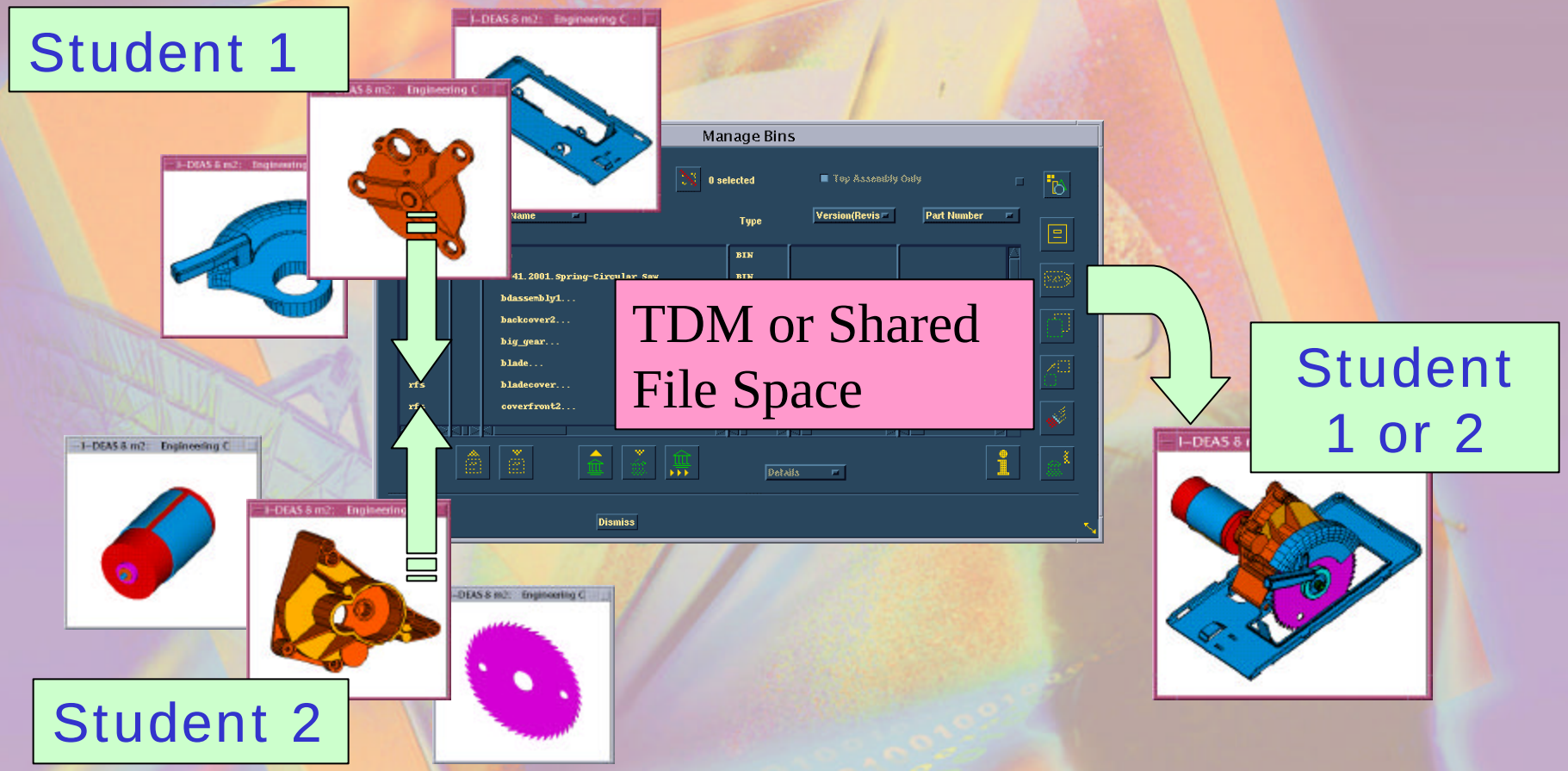
Team Data Manager (TDM)



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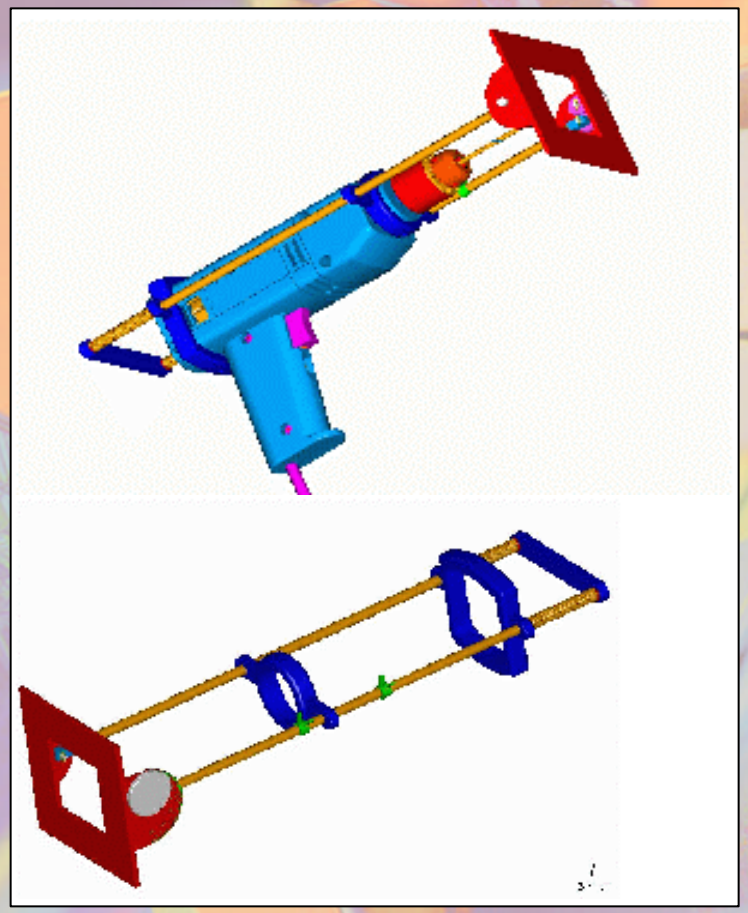
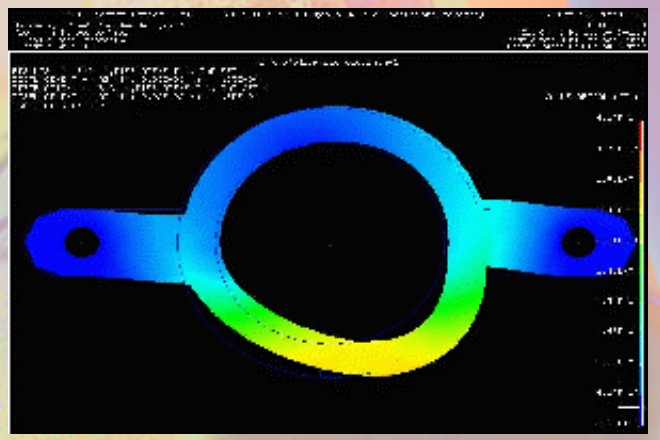
Collaboration – 4 members



ME 4182
Capstone Design



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Collaboration – 17 members

- Project conducted in the summer of 2000.
- Virtually design and build (reverse engineer) a mini-Formula car.
- 8 student groups:
  - Engine
  - Intake system
  - Chassis
  - Front suspension
  - Front brakes
  - Rear suspension
  - Drivetrain
  - Steering and pedals

- Communication through meetings, email and a team web page.

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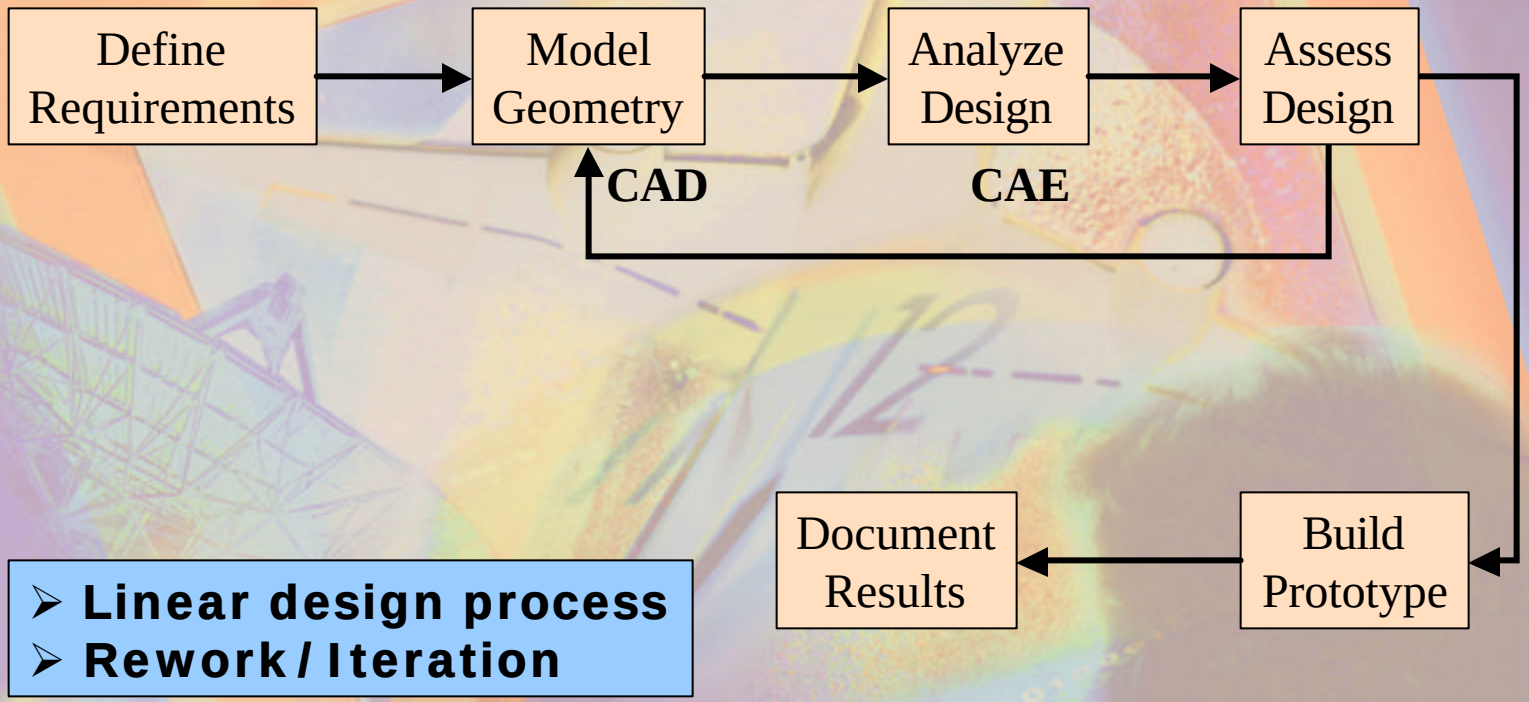
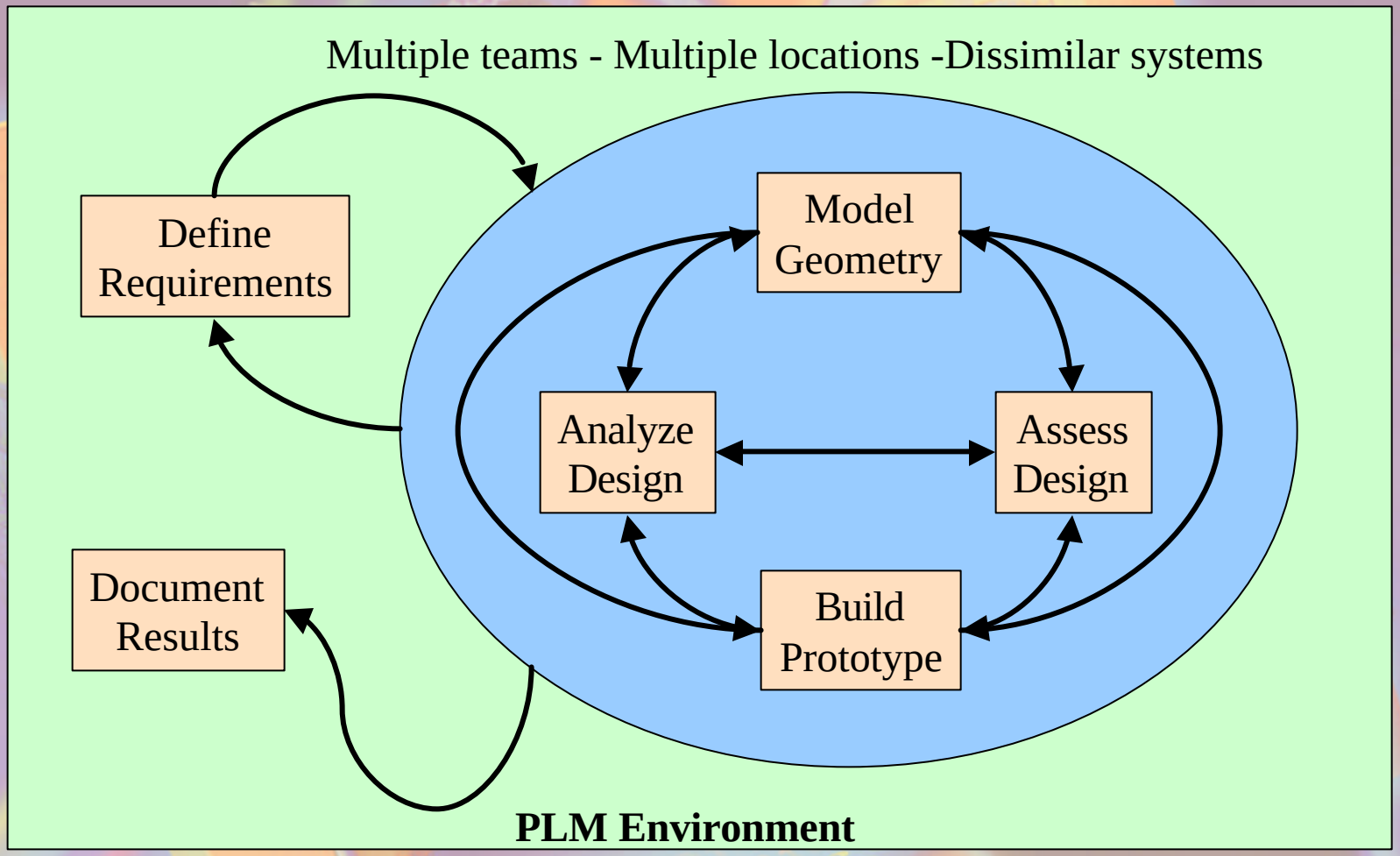
Typical CAD/CAE Design Project of Today

(1-3 person team, single site)



- **Linear design process**
- **Rework / Iteration**

PLM-enhanced CAx Design Project



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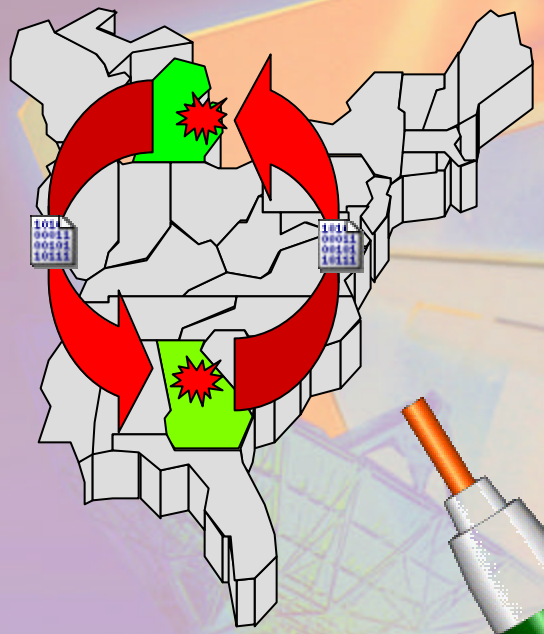
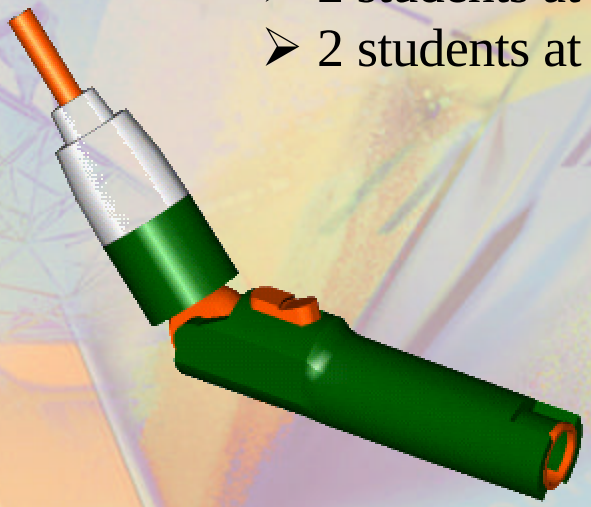
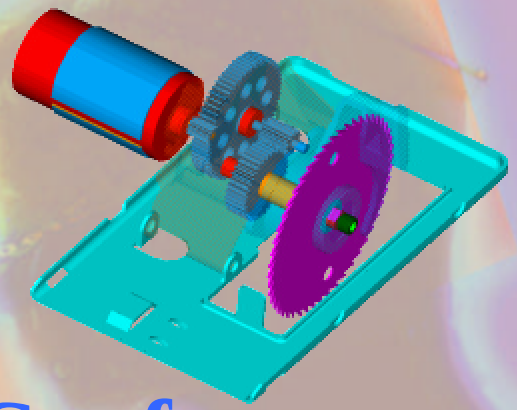
Intercollegiate Collaboration: Power Tools [1]



- Parametrically model a circular saw
  - 2 students at GT - internal parts
  - 2 students at Kettering - external parts and assemblies
- Parametrically model a cordless screwdriver
  - 2 students at Kettering - internal parts
  - 2 students at GT - external parts and assemblies





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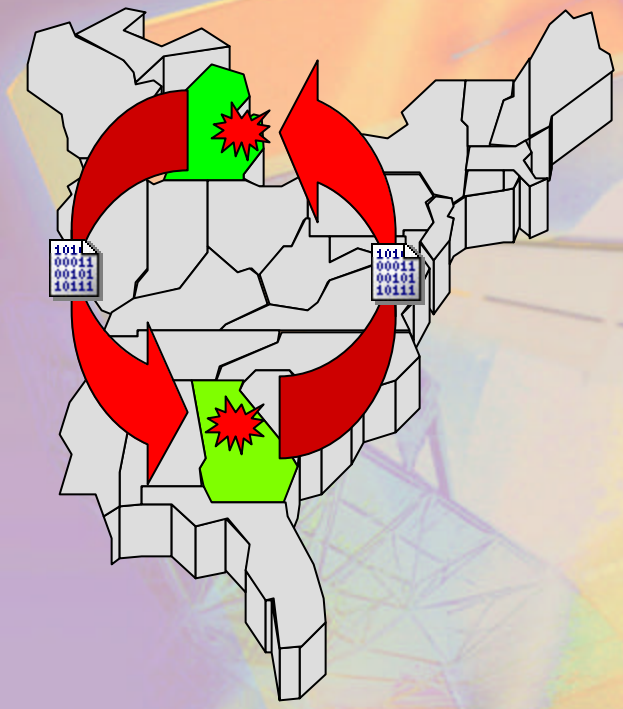
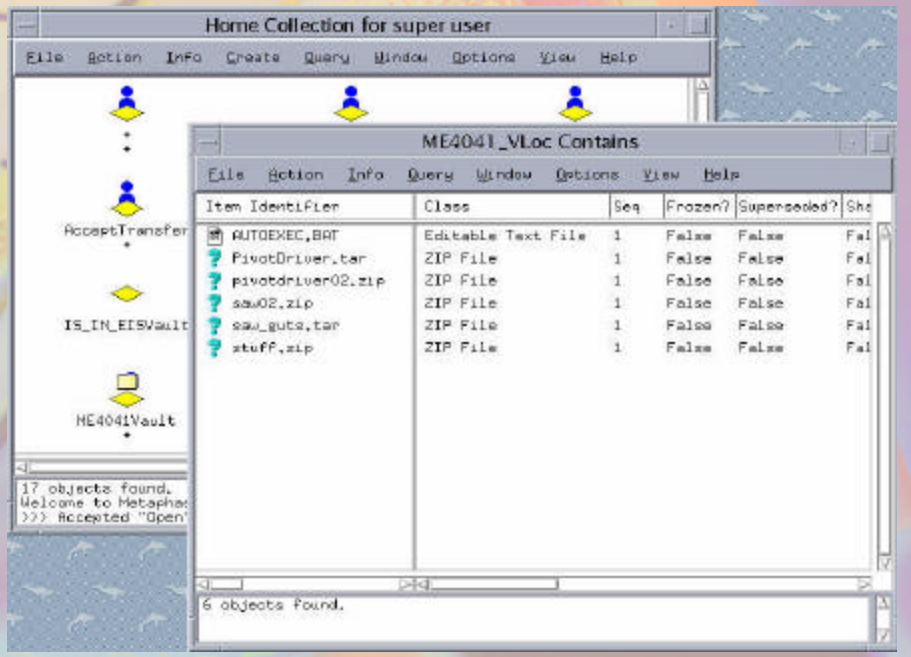
Intercollegiate Collaboration: Power Tools [2]



- Data exchanged locally using I-DEAS TDM.
- Data exchanged between schools using PLM (Metaphase).



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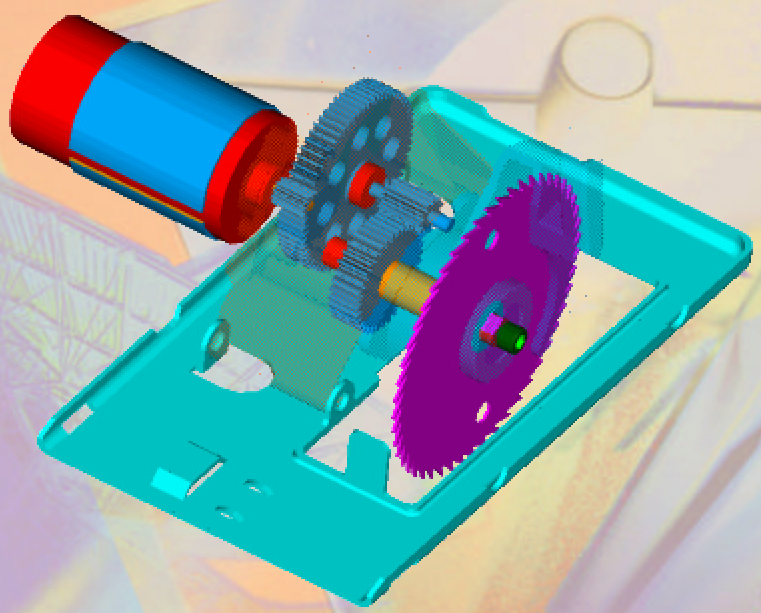
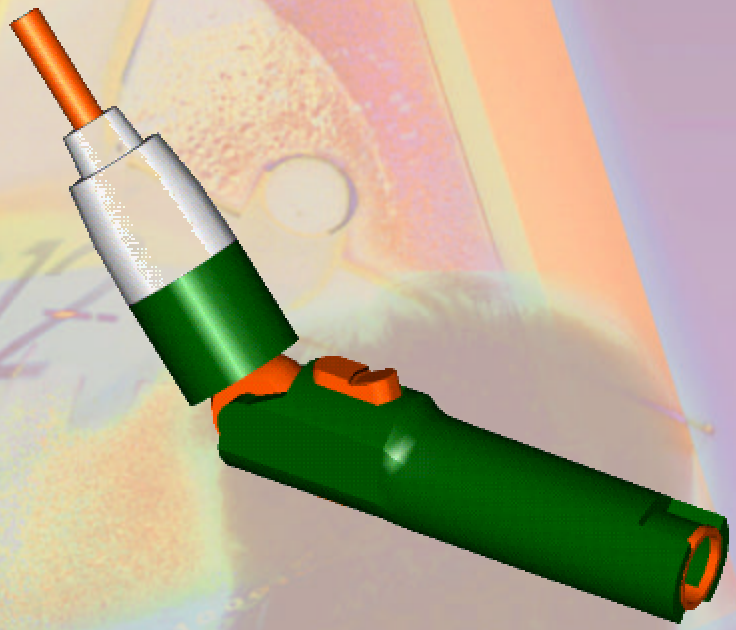
Intercollegiate Collaboration: Power Tools [3]

Students completed assemblies in Distributed Concurrent Collaborative environment





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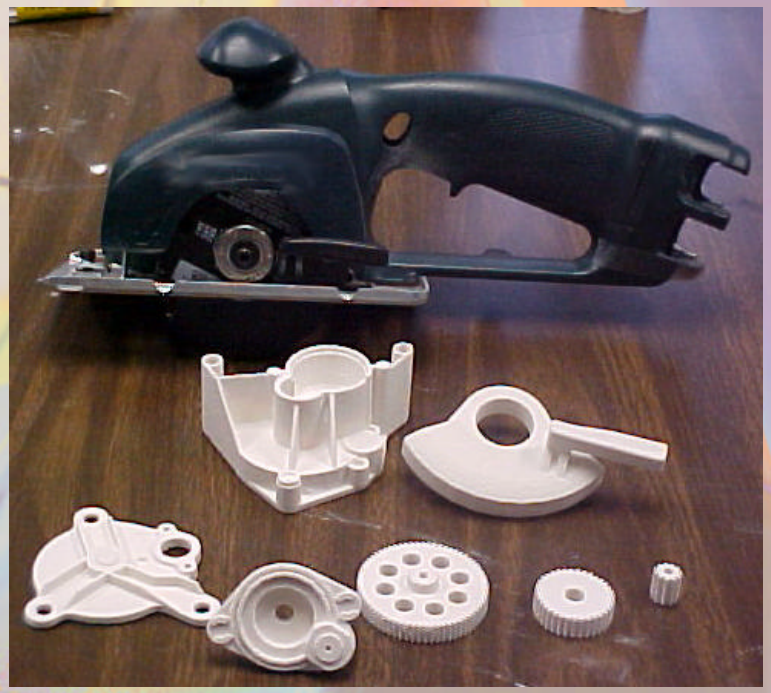
Intercollegiate Collaboration: Power Tools [4]

Students rapid prototyped parts from CAD models



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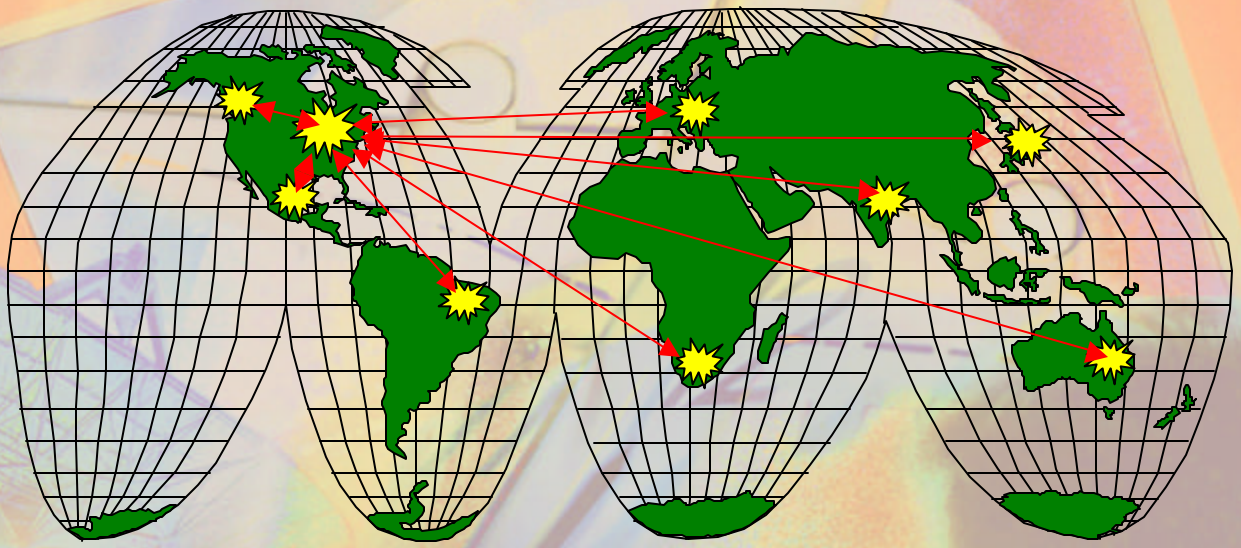
The “Grand Experiment” [1]

Multidisciplinary Distributed Concurrent Collaborative Product Development



Involves: Industry Partner(s)
Software Vendor(s)
Universities

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The “Grand Experiment” [2]

Problem statement:

How to leverage information technology to manage and conduct multidisciplinary distributed collaborative concurrent product development using a flexible, modular and robust design process?

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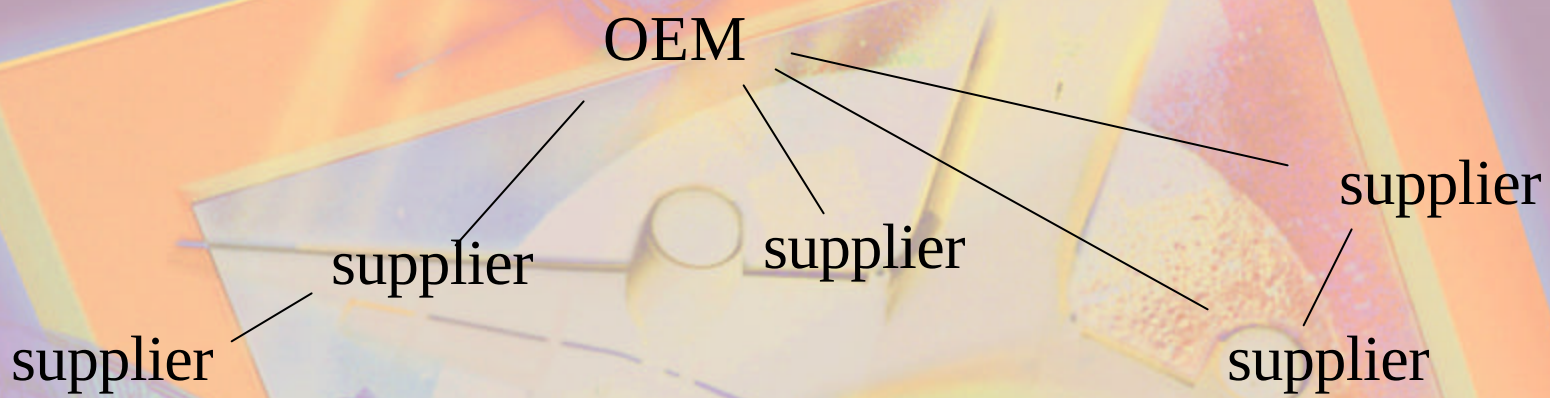
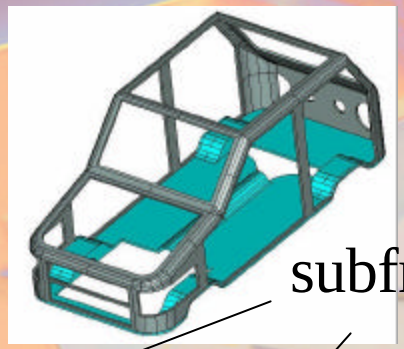
The “Grand Experiment” [3]



Project description

- **Simulate a virtual corporation**
- **OEM designs master model**
- **Universities assume role of multiple suppliers**
- **Duration 2+ years**
- **Subsystems will need to be redesigned as suppliers and requirements change**

The “Grand Experiment” [4]



subframe

engine

drivetrain

rear suspension

brakes

steering

front suspension

brakes

body panels

seats

Multidisciplinary effort:
- ME, EE, IE
- Mgt, ID
- Mkt, Mfg, etc.

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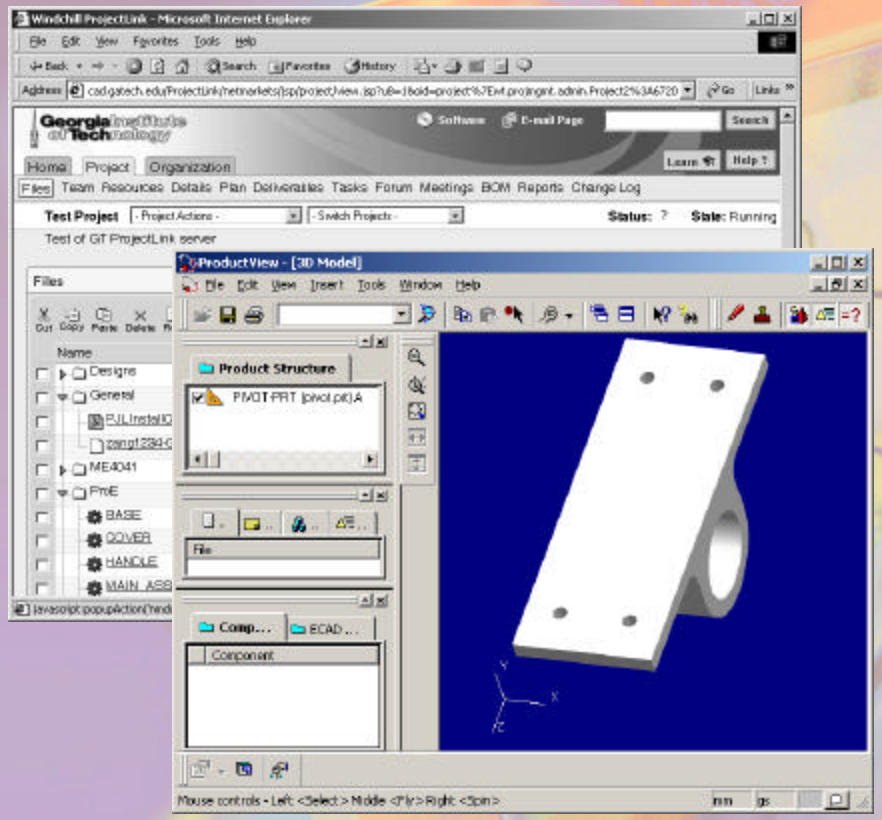
The “Grand Experiment” [5]



Collaboration server attributes

- ✓ Lightweight viewer
- ✓ Multivendor CAD files
- ✓ Versioning
- ✓ Team organization
- ✓ Workflow administration
- ✓ Centralized storage location
- ✓ Security
- ✓ Meeting center
- ✓ Web-browser access
- ✓ STEP data interchange

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The "Grand Experiment" [6]

Objectives:

- Develop model for training the engineer of the future
  - ✓ Incorporate more IT in undergraduate and graduate courses
  - ✓ Deploy latest CAx/PxM technology at universities
  - ✓ Foster intercollegiate collaboration
  - ✓ Foster multidisciplinary collaboration
  - ✓ Develop curriculum workflow management templates
  - ✓ Study aggregate project management
  - ✓ Preserve knowledge for reuse

The "Grand Experiment" [7]

Objectives:

- Explore PLM implications for Industry
  - ✓ Understand how IT can be used to bridge the distributed communication gap
  - ✓ Understand team interdependence
  - ✓ Explore top-down and bottom-up design issues
  - ✓ Understand barriers to integrating different technology
  - ✓ Explore standards to facilitate information exchange (STEP)
  - ✓ Understand supply-chain management issues
  - ✓ Understand security issues relating to data management
  - ✓ Develop guidelines/best practices for integrating PLM into the design process

PLM WORLD™

The role of Academia in the PLM Industry

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