

Syllabus & Course Schedule

Part I - The Technology of Making

Wednesday January 17

Introduction and Conceptual Foundation

- *ar-chi-tect* and *tech-nol-o-gy*
- Technology Transfer
 - Geddes, Mumford, Jordan - *Technics*
 - Eliel and Eero Saarinen
- Tools, Craft, and Industrial Modernism
 - *Machine, Tool, and "Machine-Tool"*
- Craft by Machine
 - Can craft be achieved through machine description as effectively, innovatively, and creatively as by hand?
 - Does today's "Machine" reveal a new approach toward craft, using technology and a designer's sensibility on Numeric Control?

Concepts in Numerical Control

- Geometry and vectors
- Parametric description
- Cartesian geometry, 2-, 3-, and 5- axis motion, degrees of freedom
- Tooling, Process, and Control
- Types of CNC

- Readings:
- *The Art and Craft of the Machine* - Frank Lloyd Wright [toolkit]
 - *Machines, Utilities, and "The Machine"*, Technics and Civilization, Lewis Mumford, p.9-12 [toolkit]
 - *Constructing the Future* – Nixon, Kaplicky (Future Systems) [toolkit]

Monday January 22

2-Axis CNC - the Laser Cutter – hands on lab introduction

Discussion of laser technology, materials, techniques, tolerances, diffusion, specificity, Software geometric control, software laser (color/line) control, maintenance, safety

Assignment: **Project 1 - Explore 2-axis laser control.**

- Readings:
- ARO Shure Studio book, December 2001 [CNC lab]
 - Universal Systems Laser Cutter manual (reference) [CNC lab]

Wednesday January 24

Numeric Machines / CNC in the manufacturing industries

- The first automated fabrication machine - 1725
- Henry Ford and the Model-T
- Modern Techniques - cutting, carving, turning, molds/casting, stretch-forming
- Rapid Prototyping technology - 3D printers, Stereo Lithography, FDM
- Industrial Design and Production Modeling
- Robotics in manufacturing and building construction
- CAD, CAM, CAE, CIM

Assignment: *Research an article on any NC technique and something made with it. Bring it to the next class for discussion.*

Monday January 29

Discussion: NC Technology; Articles presentation.

Wednesday January 31

Project 1 (Laser) due in class - presentations and discussion

Monday February 5

Rapid Prototyping, 3D Printing & Additive 3-D Modeling – hands-on introduction

Discussion of additive three-dimensional construction using 3-D printing / RP technology; FDM technology; Visual Model vs. Functional Prototype; Object Topology and STL processing; Settings and Software control; Model Detail control.

Assignment: **Project 2 - Explore Additive 3D Modeling / 3D Printing**

Readings:

- *Learning from the Product Makers*, Patrick Mays, Architecture 3/99, p.132-4 [Toolkit] [FA-Periodicals: NA1.A326]
- Techniques in CNC articles collection (skim) [CNC lab]

Wednesday February 7

Lab: Hands-on work with the Dimension 3-D Printer and software.

Monday February 12

"Describe and Make" – Tour the Physics Technical Services Facility

- NC milling and lathing
- Direct description - onboard NC

Wednesday February 14

Project 2 (Additive 3D / Printing) due in class - presentations and discussion

Monday February 19

3-Axis CNC – the Mill and Router – hands-on introduction

Discussion of Machine-Tools. Tools and bits; Feeds and speeds; Axes and machine control; G & M codes; Post-processors; CNC programming; 2-axis/3-axis paradigms; speculation on 5- and 6- axis systems. Maintenance. Safety.

Assignment: **Project 3 - Explore 3-Axis description**

Readings:

- The Machinery's Handbook (reference) [CNC lab]
- CNC Programming Handbook (reference) [CNC lab]

Wednesday February 21

CAD / CAM software – Introduction and Lab

- Solid and Surface Modeling, Features and Parametrics
- Creating and translating 3-dimensional object descriptions
- Modeling Process rather than Geometry

Monday February 26

Lab: Hands-on work with the Router and Mill. In-Lab Exercise.

Wednesday February 28

Lab: More work with CAM software and advanced 3D Translating and fabricating complex 3-D conditions.

March 3-11 – Spring Recess

Monday March 12

Tools, Materials, and NC Code - more details on CNC machining.

Wednesday March 14

Project 3 (3-axis description) due in class - presentations and discussion

Part II - The Art of Making

Monday March 19

Tools, Fabrication, and Design

- Tools and the Architect
- The English Arts & Crafts movement
- The Bauhaus, Industrialization, and early Modernism

Assignment: **Project 4 – Describe and make a well-known design detail**

Readings:

- *On the Origins of the Bauhaus*, Bauhaus, Magdalena Droste [toolkit]
- *Responses to Machines, Building Systems, Industrialization, and Architecture*, J. Russel, ch.3, p 69-77 [toolkit]

Wednesday March 21

Form and Shape – Constructing Architectural Surface Topologies

- Architectures of Curves - Asymptote, office dA, UN Studio, ...
- Surface – Form and concept.
- Constructing Surface.
- 3-D scanning & digitizing technology.

Readings:

- *Computer-Aided Gothic - New tools replicate stone ornamentation for New York's Jewish Museum addition*, Architecture, 11/93, p.123-7 [NA1.A326]
- *Computer Aided Manufacturing of Custom Landscape Elements - The William Smith Clark Memorial*, Landscape Architecture, 3/94 [SB469.L3]
- *The Computer School*, Architecture, 9/00 p. 93-107 [NA1.A326]
- *Harvard GSD Offices*, Architecture, 9/01 p.117-119 [NA1.A326]

Monday March 26

Complexity and Control - Frank Gehry's office

- Idea to reality - How Bilbao was built
- Data Processing Architectural Design: Jim Glymph lecture, Spring 2001
- Catia software system / Digital Project - Databases of description

Assignment: **Semester Project – Design a prototype part, process, or system**
Part 1 – Define your research

Readings:

- Frank O. Gehry, Guggenheim Museum Bilbao, Coosje Van Bruggen, 1997, [“The concept of a snake”...] pp. 40-57, and *Appendix I & II*, pp. 135-141 [N 3213.B78 1997] [Toolkit]
- *Building Bilbao*, Architectural Review, Annette LeCuyer, 12/97, p.43-45 [NA1.A67]
- *Precisely Loose: On Disney Hall and the Technology of the Curtain*, Paolo Tombesi, Ume, 2005, no. 19, pp. 12-17. [Toolkit]
- *The Commoner's Catia*, Katie Gerfen, Architecture, vol. 93, no. 12, Dec 2004 pp. 100-101 [Toolkit]

Wednesday March 28

Constructing Process – SHoP Architects | Erik Demaine

- Discussion:
- Art, Industrialization, and Computation
 - Design Intelligence: The shop in SHoP Architects
 - Computational Origami – the art and science of folding
 - Design Economy.

- Readings:
- *Folding Landscapes – defining a new landscape of surface?*, Gray, Christopher D., Landscape –The Journal of the Landscape Institute, June 2004. [Toolkit]
 - *Practice Profile SHoP Sharples, Holden Pasquarelli*, Craig Kellog, Architectural Design, vol. 71, no. 6, pp. 101-107, Nov 2001. [Toolkit]
 - *Design Intelligence: Or Thinking After the End of Metaphysics*, Michael Speaks, Architectural design, vol. 72, no. 5, pp. 4-6, Sept 2002 [Toolkit]

Monday April 2

Tour of Piedmont Metal Fabricators - Louisa, Va. (tentative date)

- Large-scale CNC laser, brake, and punch; Metalwork design and fabrication

Wednesday April 4

Project 4 (Design Detail) due – Presentations and Discussion

Students also present initial research ideas for semester project

Monday April 9

Systems, Kits of Parts, and Numeric Control

- The philosophy of *LEGO™*
- The American-System Ready Cut and General Panel Systems
- Le Corbusier and the Modulor
- Furniture systems and mass-produced housing
- Construction systems innovation – MasterFit, others.

Assignment: Semester Project Part 2 - Produce a Fabrication Prototype

- Readings:
- *Office Revolution - a new furniture system by Asymptote, Architecture*, 7/01, p.94-101 [NA1.A326] [Toolkit]
 - *Home Work - the House_n project*, Sara Hart, *Architecture*, 9/99, p.133-7 [NA1.A326]
 - *Cosmos: The First Open System for Housing*, *Architectural & Engineering News*, 5/69, p.37-40 [Toolkit]

Wednesday April 11

Mass Customization and Small Variations – Numeric Control enters Design

- Consumer products manufacturing
- Variable Form – ShoP Architects
- Gehry revisited - the “fish and snake” idea
- Gregg Lynn and the Blob - algorithmic and numeric descriptors
- Introduction to Parametric thinking

- Readings:
- *We are all prosumers now*, *Blueprint*, 1/98, p. 26-7 [NA1.B37] [Toolkit]
 - *The Smart Hands of Helga Jongerius*, *Metropolis*, 7/02, p. 109-13, 157-8 [N 6535 .N5 M47] [Toolkit]
 - *Building a Better Blob*, Joseph Giovanni, *Architecture*, 9/00, p. 126-9
 - *Gregg Lynn Form*, *Architecture*, 9/00, p.99 [NA1.A326]

Part III - Innovations / Inventions

Monday April 16

Advanced Parametrics and Generative Modeling Paradigms (lab)

- Computational (process) description
- Dynamic, Constraints-Driven (Dimension-Driven) description
- Bentley Generative Components™ architectural modeling software
- Parametric Modeling and Fabrication
- Value Engineering design (how technology helps manage cost)

Wednesday April 18

Field Trip – Tectonics Design (or other) – tentative

- Date and location TBD depending on scheduling.

Monday April 23

Preliminary Review of Semester Prototypes

- Innovations on geometry and fabrication
- Algorithms, parametrics and generating form
- Material response and manipulation
- Process and system

Final Assignment: Fabricate your Final Result

Wednesday April 25

More Parametric Modeling and Fabrication

- Applications of parametric technology
- Case study examples
- Student problems application

Monday April 30

Wrap-up and Conclusions

Finals Week Thursday, May 3 - Friday, May 11:

Final Presentation / Review of Semester Projects

- Date and location TBD