LSU | College of Art + Design

LA 7032 | Geospatial Modeling

Brendan Harmon
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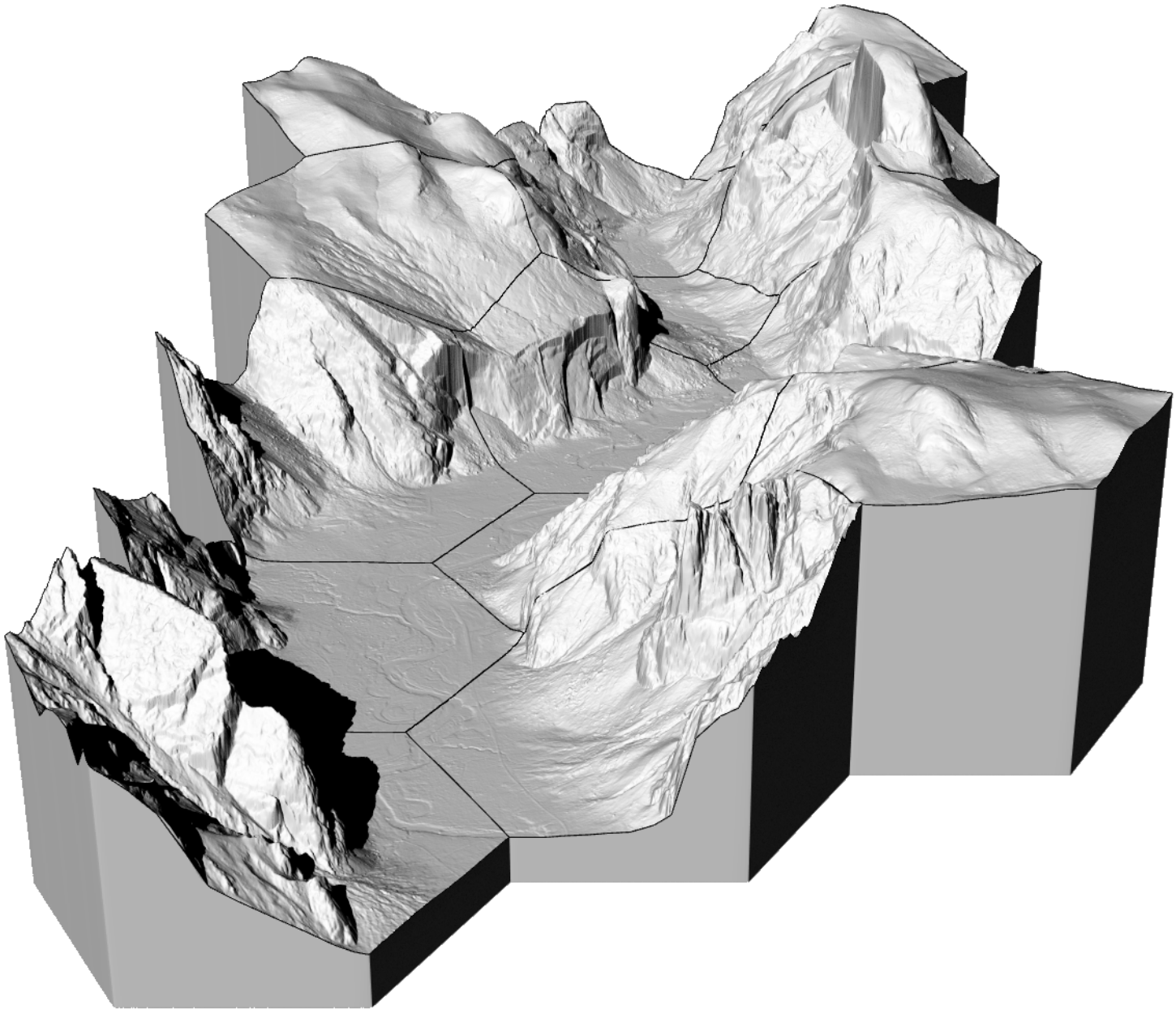
Fall 2018. Design 217.
Tuesday & Thursday 12:30am–3:20pm.



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Course Description

This course is an introduction to geospatial modeling for landscape architects. In this course you will develop a creative digital design process seamlessly integrating research and design using geographic information systems (GIS), 3D modeling and rendering, and visual programming. You will learn how to use geospatial data to model and analyze landscapes and visual programming to parametrically model and transform new landforms. You will learn how to model plants – from trees to grasses – in 3D,

automatically distribute them across your digital landscape, and render photorealistic scenes. Through a series of projects you will design the restoration of a highly eroded landscape with a deep gully.

Topics

Geospatial modeling

1 Lidar
2 Terrain modeling
3 Digital fabrication
4 Hydrological modeling
5 Erosion modeling

Generative design

6 Parametric design
7 Parametric landforms
8 Visual programming
9 Generative processes
10 Attractors

Ecosystem modeling

11 Particle systems
12 Image classification
13 3D rendering
14 Freeform modeling
15 Virtual reality

Course Schedule

Geospatial

08.21.2018	**Tutorial** | Lidar	
08.23.2018	**Fieldwork** | Surveying	**Project:** Geospatial monitoring
08.28.2018	**Tutorial** | Terrain modeling I	
08.30.2018	**Tutorial** | Terran modeling II	
09.04.2018	**Tutorial** | Digital fabrication	
09.06.2018	**Lab** | Digital fabrication	**Project:** CNC machining
09.11.2018	**Tutorial** | Hydrological modeling I	
09.13.2018	**Tutorial** | Hydrological modeling II	
09.15.2018	**Workshop** | Drone photogrammetry	
09.18.2018	**Tutorial** | Erosion modeling	
09.20.2018	**Tutorial** | Landscape evolution	**Project:** Physical simulation

Generative

09.25.2018	**Tutorial** | Parametric design	**Project:** Laser-cut bench
09.27.2018	**Tutorial** | Parametric landforms	
10.02.2018	**Tutorial** | Visual programming	
10.09.2018	**Tutorial** | Generative processes I	
10.11.2018	**Tutorial** | Generative processes II	
10.16.2018	**Tutorial** | Attractors	
10.18.2018	**Studio** | Attractors	**Project:** Families of form

Ecosystem

10.30.2018	**Tutorial** | 3D plants	
11.01.2018	**Tutorial** | Particle systems	**Project:** The Great Piece of Turf
11.06.2018	**Tutorial** | Image classification	
11.08.2018	**Tutorial** | Landscape modeling	
11.13.2018	**Tutorial** | Landscape rendering I	
11.15.2018	**Tutorial** | Landscape rendering II	
11.20.2018	**Tutorial** | Freeform modeling I	
11.22.2018	**Studio** | Freeform modeling II	
11.27.2018	**Tutorial** | Virtual reality	
11.29.2018	**Gallery** | Final review	**Project:** Gully restoration

Projects

The study landscape is a highly eroded watershed feeding into Patterson Branch Creek in Fort Bragg, North Carolina. This geomorphologically active watershed has deep gullies and extensive areas of bare soils. The creeks, streams, and rivers in this region are critical habitat for endangered species of mussels. Mussels, however, require stable stream habitat and these actively eroding watersheds with sandy-loam soils cause high sediment bed loads in streams and shifting streambeds. The aim of this project is to restore the degraded watershed and reduce sediment transport in order to enhance downstream mussel habitat.

Gully monitoring Visit Clark Creek to survey active gullies. Take photographs and 360 degree photospheres and conduct a terrestrial lidar scan. Back in the lab generate digital surface models (DSM) from the lidar data.

CNC machining Use the CNC router to machine a physical model of the study landscape out of high density urethane foam.

Physical simulation Using the CNC-machined model as a base develop a physical simulation of sediment flow. Experiment with casting, melting, and pouring. Try materials like hot wax or molten aluminum. Record your physical simulation as a video.

Parametric bench With Rhino or Grasshopper design a parametric bench and cut it into slices for digital fabrication. Build a laser-cut prototype.

Families of form Use map algebra and visual programming to generatively design erosion control features to restore your degraded study landscape. Catalyze topographic changes with algorithmically generated interventions to restore the landscape to a dynamic equilibrium. Digitally fabricate models of your designs and augment these with projected water flow and sediment flux.

The Great Piece of Turf Create a 3D model and 3D rendering of Albrecht Dürer's Great Piece of Turf. Use particle systems to distribute 3D flowers, grasses, and other ground cover across a block of soil.

Gully restoration Map the existing vegetation and landforms using automated classification algorithms. Design, model, and render in 3D a bioswale to restore this degraded landscape. Produce beautiful, photorealistic 3D renderings of the existing and restored landscape.

Drone Workshop

Conduct a topographic survey with an unmanned aerial system (UAS) at Hilltop Arboretum. After a morning theory session, survey the arboretum grounds with a drone, and then use stereophotogrammetry to generate a digital surface model.

Software

GRASS GIS | https://grass.osgeo.org/
ArcGIS | https://www.esri.com/
Rhinoceros | https://www.rhino3d.com/
Grasshopper | http://grasshopper3d.com/
Blender | https://www.blender.org/

Resources

Intro to GRASS GIS | https://ncsu-geoforall-lab.github.io/grass-intro-workshop/
Hydrology in GRASS GIS | https://grasswiki.osgeo.org/wiki/Hydrological_Sciences
Grasshopper Primer | http://grasshopperprimer.com
BlenderGIS tutorial | https://github.com/ptabriz/ICC_2017_Workshop

Graduate Certificate in GIS

This course counts as an applied topics course for the Graduate Certificate in Geographic Information Science. The Graduate Certificate in Geographic Information Science at LSU is a 12 credit hour standalone certificate. For more information about the Graduate Certificate in GIS visit: http://ga.lsu.edu/gis-certificate/.

Grading

Gully monitoring	10%	Families of form	25%
CNC Machining	10%	The Great Piece of Turf	10%
Physical simulation	10%	Gully restoration	25%
Parametric bench	10%		

Terminology

Digital culture

- Mass customization
- Generative design
- Parametric design
- Performative design
- Algorithm

Spatial data

- Raster & Vector
- Array
- Point cloud
- Mesh
- Triangulated irregular network (TIN)
- Discrete & continuous data
- Plain text
- Comma separated values (CSV)
- Integer & floating point numbers
- Non-uniform rational basis spline (NURBS)

Geospatial

- Geographic information system (GIS)
- Digital terrain model (DTM)
- Digital elevation model (DEM)
- Digital surface model (DSM)
- Lidar
- Delaunay triangulation
- Interpolation
- Bilinear interpolation
- Nearest neighbors
- Regularized spline with tension (RST)
- Map algebra
- Null value
- Least cost path (LCP)
- Resampling
- Image classification

3D rendering

- Ray tracing
- Diffuse shading
- Texture map
- Particle system
- Head mounted display (HMD)
- Cave automatic virtual environment (CAVE)

Digital fabrication

- 3D printing
- Computer numeric control (CNC)
- Collet & Bit
- High density urethane (HDU)
- Medium density fiberboard (MDF)

Geomorphology

- Watershed
- Multiple flow direction (MDF)
- Revised Universal Soil Loss Equation (RUSLE)
- Unit Stream Power-based Erosion Deposition (USPED)
- Simulated Water Erosion (SIMWE)
- R-factor
- Mannings
- Sediment mass density
- Gully
- Knickpoint

Readings

Petrasova, Anna, Brendan Harmon, Vaclav Petras, Payam Tabrizian, and Helena Mitasova. 2018. *Tangible modeling with open source GIS*. Springer.

Choma, J. 2015. *Morphing: A Guide to Mathematical Transformations for Architects and Designers*. Laurence King Publishing.

Stevens, J., and R. Nelson. 2015. *Digital Vernacular: Architectural Principles, Tools, and Processes*. EBL-Schweitzer. Taylor & Francis.

Tedeschi, A. 2014. *AAD Algorithms-aided Design: Parametric Strategies Using Grasshopper*. Le Penseur.

Beorkrem, C. 2013. *Material Strategies in Digital Fabrication*. Taylor & Francis.

Neteler, Markus, and Helena Mitasova. 2013. *Open source GIS: a GRASS GIS approach*. Vol. 689. Springer Science & Business Media.

Bohnacker, Hartmut, Benedikt Gross, Julia Laub, and Claudius Lazzeroni. 2012. *Generative design: visualize, program, and create with processing*. Princeton Architectural Press.

Dunn, Nick. 2012. *Digital Fabrication in Architecture*. Laurence King Publishing.

Carpo, Mario. 2011. *The alphabet and the algorithm*. Cambridge, MA: MIT Press.

Anderson, Robert S, and Suzanne P Anderson. 2010. *Geomorphology: the mechanics and chemistry of landscapes*. Cambridge University Press.

Deussen, Oliver, and Bernd Lintermann. 2010. *Digital Design of Nature: Computer Generated Plants and Organics*. Springer. doi:10.1007/b138606.

Goudie, Andrew, and Heather Viles. 2010. *Landscapes and Geomorphology: A very short introduction*. Vol. 240. Oxford University Press.

Picon, Antoine. 2010. *Digital culture in architecture: an introduction for the design professions*. 224. Boston, MA: Birkhaeuser.

Thompson, R. 2007. *Manufacturing Processes for Design Professionals*. Thames & Hudson.

Terzidis, Kostas. 2006. *Algorithmic architecture*. Elsevier Architectural Press.

Schodek, D., M. Bechthold, J.K. Griggs, K. Kao, and M. Steinberg. 2004. *Digital Design and Manufacturing: CAD/CAM Applications in Architecture and Design*. Wiley.

Belsey, Catherine. 2002. *Poststructuralism: A very short introduction*. OUP Oxford.

Barthes, Roland. 1978. *Image-music-text*. Macmillan.

Policies

Time Commitment Expectations LSU's general policy states that for each credit hour, you (the student) should plan to spend at least two hours working on course related activities outside of class. Since this course is for three credit hours, you should expect to spend a minimum of six hours outside of class each week working on assignments for this course. For more information see: http://catalog.lsu.edu/content.php?catoid=12&navoid=822.

LSU student code of conduct The LSU student code of conduct explains student rights, excused absences, and what is expected of student behavior. Students are expected to understand this code: http://students.lsu.edu/saa/students/code.

Disability Code The University is committed to making reasonable efforts to assist individuals with disabilities in their efforts to avail themselves of services and programs offered by the University. To this end, Louisiana State University will provide reasonable accommodations for persons with documented qualifying disabilities. If you have a disability and feel you need accommodations in this course, you must present a letter to me from Disability Services in 115 Johnston Hall, indicating the existence of a disability and the suggested accommodations.

Academic Integrity According to section 10.1 of the LSU Code of Student Conduct, "A student may be charged with Academic Misconduct" for a variety of offenses, including the following: unauthorized copying, collusion, or collaboration; "falsifying" data or citations; "assisting someone in the commission or attempted commission of an offense"; and plagiarism, which is defined in section 10.1.H as a "lack of appropriate citation, or the unacknowledged inclusion of someone else's words, structure, ideas, or data; failure to identify a source, or the submission of essentially the same work for two assignments without permission of the instructor(s)."

Plagiarism and Citation Method Plagiarism is the "lack of appropriate citation, or the unacknowledged inclusion of someone else's words, structure, ideas, or data; failure to identify a source, or the submission of essentially the same work for two assignments without permission of the instructor(s)" (Sec. 10.1.H of the LSU Code of Student Conduct). As a student at LSU, it is your responsibility to refrain from plagiarizing the academic property of another and to utilize appropriate citation method for all coursework. In this class, it is recommended that you use Chicago Style author-date citations. Ignorance of the citation method is not an excuse for academic misconduct.