California College of Art, San Francisco
Interaction Design (IxD), MDes Program

Systems Design Studio, IXDGR 6400-1
Syllabus, 2026 Spring, (v1, January 17)
http://www.dubberly.com/courses/systems_2026_spring/

More info: http://systems.dubberly.com/
https://courses.dubberly.com/systems_2024_spring/systems-core-models-231115.pdf

Meets Tuesdays, in the Hooper Graduate Center, room GC20-C
- 3:30 - 4:20 pm, Discuss readings; lecture on models of the week
  4:20 - 4:30 pm, break
- 4:30 - 5:20 pm, In-class exercise of the week; review assignment
  5:20 - 6:30 pm, break
- 6:30 - 6:20 pm, Case study (research and modeling)

Faculty: Hugh Dubberly, email: hugh@dubberly.com

Course Description

This studio course introduces grad students to the basic language and frameworks of systems design, in the context of interaction.

A system is a set of elements that someone sees as related — organized in some way (i.e., creating patterns of behavior) often with a purpose, perhaps with unpredictable results.

The Future of Design Education Initiative reported,

> "Every day, our world seems to grow more complex. Creating better ways of being in the world, that is, designing responsibly, requires understanding systems—natural, social, and technical—and their interplay. Understanding systems is essential when intervening in ecological, economic, and political issues. Understanding systems is also increasingly necessary in designing better products and services. It frames a new approach to design practice that has been emerging for years."

Objectives

Students will learn to
- Understand systems—recognize common system structures and use them to model a specific situation
- Represent systems—build models of systems and use the models to inform design of interfaces, services, and platforms
- Design systems—use common system structures to identify breakdowns, diagnose problems, and generate improvements

Requirements

Attendance is required for all class meetings. Students must construct a Figma site for their work, and they must post assignments before each class. Being late to class or late posting work will affect grades.

Grading

Weekly assignments will be graded plus/check/minus.
Assignments receiving a minus must be revised.
The overall course grade will be calculated as follows:
- In-class participation counts for 20%.
- Weekly assignments together count for a total of 20%; final web site with all assignments counts for 20%.
- Preparatory sketches for final project count for 20%; final project counts for 20%.

In-class participation is affected by contributing to discussion and critiques; missed readings and lack of preparation are self-evident. Participation will be summed and can shift the overall grade by one letter. No incomplete will be given except in extenuating and unforeseen circumstances, and you must have already completed a substantial portion of the course, with passing grades. Grade scale:
A = Outstanding achievement, A– = Less so
B = Good achievement, B+ = More so, B– = Less so
C = Satisfactory achievement, C+ = A little better, C– = A little worse
D = Poor achievement, D+ = Less so, D– = More so
F = Failure to meet course requirements

Please note: This syllabus is a living document.
Some details may change over the semester.

###

Weekly Schedule

1	T	01/20	Introduction, Concept Maps + Models
2	T	01/27	Levels of systems, Scale + Pace
3	T	02/03	User Conceptual Models, Interaction, Counting Systems
4	T	02/10	Information, Transforms, Communications, Stacks
5	T	02/17	Variation + evolution, Information Structures
6	T	02/24	Systems of Rules, Evolution, Design Systems
7	T	03/03	Open-loop (transform function), Measure, Transduce, Monitor
8	T	03/10	Systems Dynamics, Stocks + flows, Dyn. Equ., CLDs
9	T	03/17	Control, Modeling Feedback
	T	03/24	Spring Break (03/21-03/29)
10	T	03/31	Learning, Conversation, Analogy + Distinction
11	T	04/07	Digital Twins, Feedforward, Autonomy
12	T	04/14	Final Project: Current State Model
13	T	04/21	Final Project: Proposed Future State Model
14	T	04/28	Final Project: Prototype of Future State
15	T	05/05	Final Project: Summary Presentation (last class meeting)
	T	05/12	Revisions + web site due (no class meeting)
	F	05/15	Grades due

###

Reading Schedule

1	T	01/20	Novak+Gowin, “Learning How to Learn”
2	T	01/27	Boulding, “General Systems Theory—The Skeleton of Science”
3	T	02/03	Johnson+Henderson, “Conceptual Models in a Nutshell”
4	T	02/10	Shannon + Weaver, “A Mathematical Theory of Communication”
5	T	02/17	Bush, “As We May Think”
6	T	02/24	Licklider+Taylor, “The Computer as a Communications Device”
7	T	03/03	Kay, “A Personal Computer for Children of All Ages”
8	T	03/10	Meadows, *Thinking in Systems,* Chapter 1: The Basics
9	T	03/17	Pask, “The Architectural Relevance of Cybernetics”
	T	03/24	Spring Break (03/21-03/29)
10	T	03/31	Morozov, “The Planning Machine: Project Cybersyn…”
11	T	04/07	Porter, “Smart, Connected Products”
12	T	04/14	None
13	T	04/21	None
14	T	04/28	None
15	T	05/05	None (last class meeting)
	T	05/12	
	F	05/15	

###

Assignment for each week: Weekly reading concept maps

For *each* weekly reading, create a concept map —
describing the key ideas in the reading.

Start by reading the text;
highlight key ideas;
make a list of terms to include;
and build a structure linking the terms.
Be sure to label all the links.

Some readings feature clear models.
Make sure to include any key models in your diagram.
You may also include key passages from the readings;
be sure to use quote marks and include a citation

Include your name, date, the title of the reading and its author or authors.
Also include a headline for your concept map, in the form of a sentence.
The headline should summarize the point of the reading as you see it.

Format: 11x17 inches.

Save all your weekly maps!
You will need them for a final project — a booklet collecting all your maps.

Suggestions:
- Keep it neat, but don't obsess over the form; the content is what's important.
- Adobe Illustrator is a good tool, but other drawing tools may be used.
- Paint programs, such as Photoshop, are *not* the right tools.
- Plan to spend 1-2 hours on each reading and 1 - 2 hours on each map.

Due:
Each Tuesday, bring a printed version of your concept map to class.

Infrastructure

Create a "website" to host your work for this class — in a Figma page.
Think of it as a 'zoomable information space;' design it so that the information hierarchy is clear from 'zoomed out' and progressively revealed as you 'zoom in.'
Your space could be a matrix of 4 rows x 15 weeks, with a row for 1) readings, 2) main assignments, 3) notes + models from class, and 4) weekly research.
Each week should have a 'frame' in each row; fill in blank 'frames' each week.

Also, create GitHub and GPT accounts.

###

Assignment for week 1 — Due: Tuesday, January 20,
Introduction

Readings:
Learning How To Learn, Chapter 1, by Novak and Gowin
https://courses.dubberly.com/design_theory_2017/01._a_Learning_How_To_Learn.pdf

for a summary of how to make a concept map, see...
https://www.dubberly.com/wp-content/uploads/2010/03/ddo_creating_concept_maps.pdf

for some example concept maps used in design, also see...
https://presentations.dubberly.com/concept_maps.pdf

Assignment:
Make a concept map of "systems" as you understand them.
This is your first homework assignment, and it is due at the start of class on the 20th.
Please do not stress over this assignment. It's simply to set a baseline.
There is no grade, but you will want to complete it, so that you can share and get feedback.

Format:
11x17-inch sheet; landscape (horizontal); if you need more space, add plates.

Be sure to include a title in the upper left and your name and the date in the lower left.
Check spelling.
Keep the typography simple, e.g., Helvetica U&LC, 20 pt head (bold), 10/12 body (reg).
Either work in Adobe Illustrator or Figma.

Also, bring printed versions to class.

###

Assignment for week 2 — Due: Tuesday, January 27,
Levels of systems

Readings:
Boulding, K., "General Systems Theory—The Skeleton of Science"
https://www.panarchy.org/boulding/systems.1956.html

"Pace Layers," Sterling, B.,
https://courses.dubberly.com/frameworks_2024_spring/Pace_Layers_Bruce_Sterling.pdf

Create a concept map of the key ideas and models for each article, each on its own page.
Extra credit if you find another framework for classifying systems.

For fun: "How Buildings Learn," Brand, S.
https://courses.dubberly.com/frameworks_2024_spring/How_Buildings_Learn_Stewart_Brand.pdf

Exercise:
Consider Figma in relation to the readings by Boulding and Sterling.
- In what ways does Figma embody different scales?
- In what ways does Figma embody different paces?

Think through models for scale and pace in Figma and map them;
i.e., create two diagrams.

For example, Figma files support variables, styles, components, variants, instances, etc., as well as design tokens, design libraries and UI kits; also, orgs, teams, projects, files, pages, demos, and frames — and more. What are their relationships? How are they nested or contained?

Or consider Figma's many subscription plans.

Also, in what ways does Figma address fashion, business, infrastructure, and governance?

There is no 'right' answer, but some answers are better than others, i.e., more useful and more aligned with observations. Consider how you would explain and defend your answer.

Format:
11x17-inch sheet; landscape (horizontal); if you need more space, add plates.
Be sure to include a title, your name, and the date. Check spelling.
Keep the typography simple, e.g., Helvetica U&LC, 20 pt head (bold), 10/12 body (reg).
Either work in Figma or upload to your space. Also, bring printed versions to class.

###

Assignment for week 3 — Due: Tuesday, February 3
Counting Systems

Readings:
"Conceptual Models in a Nutshell." http://rivcons.com/wp-content/uploads/2015/07/Conceptual-Models-in-a-Nutshell-«-Boxes-and-Arrows.pdf
Create a concept map of the key ideas and models.

See also: "Conceptual Models: Core to Good Design"
https://www.youtube.com/watch?v=i_DWYYZD31w&noredirect=1

Exercise:
Animate every combination of segments in a 7-segment LCD digital numeric display.
Each segment can be on (1) or off (0), creating 128 possible combinations of off + on.
Each combination is represented by a base 2 number, i.e., 000 0000 to 111 1111.
List the numbers 0 to 127 (in base 2) to create a "display list" to drive the animation.

Then create a second animation displaying the segmented numerals from 0 to 9.
For this, you will need to create a second display list (with only 10 lines).

In Adobe Illustrator or a similar app, draw a 7-segment grid for your numerals.
Each segment should be a filled polygon shape (not a line and not a rectangle).
Use the art board tool to shrink the art board to fit snugly around your configuration.
Save your file in SVG format.

Download http://www.dubberly.com/courses/systems_2017_fall/Hexagon.zip
It includes 3 files: index.html, main.js, and main.css — you will edit these.
First, open a modern browser; drag index.html into the window to play the animation.

Set-up a text editor, such as Text Wrangler. (Text Edit and MS Word won't work.)
In a text editor, open your SVG file; copy the "polygon" information.
Open the index.html file; delete the lines that begin with "polygon".
In the same place, paste in your seven lines of new polygon data.
Likewise update the "viewbox" data in index.html with your new data.
Save your file. Drag the index file into your window; your animation should run.
If the polygons display out of order, re-arrange them in the index.html file.

Re-order your display list to create a second animation.
In a text editor, open the main.css file, find a string of binary numbers from 0 to 63.
Edit that list to create a new sequence; save your file; and play it.
Put both animations on your web site; if necessary, link to a new page.

Diagram how your second animation "works". How are the "data" stored?
What does the "user" see? What transformations link the two?

###

Assignment for week 4 — Due: Tuesday, February 10
Communications Systems

Reading
Shannon + Weaver, "A Mathematical Theory of Communication."
http://www.dubberly.com/courses/design_theory_2016/03._a_Shannon.pdf

Create a concept map of the key ideas and models.

Exercise
Design and make a system capable of sending a message across the classroom without using traditional text or speech.

Design a new code that can transmit any English text message.
(You cannot use existing codes, such as Morse.)

Find a partner from the class; together co-create your system + code. Test!

Document your code on an 11 x 17 page (horizontal format).
This will be your code table.

With your partner, practice sending and receiving messages using your code.
We will run a "test" during class; test messages will be about 20 characters.

Develop strategies to ensure messages are accurately received.

How could a message be made more "secure"?

Create a diagram of how message transmission by telegraph works.
Consider the actors, objects, processes, and transformations.
Map the "layers" or "stack" required in a transmission.

Format: 11 x 17 inches; landscape (horizontal format).
Be sure to add a title and your name to both sheets.
Post to your web site.

###

Assignment for week 5 — Due: Tuesday, February 17
Application Data Model

Reading:
Vannevar Bush, "As We May Think," *Atlantic Monthly,* July, 1945.
https://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/
Create a concept map of the key ideas and models.

Exercise:
Create a diagram explaining how a desktop application "works":
- How are the "data" stored? What is the "shape" of the data?
- What intermediary forms do the data take (if any)?
- What does the "user" see?
- What transformations link the stored data to what the user sees?

Choose any application that is focused on one data type, such as word processor, spreadsheet, paint program, object-oriented drawing program, sound editing app.

Imagine your audience is a bright fifth grader (a ten-year-old).

Create an example data set (or file); keep it as simple as possible;
include enough detail to convey the basic function of the app.
In addition, describe what an empty data set looks like.

Create a representation of your example data set at each "levels" of the system.
Show at least three levels and how they map to each other.
- Data as displayed
- Conceptual or high-level data format behind what the user sees
- Any intermediate levels, such as hex
- Binary

Describe and show how data is created (input), selected, and updated (changed).
What key tools are involved?

Include your name, a title, captions, and brief explanations as needed.
Consider content, writing, and typography.
Format: 11 x 17 inches; landscape (horizontal format).
Post to your web site.

###

Assignment for week 6 — Due: Tuesday, February 24
Design Systems: Styles, Templates, and Structured Documents

Reading:
Licklider + Taylor (1968), "The Computer as a Communications Device."
http://worrydream.com/refs/Licklider%20-%20The%20Computer%20as%20Communication%20Device.pdf
Create a concept map of the key ideas and models.

Exercise:
Part 1: Document a Design System
Analyze Vignelli's *Audubon Field Guides* to understand them as a (design) system.
- Identify key page types, e.g., text, silhouette, photo, species, family, glossary, index, etc.
- Snap a photo of a representative example of each page type
  and place the photos in a workspace (in Illustrator or Figma) and scale to actual size.
- Create a full-scale template for each page type and add callouts for specifications.
- Use the template as a basis for recreating the page in the photo, creating an example.
- Bring together your photos, templates, & examples in a Design System poster.
  Your audience is a designer; provide the information they need to create a new guide.
  Print scaled to fit 11x17.

For the templates, deconstruct each page type into its constituent parts:
- List the elements included, e.g., folios, headers, body text, call-outs, images, keys, etc.
- Identify any constraints on an element, e.g., maximum or minimum size or length)
- Define the styles, e.g., font family, style, size, leading, color, etc.
- Draw the underlying grid, including dimensions, and add specifications.
  Hint: There's a base grid under all the page types, so: be sure to reuse.
  Do *not* invent each page from scratch; copy and paste as much as possible.

Part 2: Describe a Navigation System
How do the Guides help readers navigate the contents?
- What are the key scenarios of use?
- Identify 3 paths through the book, e.g., silhouette to photo to species.
- Document those paths with photos (or your example pages).
- Place the paths (scaled) into a single 11x17 sheet with labels etc.

Include your name, a title, captions, etc.
Consider content, writing, and typography.
Format: 11 x 17 inches; landscape (horizontal format).
Bring prints to class and post on your web site (or provide links).

###

Assignment for week 7 — Due: Tuesday, March 3
Design Libraries: Components and Content Management Systems

Reading:
Kay, Alan (1972), "A Personal Computer for Children of All Ages."
https://mprove.de/diplom/gui/Kay72a.pdf
Create a concept map of the key ideas and models.

Exercise:
Part 1
Refer to your work from last week (the Vignelli Guide Design System Poster).

Using Figma, build a collection of components (a design library),
based on the specifications that you developed last week.
Use the components to create template pages.

Use the template pages to recreate your example pages in Figma;
be sure to use linked components and variations.
(Keep the components connected; don't disconnect them!)

Finally, build a clickable prototype (hot links), showing your favorite user path:
e.g., see a live creature, look-up the silhouette, find the plate, go to the species page,
and add a check mark on the index page.

Create a map (of screenshots) showing all the pieces you made
and scale the map to 11x17 and print; include a URL to the Figma file.

For extra credit, set-up the components and template pages (your library)
so that you can switch to "dark mode" with a single click.

Part 2: User Conceptual Model
The Audubon Field Guides are products.
Make a model describing what users need to know to use the guides successfully.

For extra credit, make a model of a Content Management System (CMS)
which might publish guides through your templates.

Include your name, a title, captions, and brief explanations as needed.
Consider content, writing, and typography.
Format: 11 x 17 inches; landscape (horizontal format).
Post to your web site.

###

Assignment for week 8 — Due: Tuesday, March 10
Information Structures: Interactive Models

Reading:
Meadows, D., *Thinking in Systems,* Chapter 1: The Basics
Create a concept map of the key ideas and models.

Exercise:
Represent a family (yours or a different one), going back to great grandparents.
Include first + last name, dates of birth + death, location, portrait, connections.
A person is a "node;" each "node" will be a "slide" or "card" or "page".
Create three interactive structures with connections as hyperlinks:

Family List
Create an index or directory slide listing everyone alphabetically.
(Extra credit for enabling alternate orderings of the list, e.g., sorting by birthday.)
Link to a "Rolodex" with a slide for each family member; enable page linking.

Family Timeline
Create a slide sequence of births and deaths starting from today, going backwards.
Users should also be able to navigate forwards in time. Add a summary page.

Family Tree
Start with yourself (your slide); link to each of your parents; link to their parents; and so forth. Links should be "bi-directional," e.g., users need a way to get back to you from your parents. Your "system" should be extensible for many more generations.
You may want to consider marriages as nodes (single slides or pages etc.).

Include a title slide with your name and a TOC.
Use transitions (animations) between slides to enhance navigation.
Keep your typography and layout simple.
Illustrations are fine in lieu of photos; however, this is not an illustration assignment.

Format: You may use Keynote, PowerPoint, Prezi, InVision, FramerX, or similar apps, or you may code in HTML/CSS/JS.
Post your file or a link to it on your web site.

(Extra credit for integrating the structures more deeply;
for example, can you have just one "slide" per person? (instead of three)
Or can you drive the whole system out of a database?)

###

Assignment for week 9 — Due: Tuesday, March 17
Dynamic Systems: Modeling Stocks and Flows

Reading:
Pask, Gordon (1969) "The Architectural Relevance of Cybernetics"
http://www.dubberly.com/courses/design_theory_2017/10._a_Pask_Cybernetics.pdf
Create a concept map of the key ideas and models.

Exercise:
Watch the BBC short documentary on re-introducing wolves to Yellowstone.
http://www.bbc.com/future/story/20140128-how-wolves-saved-a-famous-park

Part 1 — Represent the ecosystem as stocks and flows (a causal-loop diagram or CLD).
The diagram should explain two states:
1) wolves exterminated and 2) wolves re-introduced.

Consider:
- Who are the main actors? i.e., animals, plants, and other elements of the ecosystem
- How are the actors related? i.e., as stocks and flows (nodes and links)
- How do the actors affect one another? i.e., increasing A increases B (+), a positive function; or increasing A decreases B (–), an inverse function

Part 2 — Building on Part 1, develop a concept for an interactive artifact, such as a game or simulation, that would introduce the idea of ecosystem relationships (and the role of apex predators) to fifth graders (10-year-old students).
You can illustrate your concept with a diagram indicating interaction with two or three screens. Show what users see, what they can do, and the results of their actions.

Could also be a working prototype,
but the goal is to illustrate a concept, not make a complete app.

For both Part 1 and Part 2…
Format: 11 x 17 inches; landscape (horizontal format).

Be sure to add a title and your name.
Print and post to your web site.

###

March 24 is Spring Break — no class meeting

###

Assignment for week 10 — Due: Tuesday, March 31
Automatic Control Systems: Modeling Feedback

Reading:
Morozov, Evgeny (2014), "The Planning Machine: Project Cybersyn… Big Data…"
https://www.newyorker.com/magazine/2014/10/13/planning-machine

Create a concept map of the key ideas and models.

Exercise:
Identify a system that includes automatic feedback.
- The system should automatically close the feedback loop (without human input).
- Do not use a thermostat as your example.

Create a realistic illustration of the system and its operation, e.g, a photo.
- Identify the specific components of the system (the mechanism) and their functions (e.g., lever, height indicator).
- Label the components in cybernetic terms (e.g., significant variable, goal, sensor, comparator, actuator, disturbances).

Create a diagram of the system, "abstracted" in terms of feedback.
- Include all the components of the feedback loop (e.g., significant variable, goal, sensor, comparator, actuator, disturbances).
- Represent the relationships between components visually.
- Label each cybernetic component and note the corresponding physical part.

Your diagram should help the audience answer these questions:
- What are the relevant components of the system?
- How is information transmitted between components? In what form?
- What is the goal (desired state) of the system? How is the goal set?
- What forces typically disturb the system or push it away from its goal?
- What does the system measure (to create feedback)? How?
- What part of the system matches feedback (current state) to goal (desired state)?
- How does the system respond to disturbances?

Format: 11 x 17 inches; landscape (horizontal format).
The illustration and diagram should be on the same page.
Bring prints to class, and post to your web site.

###

Assignment for week 11 — Due: Tuesday, April 7
User Conceptual Models: Home Thermostat

Reading:
Michael Porter, "How Smart, Connected Products Are Transforming Competition,"
https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

Create a concept map of the key ideas and models.

If you have time:
Michael Porter, "How Smart, Connected Products Are Transforming Companies,"
https://hbr.org/2015/10/how-smart-connected-products-are-transforming-companies

Final Exercise:
Select a chronic health condition, (an issue in which homeostasis breaks down)
e.g., arthritis, asthma, CAD, CHF, Crohn's, COPD, diabetes, HIV, hypertension, etc.

Imagine a new system to help restore homeostasis. Such a system might include:

Sensors that monitor body chemistry painlessly and connect to "the cloud".
Other cloud-connected devices that deliver therapies.
Consider other types of sensing, comparing, and acting (feedback).

How could such technology be integrated into people's lives to help them better manage chronic conditions? Design an integrated "product-service ecology".

Also, consider how machine learning, digital twins, and LLMs might contribute.
Propose how a multi-agent system might be integrated, e.g., a health coach that helps a patient use a closed-loop insulin management system (CGM, pump, app, + coach).

Find a subject matter expert (SME); they could be a patient, family member of a patient, or health-care provider.

For this week, write a short proposal or project brief (less than one page),
Including:
- The name of the chronic condition you selected
- A short description of the condition
- The significant variable to be brought into homeostasis
- A description of your proposed expert

###

Final Project — Due: Part 1, 04/14; Part 2, 04/21; Part 3, 04/28; Part 4, 05/05
Product-Service Ecology — Wellness

Part 1 — Model the current state — due 04/14
Interview your expert, and describe the breakdown in feedback.
Create a model of the condition and care — in terms of maintaining homeostasis.
What does the person measure? e.g., blood glucose, blood pressure, weight, etc.
How do they "manage" that variable? (lower or raise it?) What is the feedback loop?
Diagram the system; define the key elements (e.g., people, devices, medicine, etc.); show how the elements are related; and indicate pain points and opportunities.
Include doses and timing of medications, food, exercise, interactions with caregivers.

Part 2 — Model the future state — due 04/21
Propose a system (an ecology) to help the person better manage their wellbeing.
What elements are needed? How do they work together? How are they controlled?
How do components, services, and people connect? Outline key user tasks, create a user conceptual model of the system, and wireframes for control screens.
Include scenarios describing the patient interacting with an agent.

Part 3 — Prototype the future state — due 04/28
Create detailed mock-ups of key screens in the primary user task.
Annotate your mock-ups to show how the user interacts with the controls.
Place the screens in the context of a storyboard.
Create a draft presentation introducing the problem, "ecology", and controls.

Part 4 — Create a final presentation — due 05/05 (posted on web site)
Refine your work from parts 1, 2, and 3 and create a clear explanation and story.
Be sure to include a cover, introduction, process, solution, and your name.
Your "final deliverable" will be a presentation during the last class.

Format: 11 x 17 inches; landscape (horizontal format).
Post on your Figma site.

###

Required Readings

On Modeling

- Excerpts from Novak & Gowin, *Learning How to Learn*
http://www.dubberly.com/courses/design_theory_2016/01._a_Learning_How_To_Learn.pdf

- Dubberly, H., "Creating Concept Maps"
http://www.dubberly.com/courses/design_theory_2016/01._b_Creating_Concept_Maps.pdf

- Dubberly, H., "Models of Models"
http://www.dubberly.com/courses/design_theory_2016/01._c_Models_of_Models.pdf

On Systems Theory

- Boulding, K., "General Systems Theory—The Skeleton of Science"
https://www.panarchy.org/boulding/systems.1956.html

- Joi Ito, "Design and Science," http://www.pubpub.org/pub/designandscience

- Michael Porter, "How Smart, Connected Products Are Transforming Competition,"
https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

- Capra, F., and Luisi, P. L., *The Systems View of Life: A Unifying Vision,* Cambridge University Press, Cambridge, 2014.

- Meadows, D., *Thinking in Systems,* Chelsea Green, 2008.
Chapter 1: The Basics

- Shannon, C., "A Theory of Communications," 1964, pages 31-35.
http://www.dubberly.com/courses/design_theory_2016/03._a_Shannon.pdf

- Ashby, W. R., *An Introduction to Cybernetics,* Chapman and Hall, 1957.
Chapter 1: What Is New, and Chapter 11: Requisite Variety.
http://pespmc1.vub.ac.be/books/introcyb.pdf

- Glanville, R., "Second-order Cybernetics,"
http://www.facstaff.bucknell.edu/jvt002/brainmind/Readings/SecondOrderCybernetics.pdf

- Pask, G., "The Architectural Relevance of Cybernetics," 1969.
http://www.dubberly.com/courses/design_theory_2017/10._a_Pask_Cybernetics.pdf

Suggested Additional Readings

On Systems and Design

- Gerstner, K., *Designing Programmes,* Hastings House, New York, 1964.

- Rittel, H., "On the Planning Crisis: Systems Analysis of the First and Second Generations," 1972. http://www.dubberly.com/courses/design_theory_2016/08._b_Rittel:_On_the_Planning_Crisis.pdf

- Haque, U., "On the Architectural Relevance of Gordon Pask," 2007. http://isites.harvard.edu/fs/docs/icb.topic983682.files/Week%2005/W05-2%20Usman%20Haque-%20The%20Architectural%20Relevance%20of%20Gordon%20Pask-.pdf

- Dubberly, Haque, & Pangaro, "What is Interaction?" 2009. http://www.dubberly.com/wp-content/uploads/2009/01/ddo_article_whatisinteraction.pdf

- Dubberly & Pangaro, "What is Conversation?" 2011 http://www.dubberly.com/wp-content/uploads/2009/07/ddo_article_whatisconversation.pdf

On Systems and Ethics

- Buchanan, R., "Design Ethics," 2005. http://www.dubberly.com/courses/design_theory_2016/03._b_Buchanan,%20Design%20Ethics.pdf

- von Foerster, H., "Ethics and Second-order Cybernetics," Stanford Humanities Review, Volume 4, Issue 2, 1995. http://dl.acm.org/citation.cfm?id=212248

- Maturana, H., "Meta-design," 1997. http://www.inteco.cl/articulos/006/texto_ing.htm

On the History of Systems Thinking

- Dubberly, H., "How cybernetics connects computing, counterculture, and design," 2015. http://www.dubberly.com/wp-content/uploads/2015/10/Cybernetics_and_Counterculture.pdf

Other readings:

Bonsiepe, G., “Interface an Approach To Design”, selected excerpts
http://www.dubberly.com/courses/systems_2017_fall/05._Bonsiepe.pdf

Yegge, Steven (2011), “Yegge’s Rant.” (On the need for platforms at Google)
https://plus.google.com/+RipRowan/posts/eVeouesvaVX

Lanchester, John (2017), “You are the product” (understanding Facebook)
https://www.lrb.co.uk/v39/n16/john-lanchester/you-are-the-product

“Analogy as the Core of Cognition,” by Douglas R. Hofstadter, (2009) 60 min.
https://www.youtube.com/watch?v=n8m7lFQ3njk&t=1s

Or you can read this text version:
“Analogy as the Core of Cognition,” by Douglas R. Hofstadter, (2001)
https://worrydream.com/refs/Hofstadter_2001_-_Analogy_as_the_Core_of_Cognition.pdf

“Models of Models,” by Hugh Dubberly
https://www.dubberly.com/wp-content/uploads/2009/03/ddo_article_modelsofmodels1.pdf

- Licklider, JCR (1960), "Man-Computer Symbiosis."

- Raymond, Eric (1997), "The Cathedral and the Bazaar."
http://www.unterstein.net/su/docs/CathBaz.pdf

- Andreesen, Mark (2007), "The Three Kinds of Platforms You Meet on the Internet."
http://pmarchive.com/three_kinds_of_platforms_you_meet_on_the_internet.html

- Davis, Meredith (2017) "AIGA Designer of 2025: Why Design Education Should Pay Attention to Trends," https://educators.aiga.org/wp-content/uploads/2017/08/DESIGNER-2025-SUMMARY.pdf

- WSJ *“Models will Run the World,” WSJ*

- Kissinger, Henry, “How the Enlightenment May End,” *The Atlantic,*

- Carr, Nicholas, “Is Google Making Us Stupid?” *The Atlantic,*

###

Primary Systems Models and Related Terms
What you should learn in this course.

Levels of Systems,
- static *frameworks*, simple dynamic *clockworks*, control *thermostats*, self-maintaining *cells*, simple societies *plants*, self-aware *animals*, conscious *humans*, organizations *living in language*, transcendent (Kenneth Boulding)
- static rules, dynamic, feedback, self-organizing, learning, conversation

Combinations and Permutations
- theme and variations; also state diagram, phase space
- counting in base 2, 3, and 16 (hex)
- cellular automata, recursion, fractals

Basic Information Structures + Criteria
- name-value pair, array, matrix, tree, web (graph)
- principle of least means (Ockham's razor); principle of consistency (form + content)
- necessary and sufficient
- MECE (mutually exclusive, collectively exhaustive)
- CIPU (clear if previously understood)

Systems Dynamics, from Donella Meadows
- dynamic equilibrium—stocks, flows, lag, source, sink
- process, transform functions—proportional, inverse, S-curve, hockey stick, long tail
- resource cycles, tragedy of the commons, leverage points
- open loop, closed loop

Communications, from Shannon
- sender, code, message, channel, noise, receiver, entropy

Control Mechanisms
- system, environment, boundary, homeostasis
- feedback loop—goal (set-point, threshold), action, measure
- mechanism—sensor, comparator, actuator (effector)
- essential variable, range, resolution, frequency,
- virtuous and vicious cycles
- explosion, collapse
- negative feedback, positive feedback: dampening or balancing, reinforcing
- current state, desired state
- error, detection, correction
- circular processes, circular causality

User Conceptual Model, from Jeff Johnson & Austin Henderson
- object, link, action, attribute

Bootstrapping, from Douglas Engelbart
- basic process, improving the process, improving improving

Platform, API, modularity, smart-connected product, product-service ecology

More Advanced Systems Models

Requisite Variety
- stability, invariant organization
- disturbances, responses

Second-order Systems
- goal-means trees
- observer, observed, controller, controlled

Co-evolution
- population, trait, variation, selection
- cost, advantage
- cooperation and competition as evolutionary mechanisms
- drift

Models of Learning, e.g., Nonaka

Models of Conversation, from Pask
constructivism
agreement, (mis-)understanding
"an agreement over an understanding"
bio-cost, bio-gain

Other Systems Thinking Vocabulary Terms

servo-mechanism, governor, hunting, oscillation, prediction
control, communication, structure, organization,
teleology, purpose, goal-directed, self-regulating, co-ordination, regulation

emergence, feed-forward, back-talk
first order, second order

dissipative systems, self-sustaining
autopoiesis, allopoetic systems
- structural coupling
  (Behavior is structurally determined—history, individualism, learning.)
- "consensual co-ordination of consensual co-ordination"
- "conservation of a manner of living"

black box
explanatory principle "organizational closure" self-reference, reflexive

ethical imperative, "generosity in design", "aesthetiquette"

pace layers

Deprecated Assignments
The following assignments will not be required this semester.

###

Assignment xx — Due: Tuesday, xx,
Visual Systems + Construction Sets

Exercise:
Choose an existing visual system (e.g., typeface, numbers, or Olympics icons, etc.)

Plate 1. Document the system:
- Identify major elements (components), name them, and represent them
- Describe rules for using or combining the components; illustrate the rules
- Show examples of the system in use

Plate 2. Design three additions to the system (e.g., new letters, numbers, or icons):
- Combine existing elements in new configurations
- Be sure they follow the spirit of the existing system
- Describe and represent each addition

For example, if you choose icons, make new ones following the rules of the system.
Or if you choose lower-case letters, make new letters out of the existing parts.
Pay attention to craft; design your plates so that they are clear and well organized.

Format for reading summary + exercises:
11x17-inch sheet; landscape (horizontal); if you need more space, add plates.
Be sure to add a title, your name, and the date to both sheets. Check spelling.
Keep the typography simple, e.g., Helvetica U&LC, 20 pt head (bold), 10/12 body (reg).
Either work in Figma or upload to your space. Also, bring printed versions to class.

###

Assignment xx — Due: Tuesday, xx
Templates / Structured Documents / Grid Systems + CMS

Reading:
Licklider & Taylor (1968), "The Computer as a Communications Device."
http://worrydream.com/refs/Licklider%20-%20The%20Computer%20as%20Communication%20Device.pdf
Create sketch notes or a concept map of the key ideas and models.

Please also read the *Vignelli Canon*. This is for you; no notes are required.
http://www.dubberly.com/courses/systems_2019_fall/CANON-7-2018.pdf

Exercise 1
Deconstruct Massimo Vignelli's design for the original Audubon Field Guides.
Make a diagram or "map" representing "the system" behind the guides.

Begin by cataloging all the page types:
- How many basic types are there?
- What's the "grid"?
- What information appears on each page type? (What are the content "widgets"?)
- How is each content widget constrained? (e.g., maximum size or length)
- What elements are reused?

Then catalog the content:
- How many "items" are included? (under each template)
- How are they classified? (what is the information structure?)
- How could the content be represented as a database?

Deliverable: Create a diagram or map explaining Vignelli's design system.

Finally: Turn the design system into a Figma Library.
- What components can be reused?
- How might components be nested? (i.e., use "slotted components")

For Fun
Download the free Audubon Bird Guide App, http://www.audubon.org/apps
Compare the app, website, and book. Consider how you might map the app.

###

Assignment xx — Due: Tuesday, xx
Design Systems: Grid Systems + CMS

Reading:
Kay, Alan (1972), "A Personal Computer for Children of All Ages."
https://mprove.de/diplom/gui/Kay72a.pdf
Create sketch notes or a concept map of the key ideas and models.

Exercise:
Refer back to the Audubon guides and the design system components that you developed last week; let's call that your component library.
Pull together your own version of the component library,
borrowing any missing elements from your classmates.

Then create a new file linked to the library — an "instance" for your specific guide.
And create at least one example page for each template in the library.
Lay out the pages in a clear and orderly way.
Provide annotations (specifications).
Add dimensions, annotations for typefaces, size, color, etc.

Consider these related ideas (theme and variation; type and token):
- library of components, divided into two parts: appearance and function
- appearance libraries (style sheets) can be brand libraries (multiple)
- each brand library may have a night mode
- functional components need variants, and may also need to be "slotted"
- components have a default smallest size, but also need to be made expandable,
  for different sized device screens (responsive design),
  which may have breakpoints with different organization
- may need to have variations for iOS and Android
- may also be other variations, such as large fonts
- internationalization and localization

All that is the set up:
- then you actually compose a book, magazine issue, or app out of the components
- but you have to do that in a careful + structured way
  so that the components can be changed globally, should the need arise later
- an "instance" is what we call a collection of screens,
  based on a set of components + a brand library)
- you also need to annotate the pages (screens) in the instance to make a specification
- the pages need to be laid out in an "architecture" with flows and signposts
- on top of that you can then drop in path arrows to build a demo
- all that can be hooked up to a database to make CMS (cf. Framer)
- eventually, Figima will add "tokens" so that you can do real development

###

Assignment xx — Due: Tuesday, xx
Dynamic Systems: Modeling Stocks and Flows

Reading:
Pask, Gordon (1969) "The Architectural Relevance of Cybernetics"
http://www.dubberly.com/courses/design_theory_2017/10._a_Pask_Cybernetics.pdf
Create sketch notes or a concept map of the key ideas and models.

Exercise:
Watch the BBC short documentary on re-introducing wolves to Yellowstone.
https://www.bbc.com/future/article/20140128-how-wolves-saved-a-famous-park

Part 1 — Create a concept map of the ecosystem described in the documentary:
- Who are the actors? i.e., animals, plants, and other elements of the ecosystem
- How are the actors related? i.e., describe the structure as nodes and links
- What actions do the actors take? i.e., how does actor A relate to actor B?
- What special properties do the actors have?

The concept map should include names of the actors (nodes),
and lines should be labeled to define relationships (links), e.g., ELK—eat—>GRASS.

Part 2 — Create a second diagram representing the ecosystem as stocks and flows.
See Donella Meadow's, *Thinking in Systems*.
How does one element (a stock) affect the quantities of others? (create a +/- flow)
Use the flows to organize your diagram—by showing relationships between stocks.
A first version should represent the stocks of each animal before wolves return.
A second version should represent the stocks of each animal after re-intro.
You could try the Loopy app found here … https://ncase.me/loopy/

Part 1 should be on one page.
Part 2 should be on a second page (with 2 versions of the stocks + flows diagram).
Be sure to add a title and your name.
Post to your web site.

Part 3 — Design an interactive version of your diagrams (a simulation) and create a "clickable prototype" demonstrating how a user might interact with the simulation.
The audience is students in grade 5 using an online educational app.
Illustrate how changing at least one stock change other stocks in the system:
- Student encounters the simulation. (What is its initial state?)
- Student realizes that simulation is interactive. (What indicates potential for action?)
- Student quadruples the number of wolves. (How do users provide input?)
- Student sees the number of elk decrease. (What is the resulting state?)
- Student halves the number of wolves. (What is the resulting state?)

###

Exercise:
Design a new user interface for thermostat; create 3 UI options.

To begin, create a diagram of a home HVAC system
- What are the physical components of the system? (artifacts, stocks, + flows)
- What are the information elements of the system? (information + feedback)

Create a "user conceptual model" of a thermostat that controls the system.
- What does the user need to know in order to successfully use the system?
- What "tasks" do users undertake when using it?
- What (data) "objects" do users encounter?
- What "actions" can users take on the objects?
- What "properties" do the objects have?
- What are the "relations" between the objects?

Write out a list of user tasks and create a table of objects, actions, and properties.
Your model should NOT include presentation issues or implementation issues.

Create 3 thermostat UI options (sets of displays and controls).
The physical form factor is up to you (e.g., 1.94 x 2.91 inches, touch screen is OK).
The 3 UI options should be as different as you can make them.

Your UI should map directly to your "user conceptual model".
Once you start designing your UI, you may find that you need to modify your model.

Create a mock-up of the displays and controls (what users see + change).
Specify how users will interact with the thermostat.

Format: 11 x 17 inches; landscape (horizontal format).
Post to your web site.

###

Exercise:
Describe the dimensions of the "space" of water faucets in a diagram.

Suggested process:
- Collect photos of at least 10 water faucets; place them in a photo grid plate.
- Consider each faucet in terms of interaction:
    What are the possible "states" of the faucet?
    What variables can users control?
    What is the range or possible settings for each variable?
    Are the variables discrete or continuous?
    How do users interact with (change) the variables?
    What are the possibilities for innovation?
- Create a separate plate with a diagram explaining the dimensions of the "space."

Format:
11x17-inch sheet; landscape (horizontal); if you need more space, add plates.
Be sure to include a title, your name, and the date. Check spelling.
Keep the typography simple, e.g., Helvetica U&LC, 20 pt head (bold), 10/12 body (reg).
Either work in Figma or upload to your space. Also, bring printed versions to class.

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