Visible and invisible infrastructures: alternative futures in resiliency, failure and design pedagogy

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ABSTRACT: This paper explores the pedagogic and community initiative sponsored by a multi-year interdisciplinary (M.Arch and MLA) design studio project entitled "Design Duluth." Motivated in part by catastrophic flooding in the city of Duluth, Minnesota in June of 2012, this research investigates - through the structure and pedagogic programming of the semester - how complex infrastructures are networked (or not), constructed (or fragmented), dynamic (or static) within the a complex city landscape. The project is rooted in developing, critical and creative topical to issues of resiliency and failure in and across architectural, ecological and urban systems. The studio explores how we can seed and implement innovative methods of interdisciplinary studio teaching and research and perhaps most importantly, how we can help students have agency in a blurry world of shifting pedagogy and practice.

KEYWORDS: Resiliency, Pedagogy, Duluth, Architecture, Landscape

INTRODUCTION

The contexts in which design projects are situated are more complex and difficult than ever. In particular, recent events "from extreme weather…such as epochal hurricanes and floods, geologic disruptions epitomized by the Indian Ocean and Sendai earthquakes and tsunamis, to the 9/11 Terror Attacks, ongoing wars in Iraq and Afghanistan, ethnic genocide in Darfur, popular uprisings in several Arab countries during 2011, and the global economic recessions of 2008 and 2011" (Stokols, Lejano, and Hipp 2013, 1) have diminished the capacity of design as a responsive and responsible act. Daniel Stokols states that "[r]eflecting on the succession of calamitous events that have occurred in recent years, scholars and policy makers from a variety of fields have begun to question whether humans' capacity for protecting the near-term resilience and longer-term sustainability of the earth's fragile ecosystems has been inexorably surpassed by converging environmental and societal perturbations that are now beyond our control" (Stokols, Lejano, and Hipp 2013, 1).

If the ability to manage and protect resources in the short-term, and to plan for sustainability in the long-term is beyond our control, how does design (as a conscious act of reordering systems and space) respond to this challenge? What new tools and methods must be developed to move beyond the typical short-term responses?

1.0 Resiliency

The term resilience was introduced into the English language in the early 17th Century from the Latin verb resilire, meaning to rebound or recoil (Concise Oxford Dictionary 1999). In 1858, Robert Mallet used the concept of resilience to compare the strength of materials used in the construction of ships. Mallet developed a measure, the modulus of resilience which he defined as the force required to rupture a material. The modulus was used to assess the ability of materials to survive severe conditions. The modulus is still part of the design codes for structural, civil, and mechanical engineers, and naval architects.

Mallet defines resilience as the ability of objects or systems to retain certain characteristics or performance within a tightly bounded zone of disturbance. Modern definitions of resilience have trended towards a dynamics of identity (under what conditions is the thing still the thing, or even a thing). The fundamental concepts of modern resiliency are derived from C.S.

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Holling's research into ecological change. Areas of expertise that now use or employ resiliency thinking, strategies, or concepts include economics, security disaster planning, psychology, and ecology.

Ecologist C.S. Holling first posited resiliency as an ecological concept in 1973. Holling defined resilience as the ability of an ecosystem to absorb change and still exist (Holling 1973). Holling contrasted ecological resilience against a mechanistic view (coherence/identity until failure) where ecosystem stability, resistance to disturbance, and speed of return to any stable state were the main indicators of resilience. As many ecosystems are profoundly affected by external changes, the immediacy and constancy of ecosystem behavior is less important than adaptability. "Ecological resilience is a measure of the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures" (Gunderson, Allen, and Holling 1998, 177). Holling posited that a resilient ecological system had many possible stable states, and that these states shift in accordance with external and internal changes to the ecosystem. Ecologist Richard Klein has taken Holling's concept even further and shown that ecosystems may have no stable states and may be in constant flux. In a study of the Dutch coastline, Klein defined resilience as "the self organizing capacity…to preserve actual and potential functions under constantly changing circumstances" (Klein, Nicholls, and Thomalla 2004, 40).

Resilience is a dynamic property of a system, and managing it requires a dynamic and adaptive approach. Through the course of studio, we attempted to present and explore the many different definitions and contexts of resiliency and employ design strategies derived from principles of resiliency. Students were (and are) expected to develop their own definition and design frameworks of resiliency as the basis for their work. In light of the original and emerging definitions of resiliency, we asked students to reflect on the following baseline characteristics of what may constitute a resilient infrastructure:

1. The systems we are dealing with are self-organizing.
2. There are limits to a system's self-organizing capacity.
3. These systems have linked social, economic, and biophysical domains.
4. Self-organizing systems move through adaptive cycles.
5. Linked adaptive cycles function across multiple scales.
6. There are three related dimensions to resilience: specified resilience, general resilience, and transformability.
7. Working with resilience involves both adapting and transforming.
8. Maintaining or building resilience comes at a cost.
9. Resilience is not about knowing everything.
10. Resilience is not about not changing.

2.0 All about Duluth, or, Also, the lake

Emerging from an 18th and 19th century amalgam of opportunity and enterprise colliding with Archean and Proterozoic geologies, Duluth is bounded by the ferric landscapes of the Iron Range and the liquid bodies of the Great lakes. Human industry and an extraction-based economy has given Duluth its history and set the stage for its alternative and desired urban future. At the end of the 19th century, Duluth was home to more millionaires per capita than any other city in the world. The city's port was the largest in the United States, surpassing both New York and Chicago in gross tonnage handled. To take advantage of the iron ore extraction in the Mesabi Range, US Steel constructed a $5 million plant south of the city. Steel production did not begin until 1915, and many predicted (hoped) that Duluth would be the next Pittsburgh.

Duluth's fortunes shifted radically in the 1950s as the high-grade iron ore. Low-grade ore (taconite) shipments continued, but substantially decreased due to global fluctuations in steel demand. As the shipping center for a number of extraction industries in the past and present, Duluth had been subject to the boom-bust nature of these industries. From the early lumber industry to iron ore mining, and now taconite production, the unstable economics of extraction

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has been difficult for the residents of the city and the region. Forced dependencies on large manufacturing further destabilized the future of the city — the closure of the US Steel plant in 1981 also forced the closure of the cement plant as it was dependent on the steel plant for raw materials (limestone slag). The economic (and social) downturn continued, and in the 1990s more large employers left the city, including shipbuilding, heavy machinery, and an Air Force base. By the end of the 2000, unemployment was over 15 percent.

Plateaued at an approximate population of 86,000 since the 1990s (from a steady decline since the 1960s),[i] present day Duluth wrestles a history that distorts the memory and dampens the desire to move beyond the "rose-colored view of a return to the hey-day of industrial manufacturing" towards new industries (aerospace + health-care) and new foci (art and culture, recreational tourism). This history — cultural, industrial, and urban — must also contend with the geography of the city itself and its infrastructural systems, its disparate neighborhoods, the presence of the Duluth-Superior Port and its implications as a waterway to the Great Lakes, the St. Lawrence, and the Atlantic. All of this exists in a context of the reality of new and varying capital models and the strong pull of historical and cultural memory, of shifting (and potentially drastic shifts) populations and demographics (locals, insiders, students).

The geography — both cultural and physical — is deeply embedded with and connected to the regional traditions and reality of the Iron Range — to manufacturing, extraction, ideas of place and belonging, of national and international history, of drastic turns of fortune, and of the contemporary need to address new economic, cultural, and physical manifestations of Duluth. While Duluth, Minnesota enjoyed its industrial hey-day in the early 20th century ("Philadelphia's Western Suburb!" "More Millionaires per capita than anywhere else in the US!"), it is today one of the most challenged (yet simultaneously hopeful and beautiful) cities in Minnesota. One third of Duluth's population lives in poverty or are considered working-poor (double the poverty rate of Minnesota)[ii] and 67% of the African American population and 56% of the Native American community are at or below poverty level.[iii] The population has now stabilized with a demographic that is younger, more outdoor oriented, and less affluent. Mayor Ness's 90/20 Initiative — to grow Duluth to a population of 90,000 and to become the new Boulder or Burlington by the year 2020 is a major benchmark. This conscious shift (as policy, physical intervention, and marketing bravado) away from the legacy of industry/extraction is one, which in his words will require significant risk (and pain for some).

3.0 The New Normal
Duluth is located on Lake Superior, the largest of lake in the world by surface area, and third-largest by water volume. The lake is part of the Great Lakes system, which combined holds 31 percent of the world's surface fresh water. The Great Lakes are subject to local, county, state, national, and international jurisdictions, with states often overriding (or attempting to) international policy and treaties. The International Joint Commission, a US-Canada advisory body assists in the enforcement of the 1909 Boundary Waters Treaty and management of Great Lakes resources.

The lake tempers Duluth's weather in the summer, and exacerbates snowfalls (with lake effects snow) in the winter. Today, Duluth is a 27 mile long city, with over a 700-foot elevation difference from crest to the shores of Lake Superior, formed by glacial and volcanic rocks at the Mid-continental divide, with a geologic section that has bedrock at times, no more than 100 feet below streets and buildings. Recent weather-driven events, including the first tornado sighting and damaging rainstorms make Duluth an ideal study area to test climate resilient strategies. Researchers believe that changing weather patterns and warming of (the usually frigid) Lake Superior may make torrential storms a regular part of the normal weather pattern. Changing lake temperatures (slow warming) may also be responsible for new weather patterns, and increased rainfall and large storm events.

This new normal has severe consequences for the city: "The general consensus is that much of the older infrastructure is undersized based on current weather trend…. The weather is

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clearly different in last 15 years or more. According to analyses of existing data, there is an increased frequency of big, intense storms" (Vogel 2012). Despite reducing the percentage of impervious surface from 1990 to 2000 and passage of a new unified development code in 2010 that restricted the creation of new impervious surfaces, Duluth saw record damage from the June 2012 storm.[iv] Estimated at well over $100 million, the city saw destruction of city streets, bridges, and the storm and sewer infrastructure, as well as the washout of the many hiking trails and disturbance to many stream habitats including protected trout streams (Fig 1).
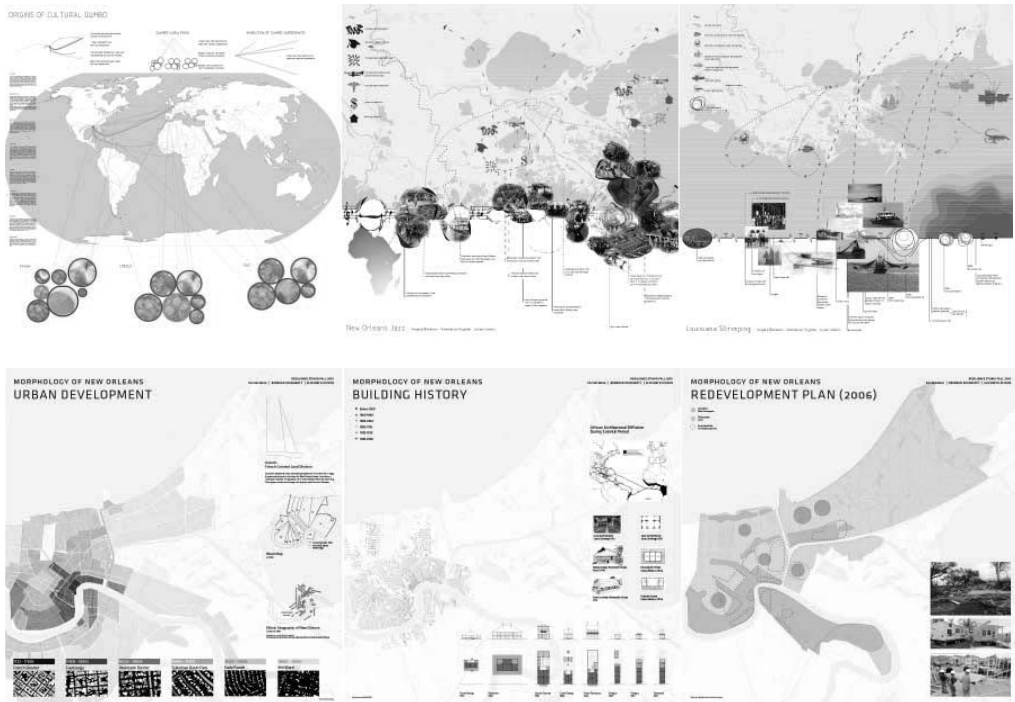

Figure 1: Duluth Storms

4.0 Year One: The 2012 Design Studio

Our initial pedagogical objectives were to research, analyze, and map interwoven and cross-scalar social, economic, and environmental systems; and to do this in ways that revealed underlying relationships and (dis)connections necessary to construct resiliency and to anticipate (or design for) future (graceful) failure. Mapping across scale, time, and within nested systems (site, city, region) challenged traditional analysis and cartographic techniques. We needed to rethink methods of data collection, analysis (type and process), and modes of graphic representation. Collecting data across both scale and time generates potentially crippling amounts of information. The challenge was to sift, edit, and transform this material into analysis as a tool for developing well informed, grounded, and projective designs. Strategies employed in the semester projects included explicit requirements for the students to work across multiple systems and scales, for projects to address long time frames (programs and designs had to projected over 50+ years), the adaptation and co-option of existing systems, and an emphasis on the design of hybrids (that encompassed soft and hard infrastructures as well as policy).

4.1 Projects

Group Project 1: Pre- and Post- in the Not-So-Big Easy — Mapping Time and Systems in New Orleans

Students were given the city of New Orleans as a case study to quantify and analyze a set of cultural, environmental, or economic systems with a focus on their historic and current relevance, physical attributes, and implications (Figures 2,3). Beginning with Hurricane Katrina as the inflection point in these systems, we hypothesized that the students would have an easier time tracking modes of resilience and failure across a large-scale catastrophic event, and would therefore build the capacity to analyze nuanced and less obvious instances when working in Duluth. During this process of research, mapping was introduced as a subjective and political act that required making decisions about where and how to gather and synthesize data. Final maps were printed on vellum and were overlaid to find new points of contestation or congruence, as well as systemic connections and disconnects.[v]

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Figures 2,3: Mapping New Orleans

Group Project 2: The Untold Delights of Duluth or Making the City Visible
Students turned to Duluth to conduct another case study, which increased the complexity of observation and analysis by requiring the study of interactions (or lack of interactions) between multiple systems at multiple scales. They analyzed the overlaps and incongruences and the physical and conceptual convergences of systems in the city and surrounding region. As the connections or disconnections were altered or aligned in different ways at different scales, students were required to produce two sets of models and diagrams; the first at a scale of their choice and the second inverted from the first (scaled up or down). This scale shift towards a smaller or larger area of focus area generated different congruencies and circumstances of interaction(Fig 4).
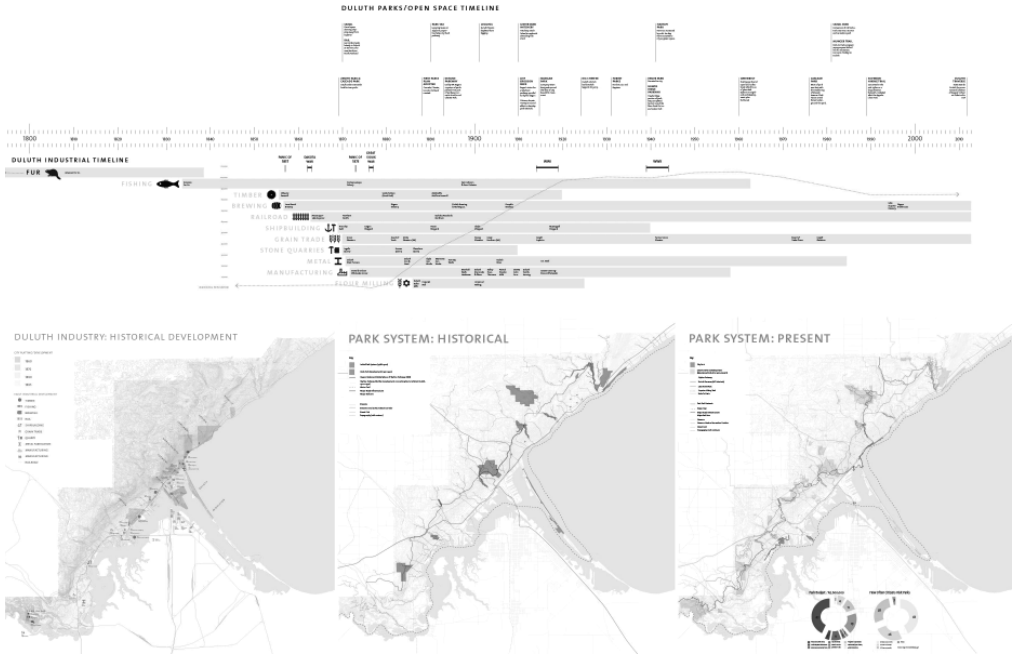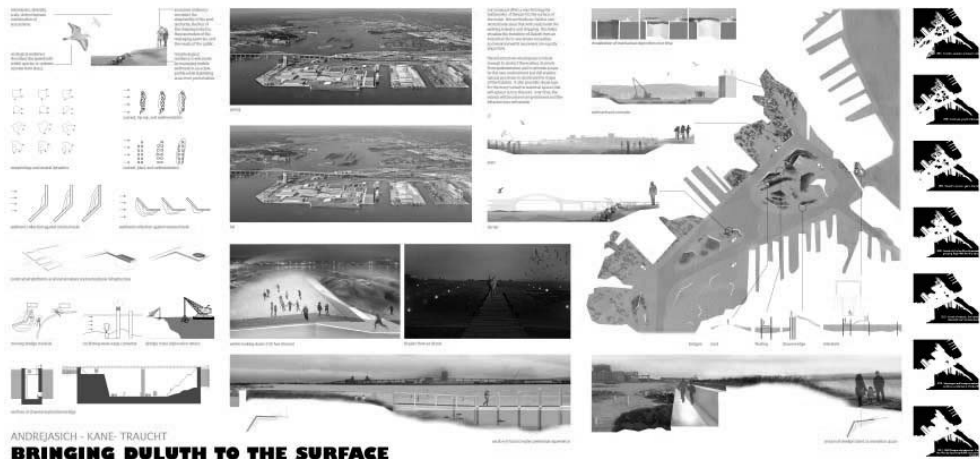
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Figure 4: Mapping overlapping systems in Duluth

Group Project 3: Lost in Transliteration

One of the challenges of research-based design that spans scale, time, and discipline is the critical distillation of abundant data sets into analysis and designs. The fourth project, a week-long charrette, developed schematic iterations of potential futures for Duluth. This exercise set the foundation for the final project by having students work in small groups to generate a shared collection of program and design options for sites throughout the city. Students developed design scenarios grounded in an understanding of historic and current systems that might be influential in future resilient designs for Duluth.

Group Project 4: Proposals for New Urban Futures

Project 5 was the creative synthesis of the studio, using the shared work generated in previous projects to craft proposals for a selected site in Duluth. With dozens of models, hundreds of diagrams, drawings, and photographs as contextual material, the students established a rationale and framework for the development of a specific site, program, and assemblage. This framework established the scope and scale of their design proposal. During this project the students developed relationships with specialists from the city, state, and federal governmental agencies, consulting firms, and NGOs. These experts provided a technical and political context for specific issues students were addressing, timelines of historical action (and in-action), and anticipated future goals for the projects. The relationships established during this time signaled a fundamental shift in the studio — from singular effort project to a larger (in time, scale, and commitment) collaboration (Figures 5,6).

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Figures 5(Top) and 6(Bottom): Alternative Urban Futures for Duluth

5**.0 Year Two: The 2013 Design Studio, or, Where we're at**
We've attempted this year to more rigorously ground the studio with a more robust conceptual framework, to better pace the structure of the studio and to get students on the ground much more quickly. We limited the number of projects (all of them concentrate on Duluth), and all of them require students to work in multidisciplinary teams.

This year we've also introduced a related seminar that we've connected to the studio via macro and micro content lectures and workshops. As a way to encourage students to remain flexible and adaptable at ALL scales, some lecturers speak to large scale, theoretical issues of resiliency or risk, while others deal with very focused, particular and granular issues.

5.1 Project One: Abducing the Past
This first project of the Design Duluth studio focused on critical analysis, processes, organization, and hierarchy. Information overload, first used by Alvin Toffler in the 1970 publication Future Shock, is a now commonly used phrase (rehashed as "linkbait" ad naseum) that refers to surfeit of virtual and real "stuff" that flows through our daily lives. Clay Shirky notes that historically information have been mediated and filtered by a third-party —publishers of books, movie studios, art museums and galleries, etc. have controlled production and distribution. With the advent of the internet, the costs of production have dropped precipitously

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and modes of distribution have also multiplied. The responsibility of filtering (or the faddish curating) has moved to other parties, including the user/consumer.

We now collect (as well as re-source and re-mix) concepts, ideas, frameworks, and details from many sources. These virtual and material bits of data are (usually) collected unconsciously and obsessively, poorly documented, and rarely cited. For all its problems, current remix culture mimics, through the action of critical re-appropriation, historical modes of creation in design and the arts — though this studio proposes to "academic up" the remix by focusing/obsessing on processes and by requiring attribution of all contributory material. Why? We are trying to embed resilience in studio processes. Thinking through resiliency requires explicit definition of systems, systems bounds, thresholds, and failure points. Design and the boundaries of that system (all the stuff we do, consume, and produce while producing) will be — in this studio at least — recorded, analyzed, filtered, and represented to make explicit the decisions and materials that are part of the product and product rhetoric. Working in these interdisciplinary teams, students were asked to reverse engineer/perform a forensic analysis on the logic and design decisions of last year's given landscape and architecture projects through the evidence provided by the assigned datasets (Figs 7,8)
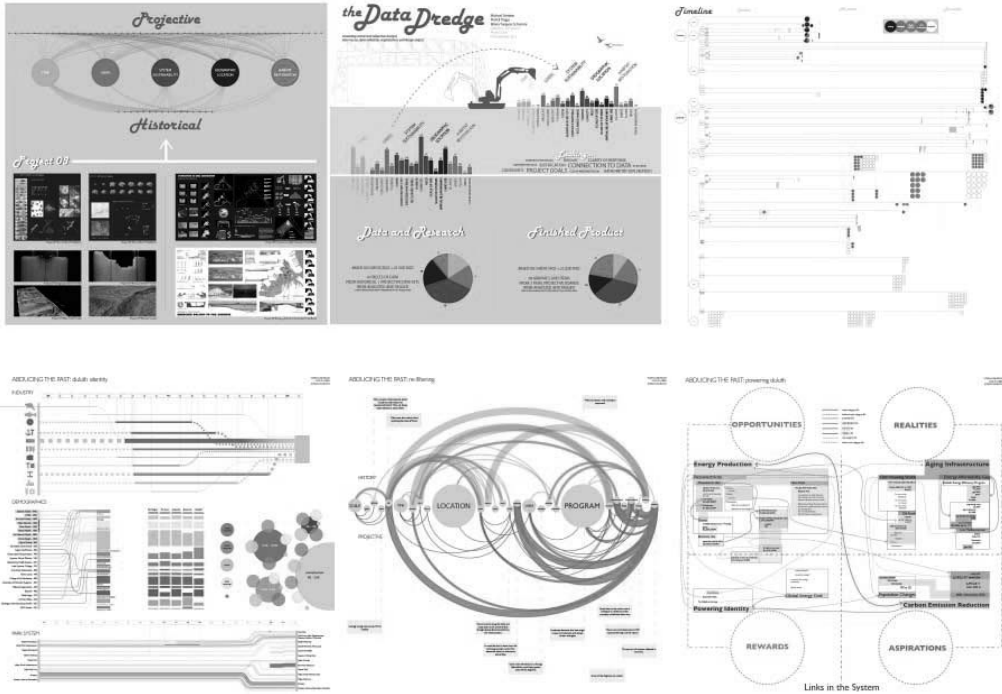
Figures 7(Top) and 8(Bottom): Reverse engineering 2012 Projects

5.2 Project Two: Gaps and Fills
As an isolated inquiry, each group analysis of the datasets from Project 1 indicated/suggested the interests/obsessions of a subset of last year's studio. This inquiry leads directly to Project 2 — the transfer/translation of abstracted knowledge to the world. Project 2 requires that each group transfer and translate the abstract knowledge gained of Duluth to the physical city — and to search for site-specific circumstances of found/recorded overlaps, redundancies, specific and non-specific indicators, potential gaps, missing information, missing programs, etc. For this project, students were asked to generate responses to site-specific instances of overlap/gap/etc(Fig 9).
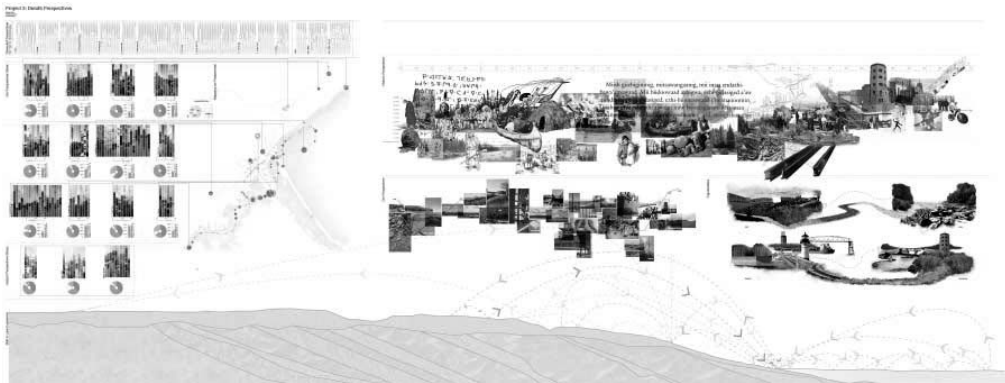
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Figure 9: Gaps and Fills

5.3 Project 3: Systems/Systems/Systems

For this project, students were asked to prepare a system-based scenario condition for Duluth, to analyze and interpret it through analytical, conceptual and design lenses, to cast-back and challenge initial assumptions and to further develop the crafted scenario. They were given an introduction to futurist strategies for scenario development ("The Long View," "Think from the Outside-in," "Embrace Multiple Perspectives") and to be clear about the nature of their scenarios (renamed as "inflection points" in order to dispense with the sometimes accumulated "preciousness" of particular scenarios). They were asked to clearly orient, explore, synthesize and act (Fig 10).
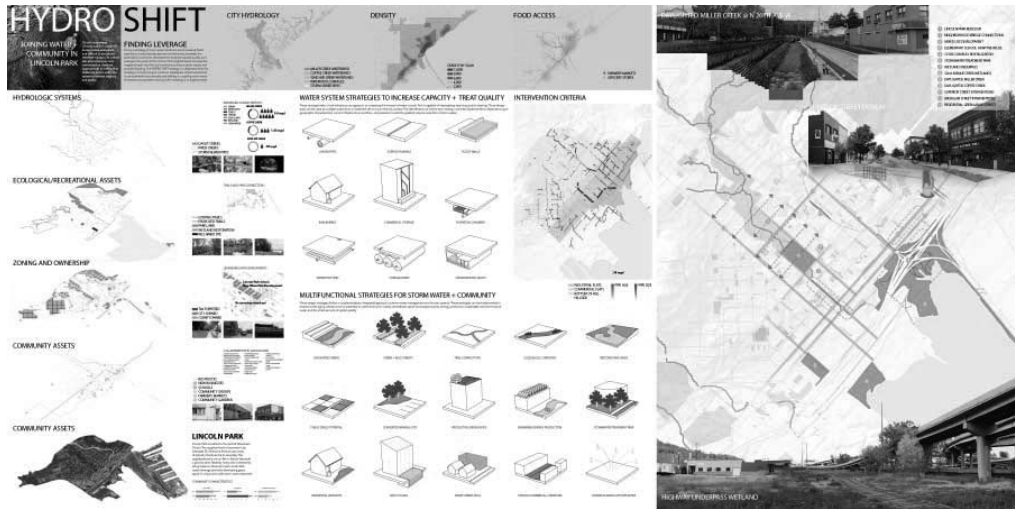

Figure 10: Potential Duluth scenarios

6.0 What we learned

As part of the post-studio evaluation from 2012 (Fig 11), we wanted to reassess what we had done in terms of pedagogy, studio direction, and community engagement. This reassessment is the foundation for another 6 years of studio teaching. The first run of the studio biased data over place and, most importantly people. The network of assets cultivated for Project 5 (over 24 organizations) became both engine and fuel for the studio. Getting connected — on the ground — faster is key to more informed data gathering, analysis, and the generation of

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transformational and projective data sets. Mapping within this grounded context is less abstract and less disconnected.
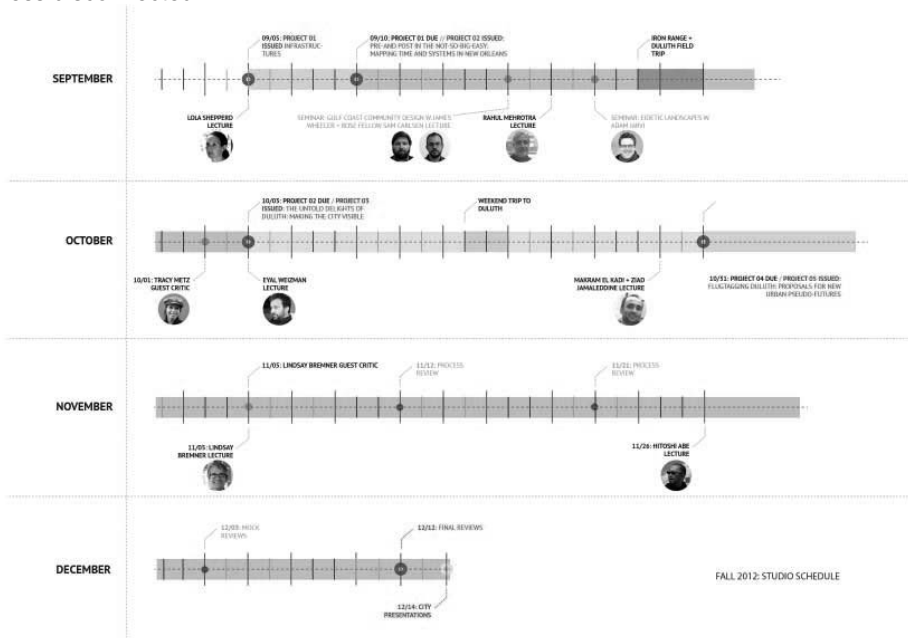

Figure 11: 2012 Studio Structure

Assigning five projects over 15 weeks was overwhelming. Large scale systems need time and productive gestation to be understood and to become useful — overlapping systems are less daunting when they are critically contextualized. We will, in the future, prioritize this across the design studio semester.

The output generated by students needs to be understood, contextualized, analyzed, transformed, and re-represented. And then reprocessed once again. Process, as a system for the organization and processing of data is critical to the studio. Complex systems defy first passes; they themselves contain processes and relationships that are not easily distilled. Process in future studios (as a technical standard and working method) will be embedded in project briefs and structures of work (Fig 12). Students will be asked to turn data into tools, and will be required to develop a system to manage systems.

- **Designers must be system thinkers.** Design Duluth is premised on the fact that only by engaging with complex and multiple systems (economic, housing-stock, transportation, water, food-systems, socio-cultural, socio-political) across a variety of scales (site to region) can we leverage interdisciplinarity as a transformative urban agent.

- **Studio projects must be grounded in community and in connection to the people who live there.** Grounding the studio in the City of Duluth brings forth vibrant projects that stem from the community. Work must deal with "the messy everyday" and generate grounded responses to difficult issues.

- **Every design studio should be (in part) an innovation hub — to cluster talent, resources, information, and tools.** The work of the studio relies on a network of individuals and organizations: community members, professionals, and academics that provide local and specialized expertise and to serve as resources (and educators) for a networked learning experience that happens within and outside the bounds of the University. In order to respond sensitively to the city context and

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develop innovative future scenarios, we seek out local expertise and knowledge as resources for design and as a forum for community engagement. Duluth benefits from the development of new networks through the collaboration of experts and community members in new forums for engagement.

- **Resilient design is grounded in building tight information feedback loops.** The Design Duluth studio is an informational free-for-all that not only encouraged open data exchange policies – it fundamentally requires it. This allows for a deeper and more nuanced exploration of complex systems and the minimization of research redundancy.

- **Mandate adaptation to site, context, and studio successes and failures.** Built into the Design Duluth collaboration is a strategic flexibility that allows for fluidity (of processes, strategies, and actions) and a fixedness (of values, long-term goals, and purpose). By collecting and systematizing as many types of information possible (the city's goals, current and long term projects, student process and design, points of contact and information sourcing) we will increase our ability to contextualize changes in understanding the needs of the city (and the students) and respond to these shifts over time.

- **Develop pedagogical design process and project prototypes (and products).** For Design Duluth, we are interested in developing prototypes of design processes with the potential of delivering projects and policies that propose lateral solutions to difficult and complex problems. We hope that the design processes and their products become a method for the city to visualize existing and potential opportunities for a resilient future. Resilient design that addresses risk management by mapping systemic fragilities and thresholds is a driver for developing new technologies that helps communities decouple from ecological scarcity and uncertainty.

- **Create and Build Capacity.** The current Design Duluth studio now has 5 faculty members with a variety of time commitments (2 full-time and 3 adjunct/part-time) and has secured over $50,000 in funding for academic and further community engagement. We are committed to the development of a long-term vision for Design Duluth and the building of capacity through teaching, community engagement, and the delivery of speculative projects. Design Duluth now cycles through a process of idea and design generation (the fall to winter design studio); reassessment, refinement, and synthesis (winter to spring); and restructuring and reframing of the studio process and theoretical and pragmatic approaches (summer). This annual cycle has an embedded responsiveness to new knowledge, relationships, and funding, and generates a feedback loop/cycle that both informs and transforms our methods of teaching, structuring community relationships, and delivering projects. Building on past projects, each subsequent studio will have the ability to analyze and (hopefully) develop more nuanced and complex projects. This is an important methodological shift in teaching environmental objectives — they are too complex and susceptible to change over time to not rely on interdisciplinary collaboration, data sharing, and a foundational knowledge of the historic, current, and projective future of the city.
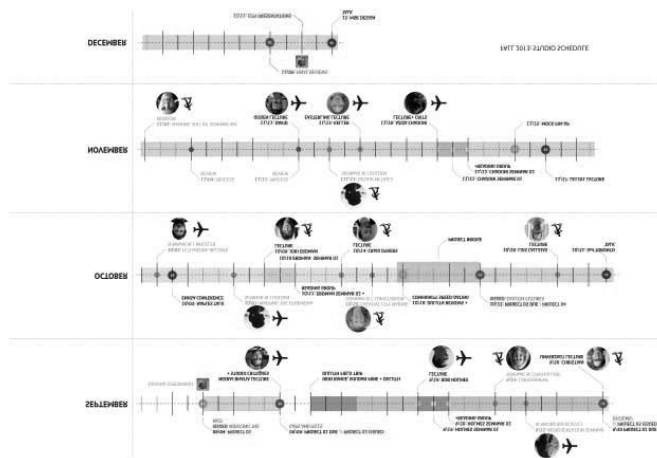
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Figure 12: 2012 Studio Structure
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02: Angela Bateson, Kammeron Hughes, Julian Lemon (Design Duluth Studio, 2012)
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10: Amber Hill, Elissa Brown, Yong-Sam Kim (Design Duluth Studio, 2013)
11: Fall 2012 Design Duluth Studio Schedule (Ozayr Saloojee, Vince DeBritto)
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ENDNOTES

i   The 2000 Census set the population of Duluth at 86,918, a small increase from 1990 Census population of 85,493. This slight population increase ended a 30-year decrease in population from the population peak of 106,000 people in the 1960 Census year. The 2012 Census estimates the current population to be 86,211 (http://quickfacts.census.gov/qfd/states/27/2717000.html, accessed 12 August 2013).

ii   The Minnesota poverty rate is 11%. Household income for family of three living in poverty is $17,374 while the median household income in Minnesota is $58,476 (http://quickfacts.census.gov/qfd/states/27/2717000.html).

iii 17% of whites also live in poverty (http://unfaircampaign.org/wp-content/uploads/2011/09/Racial_Disparities_and_Poverty1.pdf, 2010 Census).

iv   An estimated 17.5cm of rain fell over a 24-hour period. (http://www.crh.noaa.gov/images/dlh/StormSummaries/2012/June19_flood/Records.pdf).

v   Ironically, this overlay method was pioneered by Warren Manning and Charles Eliot while working in the Olmsted office in the 1890s (see Neckar, Lance. 1989. Developing landscape architecture for the twentieth century: The career of Warren H. Manning. Landscape Journal 8: 79–91). In Duluth, the past is a dimension of present and future. This looking back (both in process and context) is a core component of the studio. David Gissen observed that "But the idea of the future always implies a present and a past-and we need to think about what the role of the historical might be within some near or immediate concept of the future." David Gissen, interview with Geoff Manaugh in Geoff Manaugh, 2013. Landscape Futures: Instruments, Devices and Achitectural Inventions. New York, NY: Actar Press.

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