Digital Manufacturing and Curriculum Development

SME PLM Curriculum Modules

NSF Midwest Coalition for Comprehensive Design Education

WIRED Integrated Curriculum for Digital Manufacturing

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Product Lifecycle Management is an integrated, information driven approach to all aspects of a product’s life from its design inception, through its manufacture, deployment and maintenance, and culminating in its removal from service and final disposal. (Michael Grieves)
Curriculum Modules in Product Lifecycle Management (PLM)

for Engineering and Engineering Technology Students and Industrial Practitioners

Society of Manufacturing Engineers

$ 18,500,000
COT PLM Faculty Group
Curriculum Areas:

All modules can be downloaded in a single ZIP file [here](www.purdue.edu/dp/PLM/SME/curriculum.php).

_Click on the links for more modules:_

Curriculum Areas:
- Introduction to PLM
- Business Knowledge and Skills
- Product Design
- Manufacturing
- Product Data Management
- Service and Maintenance
- Disposal and Recycling
Midwest Coalition for Comprehensive Design Education

Advanced Technology Education Program, NSF Grant # 0603362

$ 1,500,000
Midwest Coalition for Comprehensive Design Education

- Fox Valley Community College
- Mott Community College
- Sinclair Community College
- Purdue University
- Butler Community College
- FV Community College
- Mott Community College
- Sinclair Community College
- Purdue University
- Butler Community College
- Fox Valley Community College
- Mott Community College
- Teamcenter
- CATIA
- Optistruct
- Adams
- UGS NX
- SolidWorks
- Inventor
- DELMIA
- Technomatix

Locations:
- West Lafayette, Indiana
- Flint, Michigan
- Appleton, Wisconsin
- Butler, Pennsylvania
- Dayton, Ohio
Midwest Coalition for Comprehensive Design Education

The goal of the project is to develop and disseminate curriculum in the areas of comprehensive design for associate degree technician and baccalaureate degree technology students, as well as to develop and offer programs to improve the skills of the existing workforce.

The skills in the areas of:
- CAD
- Design for manufacturability and assembly
- Collaborative engineering
- Teamwork
- Managing change

are necessary for an increased competitiveness, as identified by the Society of Manufacturing Engineers and National Association of Manufacturers.

The partner institutions on the project will work collaboratively to identify, develop and deliver curriculum that will integrate comprehensive design education across associate degree technician and baccalaureate degree technology colleges, in order to increase the skill level in the manufacturing sector. They are utilizing and building upon their respective strengths of instructional module development and delivery to traditional and nontraditional student populations. The partner institutions are having regular meetings and videoconferences through which they are exchanging ideas on novel methods for course development and delivery as well as on the methods for collaboration in course delivery across different programs.
Collaborative Product Development

Collaborative project

Prototyping phase
Development of Integrated Digital Manufacturing Curriculum

Workforce Innovation in Regional Economic Development (WIRED)
Opportunity Fund for North Central Indiana
$ 500,000
Distance Learning Modules

Factory Layout Planning

- Creation of layout from 3D models for:
  - Virtual 3D models: sales personnel
  - Photo-realistic images or animation
  - Potential customers
  - BOM: basis for price calculations
Module One: Digital Manufacturing: The Basic Terms

- Product Related Data Goes Digital
- Digital Manufacturing: What Does it Means?
- Define Basic Parts of Digital Manufacturing
- Digital Manufacturing Software Enablers
- Digital Manufacturing: The Case Study
- Digital Manufacturing Examples
Module 1

Digital Manufacturing: The Basic Terms

- Product Related Data Goes Digital
  - Lecture notes
  - Presentation
- Digital Manufacturing: What Does it Mean?
  - Lecture notes
  - Presentation
- Define Basic Parts of Digital Manufacturing
  - Lecture notes
  - Presentation
- Digital Manufacturing Software Enablers
  - Lecture notes
  - Presentation
- Digital Manufacturing: The Case Study
  - Lecture notes
  - Presentation
- Digital Manufacturing Examples
  - Lecture notes
  - Presentation
Module One: Digital Manufacturing: The Basic Terms

- Reverse Engineering and 3D Scanning
- Rapid Prototyping Process
- Rapid Prototyping – The Machine Classification
- Direct Digital Manufacturing
Digital Manufacturing: Part Manufacturing: Reverse Engineering, 3D scanning, Rapid Prototyping, Direct Digital Manufacturing

Module 2

Curriculum modules will be developed for Development of Integrated Digital Manufacturing Curriculum.

Part Manufacturing: 3D scanning, Rapid Prototyping and Manufacturing

- Reverse Engineering and 3D Scanning
  - Adobe Presenter Presentation
  - Lecture Notes
  - Presentation
  - Podcast: Right-click and Save Target (Link) As...

- Rapid Prototyping Process
  - Adobe Presenter Presentation
  - Lecture Notes
  - Presentation
  - Podcast: Right-click and Save Target (Link) As...

- Rapid Prototyping - Machine Classification
  - Adobe Presenter Presentation
  - Lecture Notes
  - Presentation
  - Podcast: Right-click and Save Target (Link) As...

- Direct Digital Manufacturing
  - Adobe Presenter Presentation
  - Lecture Notes
  - Presentation
  - Podcast: Right-click and Save Target (Link) As...
Module Six: Digital Manufacturing and Ergonomics: Product and Process Optimization

- VI -1: Product Design and Ergonomics
- VI - 2: Human Factor and Workspace Design
- VI - 3: Digital Human Model
- VI -4: Basic Ergonomic Analysis
- VI -5: Human Task Analysis
- VI - 6: Human Task Simulation
- VI - 7: Digital Manufacturing and Ergonomics: Examples
Module 6

Curriculum modules will be developed for Development of Integrated Digital Manufacturing Curriculum:

Digital Manufacturing and Ergonomics: Product and Process Optimization

- VI -1: Product Design and Ergonomics
  - Lecture notes
  - Presentation
- VI - 2: Human Factor and Workspace Design
  - Adobe Presenter Presentation
  - Lecture notes
  - Presentation
- VI - 3: Digital Human Model
  - Adobe Presenter Presentation
  - Lecture notes
  - Presentation
- VI - 4: Basic Ergonomic Analysis
  - Lecture notes
  - Presentation
- VI - 5: Human Task Analysis
  - Lecture notes
  - Presentation
- VI - 6: Human Task Simulation
  - Lecture notes
  - Presentation
- VI - 7: Digital Manufacturing and Ergonomics: Examples
  - Lecture notes
  - Presentation
A Process for Protecting Employees (OSHA)

- Industrial ergonomics is moving away from a reactive approach, in which jobs that cause injuries are modified.
- Proactive approach emphasizes assessing each job for feasibility and safety as the workplace and processes are designed.
A Sample of DM Teaching Unit
Digital Manufacturing: The Basic Terms

Unit 1: Product Related Data Goes Digital
Digital vs. Paper-Based Data

- People are getting more connected
- Through Internet or local area networks
- Digital data instead of paper-based data
Product Related Data

- Initial brainstorming – ideation phase
- Artistic design sketches
- Blueprints
- Assembly drawings
- Manufacturing plans
- Assembly manuals
- Service and maintenance documents
- Cost estimations…
Blueprints

• Type of
  – paper-based reproduction usually
  – of a technical drawing

• documenting
  – an architecture or
  – an engineering design

• The term "blueprint"
  – the visual aspects of prints
  – contact printing process of cyanotype
Computer-Aided Design Drawings

- More recently, designs created using Computer-Aided Design techniques may be transferred as a digital file directly to:
  - computer printer
  - plotter

- In some applications paper is avoided, work and analysis is done:
  - directly from digital displays
Digital Product Related Data

- Part and Assembly Modeling
- Surface Creation & Editing Tools
- 2D/3D Drafting & Detailing
- Photo-realistic Rendering (Materials, Environment)
- Display and Visualization
- Camera-based Animation
- Import/Export
- Object and Group Properties
  - Material
  - Center of Gravity
  - Volume
  - Weight
  - Density
  - Moments of Inertia
Cost vs. the Whole Product Lifecycle

- It is not just the COST that matters
- Changes in the whole product lifecycle should be considered not just the adjustments related to
  - savings
  - increasing productivity
  - cut of the production expenses

ITEA Standards for Technological Literacy

Design Process
Implementing Changes

• Product structure can be complex
• Hard to implement changes which
  – affect production
  – need lot of time
  – recourses
  – finances
Product Changes Constantly

- Designing a product
  - for manufacturability & assembly
  involves collaboration among various engineers
  needs to be documented
Sharing the Data

- Information needs to be accurate
- Faster than it was before “digital era”
Information Mirroring Model

Manufacturing Processes

- from row material to final product (mechanical part)

Supported by CAD/CAM/CAE


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