DTEQ: Digital Techniques of Urban Design

Columbia University GSAPP, Summer 2018

Course Description

DTEQ is a survey course of the digital tools, techniques, and workflows of contemporary urban design. It is a survey course that will introduce software platforms that students will continue to encounter and learn throughout the program including ArcGIS, Rhino, Grasshopper, and the Adobe Creative Suite. The course will meet weekly on Tuesdays from 4-6 in Avery 114. Outside of class, students are expected to do tutorials and submit assignments to Courseworks as they are due.

Learning How to Learn

Beyond an introduction to the software, this course is meant to develop a philosophy of self-directed learning. The capabilities of design software platforms are vast and complex, teaching every aspect of these feature-rich tools is infeasible in the confines of a single course, or even an entire program. In addition, designers, typically motivated by conditions specific to a site, seldomly use the same tool in the same way. Because of this, designers must equip themselves with the means to discover and develop their own techniques. Because of this, the coursework for DTEQ will largely be self-directed, following video and web tutorials. The final project for the class will require students to contribute a technique of their own invention to the collective knowledge base through the production of their own tutorial documentation.

The repository of tutorials contained in this syllabus, produced by the DTEQ teaching team, are only meant to introduce students to a software platform or workflow. They are by no means exhaustive, and should only be seen as a place to start. All DTEQ students should be prepared to search for and adapt other tutorials found on the web. This is a critical skill for the contemporary urban designer. Luckily we live in an age of abundant online documentation, and if you are experiencing trouble, it is likely that someone else has encountered the same problem, solved it, and posted a tutorial about it to Youtube, Vimeo, or GitHub.

Interoperability

In addition, the course will focus on “interoperability,” or how students can leverage multiple software platforms to produce ideas, spaces, and representations. Each assignment engages more than one software, and focuses on producing deliverables across many platforms. The use of multiple software platforms and representational media will allow students to address both material and immaterial design concerns confronting the contemporary city.

Course Goals

- Support the studio process and design thinking by cultivating a ‘workflow’ model of practice

- Enable students to use multiple software platforms to address particular design questions
- Enable students to learn at their own pace using self-directed tutorial documentation
- Platforms taught during DTEQ include: Rhino, Grasshopper, ArcGIS, 3DS Max, Photoshop, Illustrator, InDesign, V-Ray

Submitting Work

Assignment deliverables are to be submitted to Courseworks in the given format by the due date specified in the syllabus. When physical deliverables are asked for, they are expected to be laid out and printed onto a series of 11x17 sheets with titles and names printed in a corner in small type.

Course Conduct, Grades and Academic Policies

Students are expected to attend and participate in class and office hours, and will adhere to all [GSAPP Academic Policies.]

Instruction Team

Kyle Hovenkotter	Coordinator	-	klh2130@columbia.edu

Donovan Dunkley	Associate Instructor	-	donovan.dunkley@columbia.edu
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Andrew Heumann	Subject Matter Expert	Systems	adh2172@columbia.edu
Trevor Lamphier	Subject Matter Expert	Spaces	til2104@columbia.edu
Lindsey Wikstrom	Subject Matter Expert	Stories	lmw2167@columbia.edu

Course Schedule

June 05	4:00-6:00	Lecture	Sites	Avery 114
TBD	TBD	Office Hours	-	Studio
June 12	4:00-6:00	Lecture	Spaces	Avery 114
TBD	TBD	Office Hours	-	Studio
June 19	**4:00-6:00**	**Pinup**	**Sites**	**TBD**
TBD	TBD	Office Hours	-	Studio
June 26	4:00-6:00	Lecture	Systems 1	Avery 114
TBD	TBD	Office Hours	-	Studio
July 03	4:00-6:00	Lecture	Systems 2	Avery 114
TBD	TBD	Office Hours	-	Studio
July 10	4:00-6:00	Working Session	-	
July 17	4:00-6:00	Lecture	Stories 1	Avery 114
TBD	TBD	Office Hours	-	Studio
July 24	4:00-6:00	Lecture	Stories 2	Avery 114
TBD	TBD	Office Hours	-	Studio
July 31	4:00-6:00	Working Session	Stories	Studio
TBD	TBD	Office Hours	-	Studio
Aug 7	**4:00-6:00**	**Final Exhibition**	**-**	**TBD**

Assignment 1: Sites

Lecture/assigned: June 05 4-6pm

Due: June 19 4:00pm-6:00pm pinup

Grga Basic, gb2559@columbia.edu, Center for Spatial Research

Juan Francisco Saldarriaga, jfs2118@columbia.edu, Center for Spatial Research

Overview

The Sites assignment introduces mapping as a critical design practice, primarily through the use of Geospatial data visualization using ESRI's suite of mapping software: ArcMap, ArcScene, and ArcCatalog. Students will learn how to map both material and immaterial urban data, and begin to understand best practices of data analysis and representation. The assignment will also help students bring geospatial data into their design environments.

Tutorials

The Columbia Center for Spatial Research has a series of open source tutorials that cover basic techniques of critical mapping. Students should complete several introductory tutorials, and identify advanced tutorials that support research being done in studio projects.

Connect to the X drive
Creating a basic map in ArcMap
Downloading and displaying census data from American FactFinder
Data Types and 311 Data
Analyzing Data
Creating a 3D site model in GIS
Exporting 3D data and importing in Rhino and 3DS Max
Importing GIS data into Grasshopper
Other tutorials

Resources

Possible data sources
Other tutorials

Deliverables, pinned up in class on June 19 at 4pm, and to Courseworks

Working individually, produce two maps using ArcGIS, each at different scales that analyze or present an argument about an aspect of your site in studio. These maps should consist of base layers describing physical features, as well as analytical layers that symbolize other data. You should coordinate your maps with those of your group members so that together, your work can be read as a series that use GIS data to construct an argument or help discover something about your site. Fit your maps to 11x17 sheets.

- **Macro scale map** Make one map at either the city or borough scale. Compare conditions in your site to nearby neighborhoods or to the city at large. Use a qualitative data set like census or 311 data and use a spatial join with some other data to construct an argument.

- **Meso scale map** Make one map at the neighborhood scale. Test a symbology format other than graduated colors to represent the distribution of some data within the neighborhood.

3D massing model of site, 2 views

Working in your studio groups, make a comprehensive 3D massing model of existing buildings and other physical features such as streets, topography or orthoimagery and export it to Rhino. Each student is to produce 2 screenshots of the model, fit to a single 11x17 sheet.

- **Experiential view** Choose an interesting view from a human perspective of your site. Consider what information is being communicated and emphasized in the view.

- **Aerial view** Choose an interesting view of your site from above. Consider what information is being communicated and emphasized in the view.

Assignment 2: Spaces

Lecture/assigned: June 12 4-6pm
Due: June 26 to Courseworks
Kyle Hovenkotter, klh2130@columbia.edu
Lecture Slides
Overview

At the end of this assignment, students should be comfortable creating and transforming geometry in Rhino using basic commands, exporting drawings to Illustrator to control linework and color, and placing drawings in an InDesign file for printing and sharing.

Virtual worlds

The 3D modeling environment should be thought of as a virtual copy, or simulacrum, of the world that we live in. Space in this virtual world is described through cartesian coordinates, organized on x,y, and z axes. This is a departure from the conception of architecture as an "accumulation of partial representations"(Allen, 2000). While Rhino is a drawing tool, built upon renaissance modes of perception, namely orthography and perspective, it is the speed of the computer to construct these 2-dimensional projections as fast or faster than your body perceives reality. In a way, Rhino and your computer are like drawing power tools. Still, these representations consist of the familiar points, lines, and planes.

Objects and actions

The collapse of accumulated representations into a simulation of reality allows us to be concerned with the nature of objects and their means of making, as opposed to the construction of images alone. Because of this, 3D modeling softwares emphasize action as a way to affect objects as a means of designing them. Moreover, these actions are often derived from practices of fabricating objects (extruding, revolving, lofting, matching, etc.) So, while the act of drawing lines and projecting are still important to constructing representations of design, they are no longer the principal means of designing. Students should take this workshop as an opportunity to encounter a new vocabulary of making forms through these actions, and to recognize how this vocabulary might affect the performance of those forms as objects.

Families and resemblance

As new formal vocabularies emerge, students should record the means by which they are produced, and attempt to name, collect and organize how the means might relate to one another.

Tutorials

User interface and navigation

- Command Line
- Viewports
    - Top, Right, Front, Perspective
    - Pan, Orbit, Zoom
    - Organization (Maximize, axes, grid)
    - Basic display options
- Units and tolerance
- Selecting geometry

Geometry basics

- Points, Lines and curves
    - Point, line, polyline, control point curves, interpolated curves, circle, arc
    - Open, closed curves
    - Object snaps, ortho, tab
    - Explode, join and offset
    - Trim, split, extend, fillet
    - Text
- Geometry from curves
    - Extrusions, slab

    - Revolutions
    - Planar surfaces, extruding surfaces
    - Loft, sweep, pipe

- Primitive objects

    - Platonic solids (box, cylinder, cone, pyramid, sphere)
    - Explore! Create 6 objects using a mix of geometries from curves and primitives, use text to record the commands used

- Transforming objects

    - Move, Copy, Scale, rotate, rotate 3D
    - Sub-object selection and transformation (ctrl+shift)
    - Bend, twist etc
    - Offset surface, trim, split
    - Explore! Transform your primitives, append your text to include the transformations

- Working with solids

    - Open and closed surfaces and polysurfaces (showedges)
    - Boolean operations
    - Filletedge, shell, cap, mergeallfaces, extract surface
    - Explore! Further transform your objects, continue to append your transformations in text

Cameras, Views (forthcoming)

- Parallel versus perspective views, lens length
- Naming and saving views
- Clipping planes
- View captures
- Explore! Save an overall parallel projection view of your family of objects, an experiential view of them from ground level, and a section through one of them using a clipping plane

Model Organization (forthcoming)

- Layers, properties, blocks, groups, hide, lock

Drawings

- Make2D
- Lineweights by layer: cuts, edges, profiles and hidden lines
- Exporting your overall parallel projection view to Adobe Illustrator

Working with drawings in Illustrator

- Artboards
- Geometry creation and transformation

    - Pen tool
    - Direct selection
    - Bounding box
    - Text
    - Scale figures

- Strokes

    - Weight
    - Pattern
    - End type
    - Arrowheads

- Fills

    - Color
    - Gradient
    - Patterns
    - Swatches

- Effects

    - Opacity, blending modes
    - Drop shadow
    - Round corners

- Working with Geometry from Rhino

    - Layers and selection
    - Live Paint Groups
    - Shading faces
    - Explore! Make a matrix drawing of your family of objects from Rhino with lineweights, colors and text on an 11x17 artboard

Preparing work for printing with InDesign

- Pages
- Placing assets
- Links
- Text
- Exporting for distribution

Deliverables Due June 26 to Courseworks
Family of resemblant 3D sketch objects, 3 views
Working individually, organize the objects you made while sketching during the exploration segments of the tutorials. Do they relate to one another? If so, how? Arrange them as a matrix including the text and produce 3 drawings exploring their potential as forms and spaces. These drawings should read as a coherent series, should not aim to be photorealistic, and should definitely not be boring. Experiment with color, text, lineweight, gradients and patterns to communicate, abstract, and play. All objects are to be produced in Rhino, all drawings are to be finished in Illustrator. Each drawing should be fit to an 11”x17” sheet.

- **Overall 'axo' view of entire family** This drawing should show the entire family from an overall axonometric view, as well as text describing the commands that created and transformed the objects. The drawing should use lineweight, color and text in a coherent way to define the objects as a family. It should be well crafted and well composed.

- **Experiential view of one object** This drawing should use a perspective view to suggest how one of the objects might be experienced from the point of view of a person. Use scale figures, color, a horizon line and a gradient sky to give the drawing a sense of scale. Again, the drawing should be well composed and well crafted.

- **Section view of one object** This drawing should use the clipping plane to create a section cut through an object, describing interior space. It should use correct lineweights, thickness and color to depict the section cut, and use a ground plane to suggest a relationship to a site. Don't forget scale figures!

Systems

Lecture: June 26 4-6pm
Kyle Hovenkotter, klh2130@columbia.edu
Overview
The goal of this lecture is to provide a basic introduction to the Grasshopper plug-in for Rhino. After doing the tutorials, students should understand the potential to automate simple modeling workflows, and to produce parametric relationships between pieces of geometry that can be used to produce a series of outcomes that can be evaluated.
Tutorials
Producing geometries and relationships

- Curves
- Surfaces
- Objects on a surface

Automating modeling workflows

- Columns
- Floor Slabs
- Stairs

Advanced modeling automation with Lunchbox plugin

- Truss modeling with Grasshopper (LunchBox)
- Structural skins with Grasshopper (LunchBox)

Assignment 3: Systems 2

Lecture/assigned: July 3 4-6pm
Due: July 17 to Courseworks
Andrew Heumann, adh2172@columbia.edu
Overview
The goal of this assignment is to develop a facility with parametric modeling - connecting the skills and concepts built in the Starts + Sites workshops, enabling efficient modeling, highly customizable graphical visualization, and interaction with various static + dynamic data sources.
Objects versus Systems
Thinking in terms of discrete, withdrawn elements can be a useful perspective to interrogate things-in-themselves; however, it is also necessary to perceive (and model) how elements

interact to compose systems, networks, fields, multitudes, and totalities. At its best, system-oriented thinking can address, interrogate, and model relations, generalities, and emergent properties in aggregate; at its worst it runs the risk of being reductive, totalizing, and obscuring specificity and uniqueness.

Code as Representation

The nature of algorithmic code is that — like a drawing, or physical model, or textual description — it functions as a system of representation in and of itself. Like any representational or poetic medium it contains and distills ideas and intentions: literally encoding them as models, methods, systems of abstraction that reflect an outside world. Unlike other representational media, its mechanism of action is literal rather than figuratively interpreted or performed. Code is executed autonomously, and the representation can be effectively infinitely repeated in response to dynamic criteria, or parameters. All of a sudden, the object can be thought of as a circumstantial output of a designed process, as opposed to a designed object.

Algorithmic Literacy

There exists almost no discipline or domain that has not been altered by the ubiquity of computation and digital systems. To be merely a user of such systems is like being able to read but not write. To understand and critically reflect on a world increasingly guided by algorithmic logic, it is imperative to learn at least the fundamentals of how such logics are authored.

In-class Example Files: Download

Tutorials

As in previous workshops, students should search for tutorials that are relevant to their sites and projects, mobilize and expand on those techniques with help from instructors and teaching assistants to produce final deliverables.

Thinking Parametrically

- Introduction to parametric thinking in the Grasshopper interface
  Source files: Download
    - Modeling vs. Coding vs. Visual Scripting - what's the difference?
    - The Hierarchy of geometry - Numbers, Points, Vectors, Planes, Curves, Surfaces, Polysurfaces, and Meshes - Composition + Decomposition
    - *Explore! Try to familiarize yourself with the interface, see what components are available and try to figure out what they do.*
- Working with Data
  Source files: Download
    - Understanding lists and data structures
    - Manipulating data structures
    - *Explore! Try to create 5 different 2d shapes, extruded to 5 different heights, without using copy-paste*
- Toolcrafting - Interacting with Rhino
  Source files: Download
    - Installing 3rd party plug-ins
    - Loading geometry from Rhino - statically and dynamically
    - Creating geometry in Rhino
    - Creating custom tools to speed up modeling
    - *Explore! Take your 3d sketch objects from the "Starts" workshop and see how you can load them in and manipulate them in Grasshopper.*

Geographic Systems

All source files: Download

- GIS in Grasshopper - Introduction to Heron and Herman

    - Loading SHP files + parsing embedded data
    - Working with Coordinate Systems - Lat/Lon to world XYZ coordinates

- Beyond geometric data sets - connecting to Excel

    - Working with external data sets
    - Matching / Lookups / Data operations
    - Writing data to Excel

- Data Visualization - Graphics with Grasshopper

    - Representing “Hard” systems - points, solids, color-coding, lineweights
    - Representing “Soft” systems - point clouds, 3d graphs, contours, meshes
    - Extracting hi-res graphics from Grasshopper
    - Grasshopper to Illustrator workflows

- Introducing Web-based data sources

    - Working with APIs pt1 - Local Data from Yelp
    - Working with APIs pt 2 - Local Data from Walkscore
    - Working with APIs pt 3 - Routing w/ Google Maps

Drawing Codes - Modeling with Logic

- Systemic Urban Landscapes
  Source Files: Download

    - Attractor logic - from points to curves to fields
    - Conditional logic - If/Then rules and selective processing
    - Introducing controlled randomness
    - From simplicity to complexity - Achieving model detail from lightweight “skeletons”

- From “Code” to Code - Modeling a zoning envelope
  Source Files: Download

    - Modeling Setbacks + Stepbacks with Boolean operations
    - From Mass to Building - modeling and measuring floors
    - Advanced Conditional Logic - interpreting and implementing rules

- Automating Documentation - Advanced Graphics + Capture
  Source Files: Download

    - Slider animation
    - Camera control
    - Automatic view capture + control

Deliverables Due July 17 to Courseworks

1 multiscalar static data visualization drawing, 1 dynamic "future projection" (animation or interactive)
Working individually, employ the techniques covered in the tutorial sessions to produce two representations of your site or project.

- **Axonometric of immaterial on-site condition** This static drawing should take advantage of available data to build an argument about some condition(s) of your site. Explore traditional data sources like CAD and GIS, but also see what useful data can be retrieved from the web, from satellite imagery, from twitter, from scanned maps, from text files, etc. Use this data to investigate the intangible conditions of the site and its context, and then create a data visualization to graphically represent those conditions. The visualization should address multiple scales, and exceed (or subvert) strictly geographic/geometric/cartographic conventions in its presentation. Most importantly, it should convey an idea, position or argument through the data it presents.
- **Animation of future conditions** Engage in some speculation to explore a possible future for your site and its surroundings. What might the future look like if height regulations were different? Under radical sea level rise? In a world without cars? Use an animated slider to demonstrate the urban consequences of your speculation. You can explore time as a variable, but also consider what other variables might alter the outcomes of your future scenario. Compile at least 10 frames into an animation and upload as a video to Courseworks via Youtube. Even though the medium is different, your tool or animation should take as much care with graphic styles and visual craft as your static drawing.

Assignment 4: Stories

Lecture/Assigned: July 17 4-6pm
Due: August 2 to Courseworks
Trevor Lamphier, til2104@columbia.edu
Overview
The goal of this lecture is to develop 3D modeling and visualization skills at the outset of the final design problem in studio. At the completion of the tutorials, students should feel comfortable modeling complex, generative geometries, be able to simulate basic material finishes and lighting environments in their models, and to produce drawings that communicate multiple layers and types of information at multiple scales.
Advanced geometry creation

- Advanced Rhino UI
  - Rhino Options (Autosave and Aliases)
- Push + Pull: Soft manipulation of planes in Rhino
  - Complex surface generation
    - Curves (line, polyline, interpolated curve, nurbs curves)
    - Surfaces (extrude, loft, sweep1, sweep2, network srf)
    - Thickening and Blending (offset srf, blend crv, blend srf)
    - Building on Surfaces (Split, Extrude, Contour, SetPt)
  - Curvature management (control points, rebuilding, analysis)
  - Deformations by data (height fields, point clouds, drapes)

- Subdivide + Conquer: Quick subdivision and modifier use in 3DS Max and Rhino+Grasshopper

    - Introduction to Sub Division modeling (interface)
    - Basics of 3D Max (edit poly, modifiers)
    - Minimal Surfaces (edit poly, relax)
    - Complex Geometry- keeping it "live"
    - Fun modifiers (basic guide to 3D Max modifiers)
    - Quickly go between 3DS Max and Rhino
    - Surface subdivision types in Grasshopper and adjustment with sliders (LunchBox)

Refining forms into architecture

- Refinement of complex surfaces into envelopes:

    - Polysurface Editing (twist, taper, maelstrom)
    - Thickness and layering (offsetting, extrusions, managing corner conditions)
    - Making surfaces occupiable (contouring, setpt, splitting, etc.)
    - Making apertures (projection, booleans)

Making drawings and images (cheap tricks and dirty secrets)

- Simulating materials

    - Basic texture mapping in Rhino or V-Ray or Max (Intro and Part 1)

- Simulating environments

    - Making sharp shadow renderings with Rhino sunlights and V-Ray render (Part 2)
    - Making soft shadow renderings with Rhino or V-Ray skylight (Part 2)
    - Ambient occlusion
    - Output and camera controls in V-Ray (output settings, camera controls)

- Advanced drawing types

    - Setting up a cut-away section (make2d, split, clipping plane, export to AI)
    - Exploded axonometrics (named positions, make2d, export to ai)

- Vector drawing output

    - Make2D, Lineweights as template layers, Export to Illustrator
    - Photoshop and Illustrator overlays

- "Fake 2D," fast vector drawing approximation

    - Control of custom display modes, setobjectdisplaymode, viewcapturetofile

- Entourage

- Propogation of random elements with Grasshopper

Deliverable Due: August 2 to Courseworks
3D sectional mega-drawing, 1 view annotated as necessary
Working as a group, develop a "mega-drawing" of some aspect of your studio project. This drawing should require the production of a comprehensive 3D model of your site, complex modeling and visualization of data relating to your project, should describe the passage of time, and describe the physical experience of being in your project. At this point you should all be developing your own design and representation techniques and should see this drawing as an opportunity to demonstrate this.

- Possible things to include in the mega drawing: Topographical Information, Hydrographic/Tidal information, Urban infrastructure (streetscapes, underground systems, transit, various features), Surrounding buildings, Landscape, Ownership/Use/Policy, Atmosphere, Structures and tectonics. Fit to an 11x17 sheet.

Stories 2

Lecture: July 24 4-6pm
Lindsey Wikstrom, lmw2167@columbia.edu
Overview
The goal of this lecture is to develop immersive visualization skills in order to effectively communicate your concept and designs. The purpose of immersive drawing is to bring the viewer with you into the content of the design so that the features that you are trying to communicate become a tangible experience.
The drawings should include:

- Multiple scales
- Multiple layers of information (physical form, annotation, atmosphere, etc)
- A sense of narrative and discovery (a beginning, middle, and end, etc)

Photoshop + Illustrator

- Workflow Example
    - Rhino to Photoshop to Illustrator and back (channel management, layering)
    - Rhino Screenshots (scale, material UV maps, reflection and environment)
- Photoshop Editing
    - Color Tone (daytime, nighttime, exposure, brightness, contrast, etc)
    - Blending Modes (multiply, screen, hard light, soft light, etc)
    - Filters (blur, pixelate, noise, stylize, etc)

Animating

- AfterEffects
    - Story Boarding
    - Base Narrative (desired effect, plot, point of view)
    - Frames (timing, scale, composition)
    - Importing into aftereffects
    - Channel management

- Exporting (Render settings, quality, devices)

Designing in 360

- Iterating between tools
  - Grasshopper + Rhino (unrolling, baking, layer management for editing)
  - Rendering in Vray (camera POV, settings, set atmosphere, channels)
- Post Production
  - Entourage + Atmosphere (picture frames, mesh people, photoshop)
  - Formatting for Devices (phone, google cardboard, website)

Assignment 5: Final

Assigned: July 24
Due: August 7 to Courseworks and pinned up
Overview
The final assignment in DTEQ asks students to become an author of a new technique, and to contribute that technique to the collective knowledge base.
Students can choose to take any drawing or workflow they have made for DTEQ or studio throughout the semester and give it one more revision, adding some never-before-seen technique to it. This drawing should be printed on 11x17 and will be exhibited during a final review on August 7.
DTEQ 2018 Final Deliverables

- **Signature drawing** Students are to pin up and submit to Courseworks a revised drawing that uses their signature technique.
- **Tutorial documentation** Students are to use Open Broadcasting Software to record a tutorial of their workflow to create the signature technique. The video should be uploaded to Youtube and Courseworks.