Innovative, Place-based Solutions: The value of interdisciplinary perspectives

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Abstract

Too often, problem-solving is undertaken in separate disciplinary silos, but the toughest challenges today are anything but narrow issues. Issues of climate change, disaster recovery, rising seas, and social change have diverse causes and broad impacts. New ways of thinking and fresh perspectives are needed to help build more resilient coastal communities in an ever-changing world. This paper explores interdisciplinary collaboration in a competition setting through our first-hand participation in two design competitions (Changing Course and Rebuild by Design) as part of interdisciplinary teams. This paper evaluates the potential of interdisciplinary collaboration and competitions to produce more innovative ideas for difficult coastal challenges. In the Changing Course Competition, using an interdisciplinary approach helped our team develop ideas to create a more sustainable Mississippi River Delta. Our approach - a "Delta for all" creates positive outcomes for flood protection, navigation, economic development, regional ecosystems, fisheries, and communities. Our team's work for Rebuild by Design reflects the strong collaboration between designers, ecologists, biologist, social scientists, and community leadership to create a more resilient Jersey Shore. These innovative collaborations all contribute to building a new type of resiliency—one that not only protects the beach, but also enhances social capital and connectivity. We confirm that interdisciplinary collaboration can contribute to solutions that are context-based, integrated, and implementable, but that the competition format can have mixed results.

1. Introduction

Too often, problem-solving is undertaken in separate disciplinary silos, but the toughest challenges today are anything but narrow issues. Issues of climate change, disaster recovery, rising seas, and social change have diverse causes and broad impacts. New ways of thinking and fresh perspectives are needed to help build more resilient communities in an ever-changing world. Addressing the scale of these complex, "wicked" problems[6] requires solutions that are bold, innovative, and appropriate for the scale of the problem. Coastal settings in particular face many of these sorts of challenges, with changing environmental conditions that are difficult to forecast, the possibility of increasing frequency and severity of storms, and many different actors with divergent, sometimes competing motives.[7]

With such complex challenges and many unknowns, developing effective solutions is clearly not a straightforward, easy path. What models, methods, or practices help enable innovative thinking? Interdisciplinary collaboration and competitions are two vehicles that are generally believed to produce innovative outcomes by encouraging unconventional thinking and approaches. However, the opportunities – or challenges – of combining these two methods have yet to be fully evaluated.

The authors of this paper – including a coastal engineer, social scientist, and two urban planners - have collaborated as parts of two teams on the Changing Course and Rebuild by Design competitions. Changing Course is a design competition for the lower Mississippi River Delta, and the Rebuild by Design competition is an initiative of the Hurricane Sandy Rebuilding Task Force. This paper will explore our first-hand experience as interdisciplinary teams tackling difficult coastal and resiliency issues in a competition setting – and the opportunities for innovation that came as a result.

Our experiences in Changing Course and Rebuild by Design provide two case studies, showing how interdisciplinary perspectives in a design competition context contribute to solutions that are context-based, integrated, and implementable. Together with geomorphologists, hydrologists, a top oyster scientist, geotechnical and coastal engineers, ecological scientists, wetland ecologists, geologists, navigation experts, community leaders, and others, we have developed innovative ideas for addressing land loss in coastal Louisiana and rebuilding a more resilient Jersey Shore.

Based on our experience on these two teams, we will discuss the following key questions in interdisciplinary teamwork:

- What do interdisciplinary, systems-based solutions look like?
- What factors contributed to innovation? How were successful teams built?
- What methods or practices were successful in overcoming common challenges with interdisciplinary collaboration?
- Does interdisciplinary collaboration enrich ideas? What about the competition format?
- What is the value of combining science with design-thinking?

This paper will begin with a review of existing literature on interdisciplinary collaboration and competitions. Next, we will describe and discuss our experience as part of interdisciplinary teams in a competition context. Case Study 1 focuses on the Baird Team's concept for Changing Course. Our approach of "A Delta for All" – with an interdisciplinary team and deeply integrated process - contributed to innovative ideas for a more sustainable region. Our integrated approach helped reveal additional benefits and immediate, positive outcomes for flood protection, navigation, economic development, regional ecology, fisheries, and communities. Case Study 2 discusses the strong

[6] Brown, Deletic, and Wong write that sustainability is one example of a "wicked problem" (2015). These challenges are inherently complex, poorly defined, characterized by incomplete and/or rapidly changing information, and not able to be addressed by any one discipline, institution/agency, or actor.

[7] Including, for example, state agencies, US Army Corps and other federal agencies, private corporations, local political leaders, and diverse communities – some wealthy and others socioeconomically disadvantaged

collaboration between designers, ecological scientists, and community leadership that was fundamental to the Sasaki Team's "Resiliency and the Beach," our model to create a more resilient Jersey Shore. Our team's collaboration has contributed to building a new type of resiliency—one that not only protects the beach, but also enhances social capital and connectivity. Finally, we will conclude by sharing lessons learned through these collaborations to provide advice and takeaways for other teams. With complex challenges occurring throughout the world in many coastal settings, there are analogs elsewhere, suggesting the value of developing models that can be shared, tested, and redesigned. We hope sharing our experience will help others design collaborations that are equally fruitful!

2. Background / Literature Review

The need for interdisciplinary collaboration

All too often, experts forget that "problems of society do not come in discipline-shaped blocks."
– Moti Nissani, quoting R. Roy (1997, p. 209)

The need for teamwork that draws upon different disciplinary perspectives has been well established in many diverse topics: complex environmental issues (Brewer, 1999; Brown, Deletic, and Wong, 2015), landscape architecture (Stokols, 2011), engineering education (Davis and Masten, 1996), energy studies (Sovacool, 2014), and the challenging, complex problems of today's society (Blackwell, Wilson, Street, Boulton, and Knell, 2009; Nissani, 1997, Ledford, 2015; Szostak, 2002; Stock and Burton, 2011). Simply put, "many problems today … need more than one kind of knowledge to solve them" (Blackwell et al., 2009, p. 3).

What sets interdisciplinary teamwork apart from other forms of collaborative research is that individuals representing two or more disciplines work in an integrated team to combine knowledge from different perspectives solve a common problem (Blackwell et al., 2009; Nissani, 1997; Szostak, 2002; Brewer, 1999; Stock and Burton, 2011). Related, but distinct teamwork structures that involve more than one discipline include "multidisciplinary" (different disciplines work in parallel without significant integration) and "transdisciplinary" (groups work in such an integrated fashion that they seek a "transcendence of disciplinary perspectives" (Stock and Burton, 2011, p. 1098); groups can include stakeholders or the general public, and may require crossing boundaries at the levels of institutions or the forming of new disciplines (Blackwell et al., 2009; Stock and Burton, 2011)).

Benefits

Interdisciplinary thinking has been on the rise for the past few decades in the natural sciences and engineering and the social sciences (Van Noorden, 2015). Today it could be at an all-time high, as demonstrated in publishing trends; more than one-third of the references in scientific papers now point to other disciplines (Ledford, 2015; Van Noorden, 2015).

The appeal and success of interdisciplinary research is due to many of its potential benefits. First, by bringing together ideas from many backgrounds and perspectives, it facilitates creative breakthroughs and richer ideas capable of addressing complex problems (Paulus, 2000; West and Sacramento, 2006; Sovacool, 2014; Nissani, 1997). Nissani describes how complex topics like the Cold War are impossible to be understood from a single disciplinary perspective; viewpoints from many are needed to more fully understand the many dimensions of the subject (1997). Showing how interdisciplinary teams can generate innovative ideas and also facilitate implementation, Brown et al. describe how combining technical expertise focused on stormwater technologies with social science centered on urban water governance has helped increase implementation of sustainable water practices in Australia, Singapore, China and Israel (2015).

Second, interdisciplinary teams ensure that questions will arise about practices that are accepted as state-of-the-art in other disciplines, raising likelihood of innovation. Nissani, for example, describes the ability of "immigrants" to be able to be more critical of accepted theories and practices because of their newcomer status. He posits, "The natives live and breathe their customs; the perceptive foreigner doesn't…Disciplinarians often commit errors which can be best detected by people familiar with two or more disciplines" (1997, p. 205).

Third, the innovative solutions of interdisciplinary collaboration, however, are often enabled by another benefit of interdisciplinary thinking that comes towards the very beginning of the process. Often, interdisciplinary groups will realize that the given question is only part of the real challenge. By reframing the question, groups give themselves a "broader canvas" which helps enable them to see more options; in turn, this can lead to "radical successes" (Blackwell et al., 2009, p. 82) and "better solutions" which can more comprehensively address the underlying challenges (Szostak, 2002, p. 118). As Blackwell et al. summarizes, "Successful interdisciplinary outcomes … involve not only new answers, but also new questions. …All too often interdisciplinary teams are brought together 'to fix the plumbing' – only to tell the client – 'we can fix the plumbing sir, the problem is you're living the wrong house'" (2009, p. 82).

Additional benefits described by Nissani include the growth of knowledge, other social benefits, and personal rewards (1997).

Challenges

Interdisciplinary collaboration, however, is not easy. In fact, many of the aspects that contribute to the promise/potential success of interdisciplinary collaboration are also what make it exceptionally difficult. With the potential for teammates to act as competitors and jockey for position or on the other hand, slack off while others think, teamwork in general can be difficult (Paulus, 2000; Chatenier, Verstegen, Biemans, Mulder, and Omta, 2009). Add to this individuals with very different perspectives and backgrounds, and the challenge can be even greater (Brewer, 1999; Nissani, 1997). Brown, Deletic, and Wong describe the challenges that resulted when social scientists and biophysical scientists are asked to work together:

> We witnessed biophysical researchers accusing social scientists of poor rigour and of spending too much time conceptualizing problems without exploring and offering solutions. Conversely, social scientists were often frustrated that biophysical researchers were too focused on solutions, reductively overlooking the wider societal implications of their proposed solutions. (2015, p. 316)

Sovacool similarly describes a similar challenge of social science being undervalued in energy research (2014).

At the core of these communication challenges is often a result of individuals speaking different disciplinary languages (Davis and Masten, 1996; Paulus, 2000; Oskam, 2009; Brewer, 1999). Overcoming these challenges and developing constructive working relationships is possible, but it takes time. The length of time typically required for successful interdisciplinary collaboration can be another challenge (Blackwell et al., 2009; Brown et al., 2015).

Team management, unsurprisingly, is another challenge. The first challenge is knowing which disciplines to draw from to address a problem. If time allows, the first set of recruits may be better positioned than the convener to identify needs from neighboring disciplines. Getting a diverse group to work well together can be a demanding, grueling charge. Furthermore, the unpredictable nature of collaboration can add to the challenges of management. Since one of the benefits of interdisciplinary teamwork is reframing of the problem, the final outcomes or necessary path to get there cannot be predicted at the beginning of a process, which can make management trickier. Blackwell et al. demonstrate these challenges through an imaginary interdisciplinary sales-pitch, "You might not get what you expect but trust us, it will be valuable, but it may be difficult to measure in a comprehensive way, and oh yes, it might take longer than we initially said" (2009, p. 81).

Finally, institutional structures and practices that have been organized along disciplinary lines can deter interdisciplinary research. Promotion decisions, journals and publishing, and funding tend to prioritize specialization over interdisciplinary development (Brewer, 1999; Brown et al., 2015; Blackwell et al., 2009). Some of these barriers, however, are more inhibiting at the individual level than for teams.

Best Practices Literature Review

What makes interdisciplinary collaboration work well? How can we maximize benefits while overcoming challenges? Existing literature provides suggestions for how to build productive teams that work together effectively. Key elements include the following recommendations:

1. *Cultivate a collegial atmosphere of trust and mutual respect, which fosters constructive dialogue.*

   With communication a critical factor for team success, cultivating good team dynamics are essential. Brown et al. recommend teams "forge a shared mission" and "nurture constructive dialogue" (2015, p. 316 and 317). Building personal relationships among team members and an atmosphere of collaboration and mutual trust is important to ensure that everyone is comfortable sharing their ideas and ideas are considered with an open mind (Chatenier et al., 2009; West and Sacramento, 2006; Ledford, 2015). Collaborative dialogue is key to success and innovative thinking. As Oskam (2009) describes:

   > It is not sufficient to merely cut up the assignment into small sections, allow each discipline to deal with its own bit of the project and then glue the pieces back together again (multidisciplinary cooperation). Interdisciplinary teamwork is needed through which the design problem is investigated jointly, solutions are elaborated and models are made and tested. (p. 7)

2. *Find the leader with the right personality and background to direct an interdisciplinary team and process.*

   The leader plays a particularly important role on an interdisciplinary team, helping to integrate knowledge while also building the "team." He or she must carefully facilitate the process and cultivate team dynamics towards a shared mission (West and Sacramento, 2006; Chatenier et al., 2009; Paulus, 2000). Blackwell et al. finds that a special type of leader is needed – one with "passion" and "humility" (2009, p. 65-66). Curiosity and drive are needed to keep the process moving forward despite setbacks; an open attitude is key to recognize contributions from other disciplines. West and Sacramento found that the leader's technical background was especially important for facilitating innovation, playing a key role in problem-solving and recognizing potential hurdles and opportunities (2006).

3. *Team Diversity: Assemble a team with "the biggest box" possible, including expert – yet open-minded – individuals*

   What characteristics make for a successful team? Fudge and Roca (2012) find that "assembling a group of people only capable of thinking 'outside the box' clearly won't be sufficient for success, as the generation of the idea is only one part of the process"; they posit instead that the foundation of a good team is starting with "the biggest box possible" (2011, p. 3).

   Some disagreement exists about the desired level of diversity – both from disciplinary and demographic perspectives. Diversity of knowledge is needed, but is more always better? West and Sacramento find that more diversity is a good thing (2006), but Paulus believes that too disparate knowledge foundations can hinder communication, leading to lower levels of innovation (2000). Demographic diversity has found to have mixed results (West and Sacramento, 2006; Paulus, 2000); experts believe that the impact, again, is on the ability of team to communicate effectively. Too little demographic diversity can mean less interesting ideas, but too much diversity can inhibit communication. Other aspects of diversity found to be favorable include: social scientists in addition to engineers and other scientists (Brown et al., 2015; Sovacool, 2014); diverse personalities types, leadership attitudes, and educational backgrounds (West and Sacramento, 2006); women (Sovacool, 2014; West and Sacramento, 2006); and minorities (Sovacool, 2014) has been found. As discussed, the importance of communication cannot be overlooked. Accordingly, the need for team members to have good communication skills is a must, particularly to explain complex ideas (Davis and Masten, 1996). The makeup of a team may have special importance when the team works on problems that are relevant to public or policy, particularly if they have to interact with clients or members of the public

from different demographic groups. A socially diverse team is more likely to have broader awareness of public issues and can appear more credible to some audiences.

The best team members typically display an openness to new ideas and have strong synthetic and analytic abilities (Blackwell et al., 2009; West and Sacramento, 2006). Many find that the best teams, especially for complex challenges, are comprised of individuals who are experts in their own disciplines. In their aptly-titled paper "Superman or the Fantastic Four: Knowledge Combination and Experience In Innovative Teams," Taylor and Greve (2009) explore whether individuals or teams are more effective at innovation. Their findings suggest:

> Individuals are capable of more creative integration of diverse experiences than teams are. Combining knowledge requires a deep understanding of knowledge, rather than information scanning or exposure... When seeking innovation in knowledge- based industries, it is best to find one 'super' individual. If no individual with the necessary combination of diverse knowledge is available, one should form a 'fantastic' team, with each team member having deep knowledge and experience working with the other team members. (p. 735-737)

Given the challenges of the most complex problems today, the possibility of finding a contemporary Renaissance man or woman with the right combination of deep, yet diverse, experience across all relevant fields for a particular challenge is slim at best. Therefore, the need for team members to be experts in their own discipline is critical. Brewer supports this idea, calling for "excellent disciplinary specialists" (1999, p. 333). The idea of deep experts, but also open to new ideas and with some exposure to related fields, is captured in the idea of "T-shaped" individuals (Oskam, 2009; Brown et al., 2015). "T-shaped" describes an individual who has an expert background in one discipline (represented by the tall part of a "T") combined with knowledge of related disciplines (the top horizontal line of a "T"). This related knowledge is especially helpful when "T-shaped" individuals work together, helping them more easily bridge gaps between disciplines and communicate with one other while also offering their deep perspectives to the issue at hand.

Design Competitions: The Opportunities and Drawbacks

Design competitions are used to generate innovative ideas for buildings, products, public spaces, communities, or other topics. During a competition, teams or individuals are given a challenge or design prompt. They then work to develop their ideas for a relatively short time-frame and then submit their proposals. Competitions are common in design fields like architecture, landscape architecture, urban planning, and urban design. In fact, 77% of designers who responded to a recent Van Alen survey indicated they had entered at least one competition in the past two years (2015).[8] For example, the 9/11 Ground Zero Memorial design competition asked designers to submit designs for the memorial landscape in New York City.

Design competition organizers can be a city department, private company, university, foundation, or other organization or individual. The focus of design competitions is typically physical design concepts, but they can also include policy ideas, especially if the scale is larger than a single site. Compared to traditional architecture or design projects, "ideas" competitions often have fewer constraints: there are fewer budgetary or practical limitations and the design team is typically free to develop ideas without the input of a client. After ideas are submitted, a jury evaluates all the entries and selects the "best" idea declaring a single winner. Sometimes the prize of winning is implementation of the design; other times the prize may simply be a small monetary purse and additional exposure and publicity for the winner. For non-winners, the project can be added to their portfolio.

[8] More than 1400 designers from around the world responded to Van Alen's survey (2015). Of these respondents, most had a professional background in architecture (79%); 8% were trained in landscape architecture and about 2% each in urban planning and urban design. Demographically, 66% of respondents were male and 29% were female; 69% were white/Caucasian, 8% were Asian or Asian American, 5% were Hispanic or Latino, and 2% were Black or African American.

Design competitions are notoriously demanding, poorly compensated (sometimes even including the winning team!), and may not lead to implementation.[9] So what motivates designers to continue participating in these events? Given the low likelihood of winning/implementation, teams must feel the publicity and prestige will be compensation enough. According to the Van Alen survey, the top four reasons respondents enter design competitions are:

1) The opportunity to experiment, work more creatively than in typical projects (57%),
2) Interesting issue (55%),
3) Opportunity to gain publicity (39%), and
4) Opportunity to build portfolio in particular sector (38%).[10]

These results reflect that design competitions can be a chance to explore issues and develop experience in new topics which traditional projects do not. In other words, designers view competitions as an appealing chance to be more innovative than typical projects afford. For many, a particular competition's benefits may outweigh the drawbacks.

Design competitions commonly are entered by individuals or teams, but it's less ordinary for competitions to include multiple disciplines. Design competitions and interdisciplinary teamwork are both believed to create innovative results, but they are not typically paired. About half of respondents to the Van Alen survey indicated they rarely or never work with other design disciplines (architecture, landscape architecture, planning, etc.). An even higher percentage (70%) reported rarely or never working with professionals outside of the design fields.

Recently, competitions have been changing shape. Competitions are becoming more complex events, with multiple stages, a more collaborative structure, and more than one "winner" (Lampel, Jha, and Bhalla, 2014). These shifts have been more common in ideas competitions than in design competitions.

3. Case Study 1 – Changing Course

Context: The Changing Course Competition

Southeast Louisiana, including New Orleans and the surrounding region, has been experiencing "a coastal crisis" (2012 Master Plan, p. 15). Since 1930, 1,880 square miles of wetlands have been lost, a rate of 12,000 acres per year, the equivalent of one football field each hour. Scientists project that if nothing is done, land loss could continue to increase, to 22,200 acres per year, totaling an additional 1,750 square miles lost by 2062 (Coastal Master Plan 2012). Much is at risk – culturally, economically, and ecologically. The 2012 Coastal Master Plan tested many ideas for restoring the coast. Through research and modeling, the Master Plan team found that realigning the river had the potential to be the most effective, but did not go any further under the 2012 plan.

To help test the possibility of river realignment, Environmental Defense Fund, Van Alen Institute, and other foundations and organizations organized a five-month-long design competition. A group of selected teams was asked to develop solutions for the region that would address three goals:

- Maximize restoration of a functioning Deltaic system (land building and natural habitats) in areas adjacent to the Mississippi River and below New Orleans
- Continue to meet the needs of navigation, flood protection and coastal industries and communities
- Contribute additional innovation, competition, and private sector engagement in time to inform Louisiana's next coastal Master Plan in 2017 in terms of a possible option for river mouth re-alignment

[9] The Van Alen Survey found that the #1 limitation to participation in design competitions was the lack of compensation for time/resources spent on competition (79%). The next common constraints were the low probability of winning (29%), no or low chance of implementation (29%), jury decisions too subjective or not primarily based on the merits of the proposal (27%), insufficient time allotted to produce entries (27%), and minimal recognition and visibility for non-winning submissions (25%).
[10] Respondents could select up to three answers, so percentages do not total 100%.

Our team, the Baird Team, was one of three teams selected for of the competition, and also one of the three teams later declared winner.[11]

Beyond the obviously difficult challenge of addressing regional land loss, the competition itself presented several challenges for our team. The six month competition timeframe (after about a year-long selection process) was much shorter than conventional projects of this magnitude. Likewise, the budget was much smaller. The competition work was also governed by a strict confidentiality agreement; we were not allowed to include public outreach in our process, a significant drawback to creating an implementable solution by not allowing a more open process or public input. The lack of prior public consultation was especially concerning given that much of the loss is due to oil and gas activities that are crucial for that state's economy and that many residents in the most vulnerable sites are poor or members of minority ethnic groups.

Our Team

Our team, The Baird Team, includes a core group of about 21 experts representing more than 15 disciplines and sub-disciplines, along with support from many others at Baird, Sasaki, Tetra Tech, Applied Ecological Services, Research Planning Inc. and Vickerman and Associates. Some team members represent firms; others are academics from the Louisiana State University, the University of New Orleans, and other universities. Overall, our team was designed with expertise across a broad range of topics: coastal engineering, geospatial modeling and analysis, geomorphology, environmental science, ecology, geology, urban and regional planning, socio-economic analysis, social science, landscape architecture, graphic design, geotechnical engineering, shipping & navigation, dredging, flood risk, oysters, fisheries, wetlands and nutrients, flow of nutrients and sediments, and watershed and river considerations.

Team members were also asked to be more than experts – to also represent the perspectives of related stakeholder groups. For instance, Tom Soniat, an oyster scientist, helped our team understand how oystermen might view our ideas. With very limited outreach allowed by the competition's strict confidentiality rules, we had to build outreach into our internal team as much as we could. Unique among the three teams, we also had an internal stakeholder group – the Navigation Expert Advisory Panel (NEAP), which included five top representatives of the Louisiana navigation community, including leaders of the two major ports and leaders of the pilots associations. The NEAP advised on issues of shipping and navigation.

Originally, the team was conceived as a combination of a "Fresh View Team" with international experience and the "Delta Team" with deep delta roots and local knowledge. Fresh View team members bring independent, new perspectives based on a wealth of international experience. Most members have not been involved in previous CPRA or Corps efforts on coastal protection and restoration in Louisiana. The Delta Team features top local experts, many of whom have spent decades researching and understanding key areas associated with this challenge.
In practice, the team operated as a cohesive unit, with Fresh View and Delta Team members working collaboratively together.

[11] In a surprising outcome, the competition organizers determined that all three teams would be declared winners, recognizing the valuable ideas that each contributed. This outcome is quite unusual for a design competition!

Figure 1: Original Team Chart included in our pre-competition qualifications submission

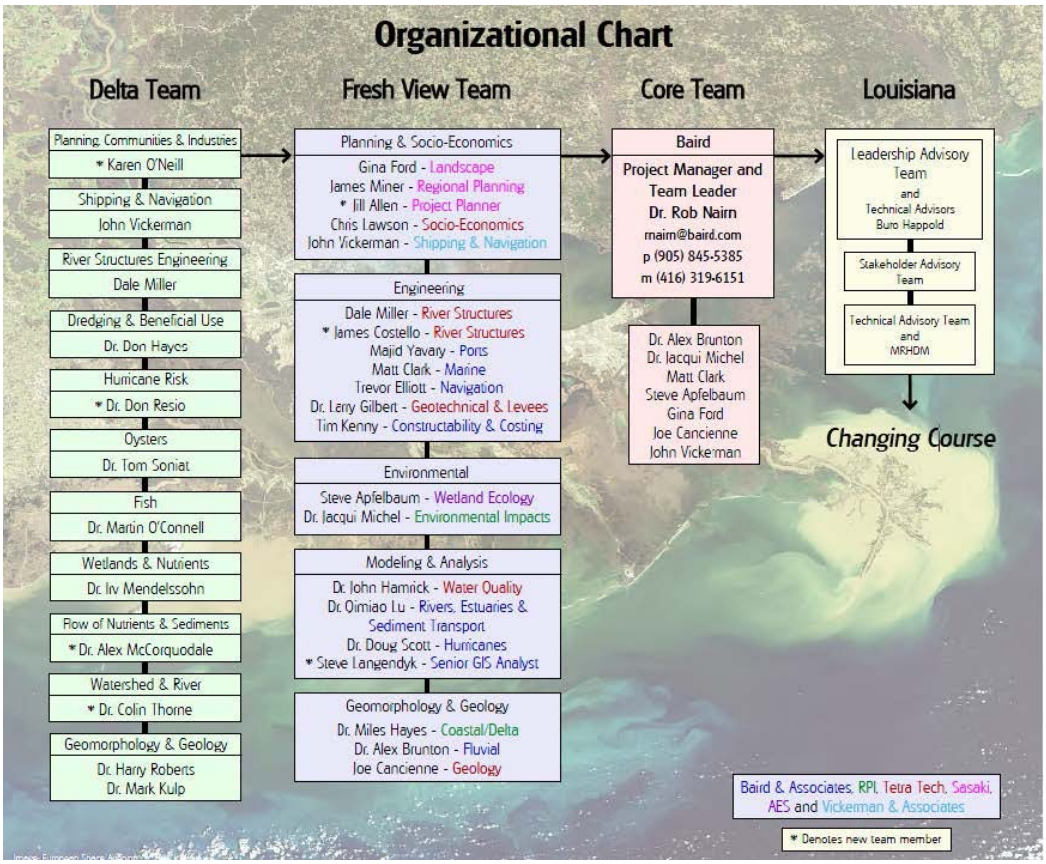
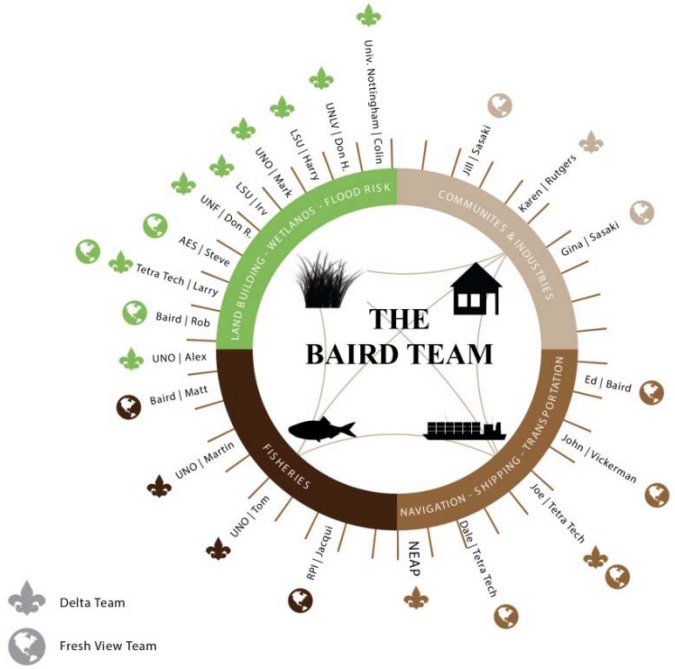


Figure 2: How we actually worked: An Integrated, Collaborative Team



Compared to a typical design competition team, our team represents a much broader range of disciplines and collaborated more closely (often, competition teams with several disciplines more commonly operate with each discipline working in parallel, rather than collaborating in a more integrated manner). Baird's lead role on the project is also a distinguishing factor; it's extremely rare for a design competition to be led by an engineering firm.

Our process – from a diverse group of individuals to a collaborative team

To work together effectively, our group of experts needed to become a "team." Many team members had experience working with one or two others, but the group as a whole was assembled specifically for this competition and the diverse challenges of coastal Louisiana.

During the year-long selection stage (which included submitting qualifications, interviewing, and providing a more detailed proposal), we began the process of forming a true team. The Baird team leaders began by carefully identifying the right combination of individuals and conducting one-on-one calls to discuss key issues in detail. Located across the US and in several other countries, our process included several all-team conference calls early in the process. These were organized as structured sessions, with each person given a designated time to share his or her background. A similar process occurred over two days in New Orleans around the team's interview. These sessions set the stage for our team's successful collaboration by giving the full team a common knowledge base of the very wide range of issues in the region.

Once our team was selected as one of three to participate in the competition, our collaborative process continued. The heart of our team's interdisciplinary collaboration was two core team workshops at the University of New Orleans. These were full-day gatherings, conducted on donated time over weekends. Navigation experts learned about oysters and wetland nutrients; geologists were enthused by the idea of "the economic delta." The days were intense, but overall quite enjoyable for our team. Many ideas – even seemingly crazy ones – were suggested and considered. Through these debates and discussions, our team's core ideas took shape. We used de Bono's *Six Thinking Hats (1999)*[12] to structure our brainstorming and found it an effective tool for group discussions.

Through these workshops, smaller working groups developed, focused on topic areas like fisheries; communities and industries; navigation and shipping; and land building, wetlands, and flood risk. Following the workshop, these groups worked together to refine and evaluate ideas and develop more detailed strategies.

The Complex Challenge of Coastal Louisiana: The Foundation of Our Team's Innovation

The geological challenges of Southeast Louisiana are well documented and widely cited: The region is losing land at a rate of a football field each hour (rates cited in 2012 Coastal Master Plan are equivalent to this factor). The large-scale manipulation (via dams, levees, and channelization) of the river's natural course has served our nation well over many decades, allowing for more stable navigation, more suitable areas for habitation, and somewhat more predictable flood risk. Yet, it has also had significant consequences, including an increasing and alarming rate of land loss in recent decades.

Land loss in the Mississippi River Delta is caused by three dominant factors:

1. The river is carrying three to four times less sediment than it once did.
2. Sea levels are rising and land is sinking.
3. The sediment in the river today is being sent out into the Gulf of Mexico, a by-product of channelization.

[12] Edward de Bono's 6 Thinking Hats is a brainstorming tool. Six colored hats each represent a different type of information/thinking and are used sequentially to allow for a thorough consideration of ideas. During a brainstorming session, team members all wear the same hat (ie. think in the same way) at the same time. Hats include new ideas/creativity (green hat), information/facts (white hat), overall procedure/process (blue hat), caution/critical thinking (black hat), optimism/benefits (yellow hat), and feelings, intuition, and emotion (red hat). For more see de Bono, E. (1999). *Six Thinking Hats* (2nd ed.). Boston, MA: Back Bay Books.

Other factors contributing to land loss include dredged canals, oil and gas extraction, roads, and other landscape changes.

The Changing Course competition was primarily conceived to address the challenge of land loss by asking teams to study river realignment options. Ecology and wetlands–creating functioning deltaic habitats – were to be the primary focus. We were only asked to "continue to meet the needs of navigation, flood protection, and coastal industries and communities." Our team added the phrase "and expand opportunities for" to this statement to reflect our more aspirational goal ("continue to meet the needs of and expand opportunities for navigation, flood protection, and coastal industries and communities").

Our team's innovative ideas were a result of redefining the problem early in the process. From many different perspectives, coastal Louisiana was struggling, and our team came to see that land loss was only part of the challenge. John Vickerman, our navigation expert, explained how the Lower Mississippi River is nearing capacity and will soon be unable to accommodate increased demand anticipated with the Panama Canal expansion. The need for a 50 foot or deeper channel is growing more urgent, but maintenance costs for maintaining the current depth are increasing each year. One of our paper's authors, Karen O'Neill, a social scientist from Rutgers, helped the team understand the struggles, uncertainty, and very tough choices facing coastal households. How do residents choose between staying where flood risk is known to be high or moving to a safer, more expensive home away from their close-knit local social network and largely water-dependent livelihoods? Tom Soniat and Martin O'Connell, respectively an oyster and a fisheries specialist at UNO, explained how many Gulf fisheries are approaching a tipping point. Experts know that at some point, the wetland loss will be severe enough to lead to widespread challenges, but it's not clear when this point will arrive. More land/wetland building is needed, but land-building options like diversions will bring freshwater impacts to estuarine fisheries.

The list continued, with each discipline explaining a different social, ecological, geological, political, and economic challenges. **These individual challenges had been recognized by others, but had not been considered together. Our team's strength and early innovation was combining all existing information to obtain a comprehensive view of the many challenges facing the region, its communities, fisheries, ecosystems, and economies.** With such a complex challenge, our team set a bold goal for a concept for the region: A Delta for All.

The Innovative Ideas: A Delta for All

The idea of "A Delta for All" inherently reflects our team's interdisciplinary spirit. Our solution for creating a sustainable delta needed to benefit the delta's full range of stakeholders; unlike previous planning efforts, it would not focus on land creation at the expense of others (estuarine fisheries, especially oysters) or without regard to possible synergies (navigation). The innovation at the heart of our team's work was an optimism and a desire to seek solutions that would work together to address the complex challenges of the region, building more land while at the same time improving navigation capacity, reducing flood risk and uncertainty for delta communities, growing regional economies, and creating a diversity of delta ecosystems to ensure the long-term health of local fisheries. Addressing the diverse, complex challenges of the region demands an interdisciplinary and bold approach. Creating a sustainable delta is not possible by "tweaking" the existing system; the scale of the solution must align with the scale of the challenge. Therefore, our team seeks to re-invent the system in a revolutionary vs. evolutionary way.

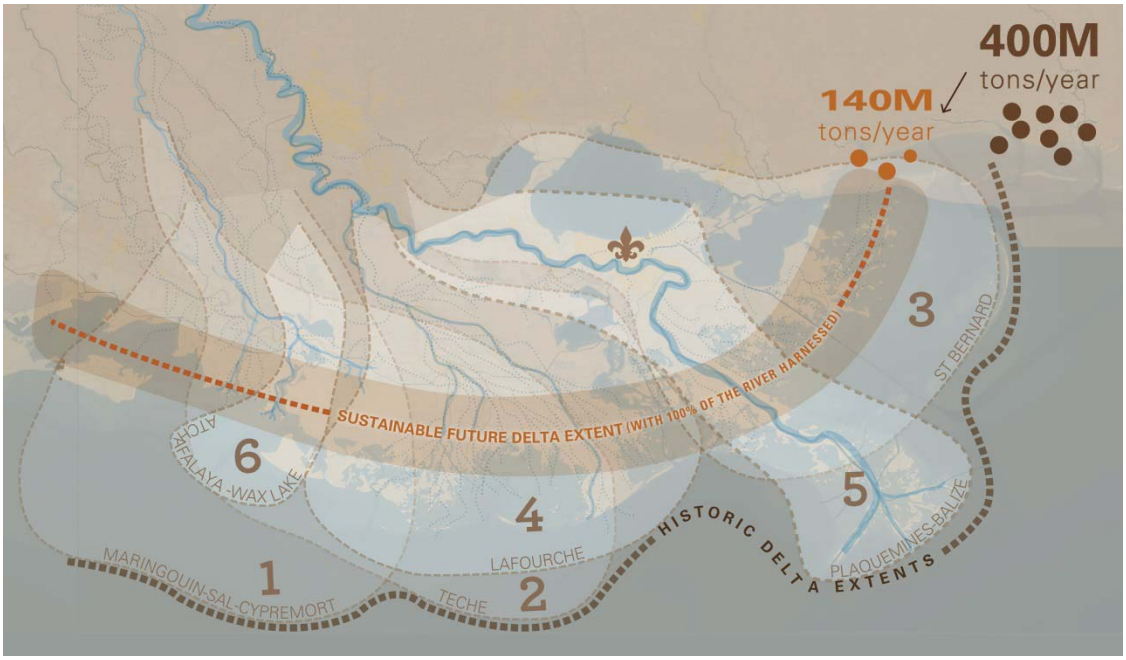
Through many spirited debates, off-the-wall ideas, and gradual progress, our team's ideas took shape. The core idea was is to build with the river, harnessing the natural deltaic land building processes of distributary deltas, by creating and managing new river distributaries or mouths (think of them as faucets).[13] These "managed distributaries" would be opened and closed every 50 years or so to build new sub-deltas within the sustainable delta footprint. The new

[13] The infrastructure for our river mouths will consist of a series of modular lift gate structures that can be opened and closed as required. We believe that once a desired flow is attained, the gates will remain open most of the time until the new sub-delta is complete in approximately 50 years time. The modular construction will allow re-use of these gates at new river mouths that are turned on in the future as we cycle between basins, resulting in significant cost reduction. The gates will be transported through flotation for initial deployment and future deployment at new locations.

river mouths would be much larger than the diversions currently being studied by the Louisiana Coastal Protection and Restoration Authority (CPRA).[14] Together, the goal was to harness 100% of the river for new land-building; "capture every grain" became our team's mantra.

The benefits of - and the need for - this bold goal quickly became clear through our team's calculations. With the input from our team's geomorphologists like Harry Roberts, our team completed a preliminary sediment mass balance to determine how much land we can realistically expect to maintain in the future in the face of relative sea level rise. With one-fourth of the historic sediment loads flowing through the river today, rising seas (1 m), and land subsidence (about 0.5 m on average), the results are startling: even if we harness 100%, the sustainable delta is only about half the size of the historic Delta. Our team's plan is bold out of necessity; the future delta will be smaller, but we want to make it as big as possible.

Figure 3: The Sustainable Delta (if 100% harnessed)

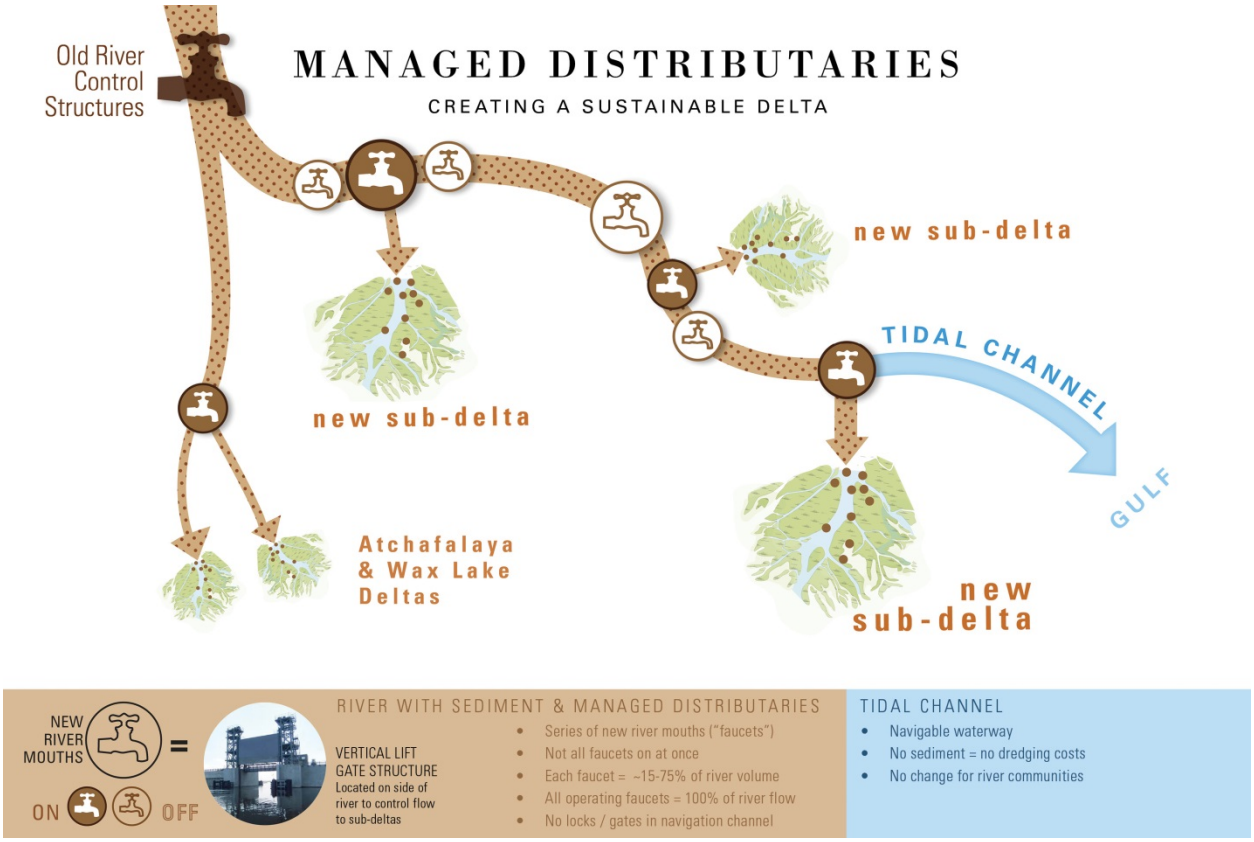


Our approach would place the last new distributary mouth somewhere in the vicinity of English Turn, just downstream of New Orleans.[15] The primary reason for this relates to focusing land building at "updip" locations (further inland where subsidence is lowest and trapping efficiency will be highest). The existing lower Mississippi River below English Turn would become a tidal navigation channel without river flow or sediment. Together these two simple ideas of harnessing 100% of the river and placing the last distributary near English Turn are what revolutionize the system and provide huge immediate flood protection and navigation benefits – advantages not gained by the Master Plan diversions, either individually or collectively. By placing the last distributary outlet near English Turn, we are "taking the river with sediment out of the channel."

[14] Even if all the Lower Mississippi diversions in the State Master Plan are implemented only 50% of the river would be harnessed (including the Atchafalaya and Wax Lake Deltas).

[15] Our team has completed hydraulic analysis and 2D numerical modeling of several different combinations of new river mouths to verify that target distributions of flow and sediment can be achieved through a combination of sizing and gating the outlets (and importantly, without structures in the river). This work also yielded some important principles for planning new river mouths, one of which would be to have the largest outlet at the most downstream location. Also, it was shown that gates may not be required on the smaller, upstream outlets.

Figure 4: Managed Distributaries Concept



Together, this approach reflects a systems-based, bold solution to create a more sustainable delta. The benefits it creates are diverse, reflecting the many disciplines that collaborated to create it. Key benefits include immediate flood risk reduction, expanded navigation capacity, community benefits, and ecological enhancements.

Immediate Flood Risk Reduction

With all approaches, it will take at least 15 years to realize tangible benefits on flood risk reduction from building new land. Our approach, however, does not take a decade or more to provide significant benefits. In fact, taking the "river out of the channel" below New Orleans has game-changing benefits immediately in terms of flood risk reduction. Our approach takes the New Orleans area's flood risk from 1 in 100 year protection to more than 1 in 1000. This reduces the risk of severe flooding over the next 50 years from 40 percent under the current system to less than 5 percent. The risk reduction is experienced during both river floods and hurricanes.

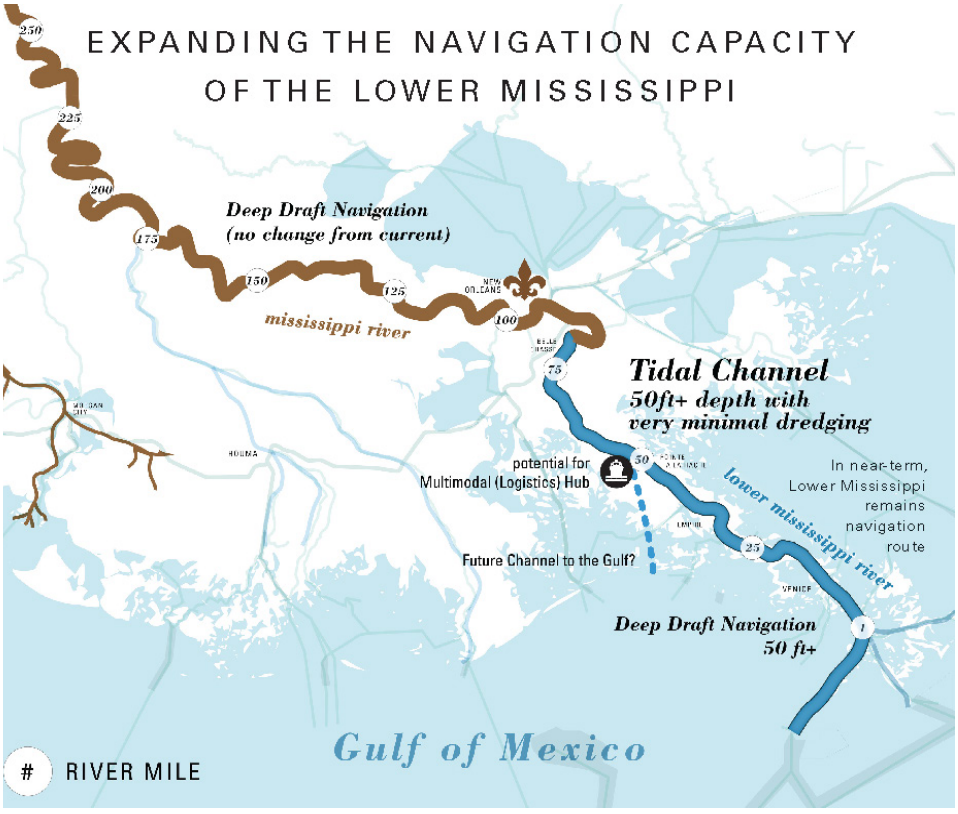
River floods: Through hydraulic analysis we have shown that peak river flood levels through New Orleans and further upstream will be reduced by 10 to 15 feet by moving the primary river mouths to locations at/or upstream of English Turn. The levees that have recently been reconstructed to an elevation of 25 feet were within one small tropical storm of being significantly overtopped during the 2011 river floods. In addition to risk reduction there will be huge avoided costs in the future, because there will be a significantly reduced need to raise the river levees through New Orleans and upstream in response to sea level rise. Reducing river flood levels by 10 to 15 feet is similar to an increase in levee height by the same amount for river flood protection. In addition, the Bonnet Carré spillway would no longer be needed, resulting a future avoided cost of replacement of approximately $500 million.

Hurricane surge: Taking the river out of the channel, allows the opportunity to create a series of storm surge relief channels at strategic locations through the Mississippi River levees (on both the east and west sides) below English Turn. Through parametric storm surge modeling with ADCIRC by Don Resio we have shown these channels would reduce hurricane surge levels on the southeast side of New Orleans by at least 5 feet during Katrina-like events. Similar to the river flood benefit, not only does this reduce flood risk, it also defers significant future levee upgrade costs. We have estimated that the surge relief channel components of our plan would increase the level of protection from a 100 year to a 700 year return period. Savings associated with avoided damages would be in the billions.

Navigation and Shipping Benefits: Expanding the Capacity of the Lower Mississippi River

The other huge and immediate opportunity for benefit from our plan relates to navigation and shipping. The nation stands at a watershed moment for navigation and related marine commerce. With increased exports of agricultural products, natural resources and manufactured goods, the Panama Third Lane, the recently completed Suez Canal expansion, the Lower Mississippi River needs more capacity for the future. By placing new river mouths upstream of English Turn, the river and its sediment are separated from the navigation channel; south of English Turn, the Lower Mississippi becomes a tidal channel, unlocking huge benefits for navigation.

Figure 5: Navigation Overview Map



The greatest current need for shipping on the Mississippi River is to increase the navigable depth to 50 feet to allow larger ships passing through the third lane of the Panama Canal to navigate the Mississippi River. Deepening the river is necessary to ensure the ports of southern Louisiana can keep up with other ports nationally and globally. By taking the river out of the channel below English Turn, dredging costs will plummet because we fully remove the river sediment supply that necessitates maintenance dredging of the lower course of the Mississippi. This means a

significant reduction (if not complete avoidance) of $50 million/year currently expended on dredging for the 45 feet deep channel and $140 million/year for the projected maintenance dredging that a 50 feet deep channel would require.[16] By taking the river out of the channel, it will be possible to consider increasing navigable depths to much greater than 50 feet if and when the need arises in the future.

Additional navigation benefits created by "taking the river out of the channel" include:

- Extends the service life of the Southwest Pass
- Provides the possibility of a new channel to the Gulf, around River Mile 50, saving more than 30 miles and associated transit times to all facilities above River Mile 50 on the Mississippi and resulting in significant economic advantages to both imports and exports.[17]
- With the reduction in water levels through New Orleans the IHNC and Harvey locks that are long overdue for replacement will no longer be needed for navigation purposes. Operational costs for those two locks and the Algiers Lock will also be avoided in the future, an annual savings of $2 to $3 million each. Eliminating the need for the locks also increases navigation capacity and reduces transit times.
- Allows for future expansion of the river width without the attendant sedimentation that would occur under the current system. It will be possible to expand anchorage areas, existing ports and to create an inland port basin rivaling the largest in the world.
- Possibility of a multimodal logistics hub

Our team's navigation options benefited from the advice of our Navigation Expert Advisory Panel (NEAP), which consisted of senior leaders of key local ports, both pilots associations, and the Marine Navigational Safety Association.

Other Community Benefits: Help Transitioning, Less Uncertainty, and Greater Economic Opportunity

For many people of the Delta, home is more than a house. Home is a way of life that is largely defined by the broader ecological context and a series of deep social networks. The ecological context includes the waterways and wetlands that provide diverse economic and recreational activities. The social networks are rich communities that make relocation, even in the face of repeated disaster, hard. Yet, generational change is happening. Inherited ways of life no longer always coincide with an increasingly global and technological context. The next generation struggles with reconciling years of tradition with new horizons. Families struggle with community identity: How can a way of life be preserved, yet adapted to new ways of working, thinking, and recreating? How can memory be passed down without being a limitation to an ever-expanding future? Our solution aims to begin to answer those tough questions.

Our plan aims to improve current quality of life and the future outlook for Delta communities and businesses. Importantly, by defining the sustainable perimeter (the land area that can be sustained over the long-term), we reduce uncertainty and allow for more planned transitions to safer areas. Communities outside the sustainable perimeter will likely need to move – but no sooner than in a future without a plan.

Economically, our plan catalyzes the growth of new fields like ecotourism and delta management, while also supporting existing sectors. We want to broaden the local and regional economy so residents have more employment options. The implementation of such a bold plan will vault Louisiana into the lead worldwide in sustainable Delta management. As a catalyst for this economic development we propose Delta Discovery Centers, located near the mouth of each new sub-delta. These centers will be hubs for education, job training, research, and ecotourism.

[16] There will, however, be some sedimentation from tidal action and suspended sediment moving upstream from the Gulf.
[17] The option to create a new, shorter channel is made more feasible by taking the river out of the channel below English Turn as this avoids the need for control structures and precludes heavy sedimentation that might otherwise occur at the opening to the new channel.

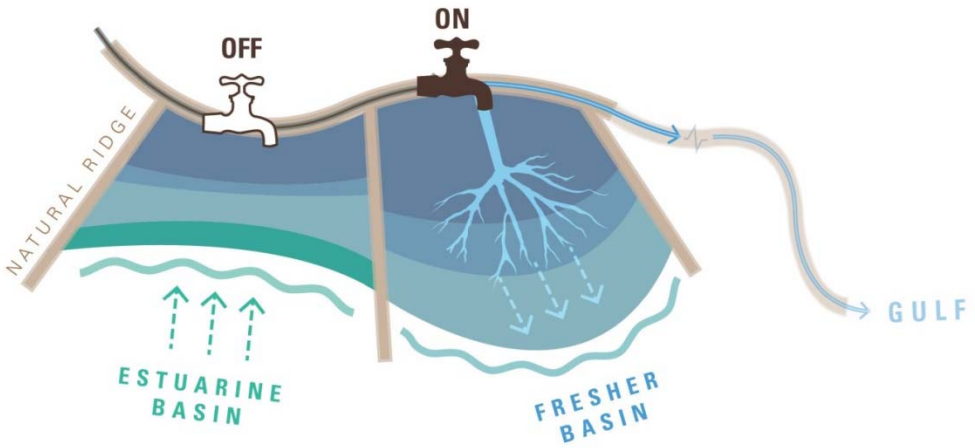
Innovation example: Our Two Home Program aims to help coastal communities transition, by providing a means for groups that wish to move more inland to do so. It would be a voluntary, but assisted program, where groups could acquire lots in areas more protected from flooding. In the near-term, this protected home could be used on a more temporary basis, but could shift to be a more permanent home in the future as conditions change. The 2 Home Program could coordinate with the Louisiana Land Trust (LLT), which is the land bank mechanism in the state with the authority to collect properties and transfer/ sell ownership to others. In the near term, the 2 Home Program can coordinate with Parish governments, which now have legal authority over surplus LLT parcels acquired through the Road Home Program. This program can help reoccupy vacant land inside of protective levees, while providing more flexibility and choice to Delta residents. There are few examples of successful relocation in the US beyond very small communities, so this community safety program would be just as innovative as the engineering components of this plan. It would provide a model for coastal transitions that could be used in many vulnerable deltas around the world.

These benefits to communities were developed through close collaborations between a flood risk expert, social scientist, urban planners, and landscape architects.

Fisheries Benefits: Managing Switches and the Delta Cycle; Preserving the Estuary

Building with the river maximizes land growth, but it introduces freshwater into areas that are currently estuarine, significant for commercial fisheries and oysters. Our plan acknowledges that this is a very difficult tradeoff. We must find a way to balance the needs of all residents of the Delta to find a way forward. We cannot afford to sustain the Delta solely through dredging, so our plan begins to identify ways to build with the river while also providing the greatest possible support for the fishing community. We seek to find an equitable balance between freshwater and estuarine areas through turning new river mouths off and on with time. This approach replicates the natural delta cycle of growth and abandonment, supporting ecological restoration to the fullest extent. Importantly, this approach ensures fisheries will stabilize in the future, rather than approaching a looming tipping point with wetland loss leading to dramatic collapse of the industry.

Figure 6: Managed to Preserve a Balance: Not all distributaries operate at the same time



To assist impacted fishermen with the transition to a delta that is not estuarine in all basins, our team developed a range of initial ideas and options. With some basins estuarine and others fresher, fishermen in areas that have been made fresher could choose to respond in many different ways, including:

1. Move to an estuarine location in the new delta where they can continue to fish the same species
2. Move to a central location and fish in any of the estuarine areas in the delta

3. Stay, but change to recreational fishing
4. Transition into another related or unrelated field

Our team also developed tools and programs to support these options including the 2 Home Program; Delta Discovery Center for job training and opportunities to lead ecotours; and the Mississippi Delta Working Landscape Conservation Reserve (a governance framework for the region based on a public-private partnership model)

This topic benefitted from collaboration of fisheries scientists and an oyster expert, working with wetland scientists, ecologists, engineers, planners, and landscape architects.

Summary

Through interdisciplinary collaboration, we have developed a revolutionary plan that is sustainable, feasible, and fiscally responsible, restores land and wetlands, and achieves both short-term and long-term benefits for navigation and flood protection, serving a wide range of stakeholders - A Delta for All, sustained for future generations. By taking an interdisciplinary approach, we have created an approach that brings a much broader range of benefits than would have been possible if we had focused solely on wetlands or any other single topic.

4. Case Study 2 – Rebuild by Design

Context: The Rebuild by Design Competition

Rebuild by Design[18] is a competition that asked some of the world's most talented design professionals to envision solutions that increase resilience across the region affected by Hurricane Sandy in 2012. Launched in the summer of 2013, the Rebuild by Design competition has produced regional, cross-disciplinary collaboration between state and local governments, international design teams, educational institutions, and the public. The competition is one of the initiatives of President Obama's Hurricane Sandy Rebuilding Task Force, in partnership with the Municipal Art Society, NYU's Institute for Public Knowledge, Regional Plan Association, Van Alen Institute, and Rockefeller. Together these partners create a more complex “client” group than is typical of competitions. The client group was a multidisciplinary partnership in itself!

Leveraging nontraditional partnerships among designers, scientists, the local communities, and the federal government, Rebuild by Design set a goal of developing resilience solutions that are locally contextual, but also regionally scalable. The competition itself was envisioned as an interdisciplinary opportunity, as explained by Henk Ovink, Principal of Rebuild by Design, and Senior Advisor to Secretary Donovan:

> Understanding what really is at stake and what happened during hurricane Sandy informs a path forward that can reconnect the social, the economy and the ecology … Design can bridge these gaps and marry science and politics, the real world with imagination. Rebuild by Design is not about making a plan, but about changing a culture (quoted in HUD, April 20, 2014).

10 teams were selected from 148 proposals from around the world to participate in Rebuild’s two-stage, 7 month design competition. The first phase, “Collaborative Research,” focused on analysis at the scale of the region, and the second phase paired teams with different communities to propose specific ideas to improve resiliency. At the end of the second phase, “Collaborative Design,” seven designs were selected for implementation funding.

Unlike most design competitions, Rebuild did not hand teams a common project or site at the beginning and ask for design ideas. Rather, the competition began by asking teams a more open-ended question: How do we make the communities affected by Sandy more resilient? Other elements of Rebuild also distinguish it from a conventional

[18] RebuildByDesign.org

design competition. First, it featured a more collaborative, open structure. The finalist teams worked independently, but presented in front of one another at interim check-points and participated in joint workshops, tours, and charrettes. Second, the collaboration with local communities and public outreach in the second phase is also relatively uncommon for design competitions. Third, the competition was intended more broadly to influence funding decisions by the U.S. Department of Housing and Urban Development for rebuilding after the storm.

Our Team & Collaboration Process

Sasaki's proposal focuses on resiliency for the Jersey Shore. Our team included landscape architects, urban planners, graphic designers, architects, and urban designers from Sasaki, coastal engineers and sustainability planners from ARUP, and ecologists, biologists, environmental engineers, and sociologists from Rutgers. In the second stage of the competition, our team also collaborated with local leaders in the Union Beach, Asbury Park, Toms River, Berkley Township and Keansburg communities of the Jersey Shore.

As a working methodology, the formal organization of the competition brought the team together regularly for shared site visits, charrettes, public meetings, and seminar-style discussions of key issues. In-person gatherings, at different times in Sasaki, Arup's, and Rutgers' offices, were particularly effective for sharing ideas. Given the rapid pace of the competition and the newly formed team, shared discussions over email, conference calls and other methods were less effective.

Resiliency is a cultural issue, not just an environmental one

Through interdisciplinary collaboration, our team's research and design strategies focus on the value of "the beach." Along the Jersey Shore, the beach is a place of special significance to memory, state and local economies, and a vital component of coastal ecosystems; yet, it is also incredibly vulnerable to sea level rise impacts. Over the past century, Jersey Shore tourism has evolved to play a significant role in the state's economy and in the region's cultural identity. At the same time, practices to support tourism and other development have impacted the underlying ecology and resiliency of the beach and shore communities. Our research underscores that the shore's relevancy and resiliency is much deeper than the narrow strand of sand we typically associate with the beach, where the ocean waves fall. Instead, in order to be truly resilient in the future, the beach must be conceived of as deeper – ecologically, socially, and economically.

In New Jersey, sandy soils extend inland to the Pine Barrens, expansive, ecologically rich pine forests. A series of twenty-two coastal lakes and myriad rivers and creeks connect to estuarine and wetland environments that sit miles inland from the coast. While storm surge and coastal flooding will pose increasing threats to the coastline, the inland environment and patterns of development mean that watershed stormwater impacts will also constitute a significant portion of the future threat for flooding in the region. **Ultimately, the Jersey Shore's future resiliency cannot only be solved through engineering and social solutions that address the immediate coast; a resilient beach must be linked to projects that deepen the physical extent, ecological reach, and cultural understanding of the beach.** Informed by a close reading of the coastal typologies that exist along the Jersey Shore, our team developed a regional strategy and local solutions for long-term resiliency along the Jersey shore. This strategy demanded an interdisciplinary approach and team.

The Foundation: 3 coastal landform typologies

While many economies are powered by urbanism linked to dense cities, the economies of American beaches are an exception, driven instead by the diverse, underlying coastal ecology. Our team's research focused on understanding the characteristics and vulnerabilities of the coast based on physical landscape character. As our team's ecologist explained, every inch of the Atlantic coast of the United States, from the Jersey Shore to the Sandy-affected areas and beyond, can be defined and categorized into three distinct environmental typologies: the Barrier Island, the Headlands, and the Inland Bay. While this information may have been viewed as common fact to the lead ecologist, it was revelatory for the design team and became the foundation of the project's argument and scalability.

Over time on the Jersey Shore, the physical characteristics of each community's coastline have provided the foundation for the ways that adjacent development has grown and evolved. For example, the Jersey Shore's Headlands communities are typified by a public waterfront, with a parallel, linear boardwalk and several blocks deep of waterfront commercial property. In contrast, Barrier Island communities more frequently host private waterfronts, with residential homes built up to the water's edge. Inland Bay communities, which grew up around waterfront industries, have more varied industrial or marina-based waterfronts.

Our team's research has shown that coastal types also directly relate to an area's vulnerability to sea level rise. Along the Shore, an average Headlands community is typically "higher and drier" (at an average elevation of 13 feet) than a Barrier Island community (at 3'). Hence, Barrier Island communities in New Jersey, with densely developed, high value land along ocean or bay edges are highly susceptible to very early levels of sea level rise (1'-2') that pose significant threat to private property. New Jersey's Inland Bay communities are already vulnerable to regular flooding from inland drainage and storms; sea level rise compounds this risk. When measured against other Atlantic Coast barrier island communities, New Jersey's barrier islands also have a marked concentration of second homes, a trait that leads to additional challenges around flood insurance and community cohesion.

Our team used these three classifications to develop prototypical and replicable solutions for vulnerabilities along the Jersey Shore, as well as throughout the region.

Innovative Ideas: Living Infrastructures that link Ecology & Culture

Resiliency for the Jersey Shore, and other American beach communities, necessitates a combination of both regional cooperation and local solutions across multiple disciplines. Like watershed planning approaches which cross jurisdictional boundaries to promote better water management through a regional approach, our project proposes planning for resiliency through strategies based upon the regional coastal typologies. Understanding the different development patterns and vulnerabilities of the Shore through the underlying coastal structure helped shape our team's local pilot projects as well as an overall regional strategy for a resilient future for the Shore. At the regional scale, these solutions include embracing and improving ecology, protecting tourism economies; and strengthening social cohesion through a cross-jurisdictional resilience network.

At the local scale, our team's designs draw inspiration from the iconic elements of the human experience of the shore – the pier, the boardwalk, and the marina. Each of the three coastal types is paired with a distinct cultural emblem that connects people to their waterfronts: the barrier islands with piers; the headlands with the boardwalk; and the inland bay with marinas. In order to design for resiliency, the projects integrate these three cultural icons with greater ecological resilience that will help coastal communities adapt and strengthen in the face of ongoing sea level rise and storm threats.

Three main pilot sites were selected to represent each of the three coastal typologies along the Jersey Shore. The Barrier Island strategy is tested in a district comprised of Berkeley Township, Toms River Township, and Seaside Heights. Asbury Park represents the Headlands condition. Finally, several communities surrounding Natco Lake – Keansburg, Union Beach, and Hazlet – provide a pilot site for the Inland Bay condition. Each of these sites has local and site specific needs, yet also embodies typical conditions that allow the projects to be replicable across other communities on the Jersey Shore as well as the entire Atlantic seaboard. The strategies for each site include social, ecological, and economic strategies, reflecting the close interdisciplinary collaboration at the heart of our team's work.

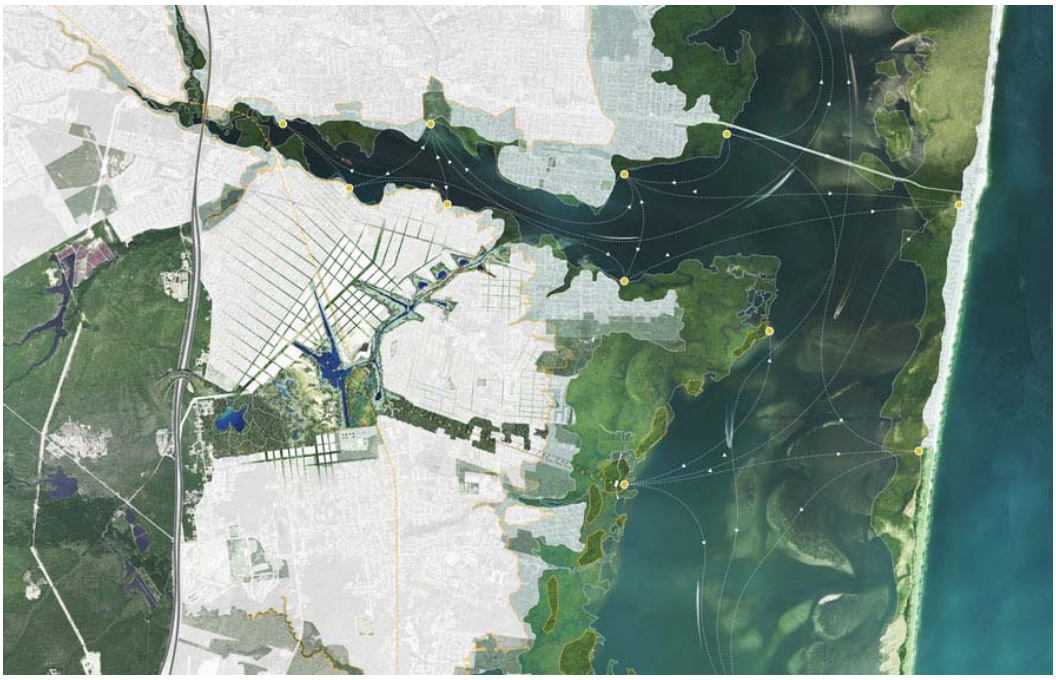
Barrier Island: "Pier-to-Pinelands"

The barrier islands are the most dynamic stretch of the New Jersey shore, constantly shifting with the energy of tide and storm.

While ecological dynamism has been a source of value for barrier island tourism economies, it is their principal threat in the future. With three-feet of sea level rise, barrier islands are projected to lose half their land area; with six-feet, 100% of popular beachside tourist destinations disappear. Compounded by sensitivity to tidal change and storm surge, New Jersey's barrier islands may be uninhabitable a century from now. Rather than fight this shift, our team's project diversifies the traditional beach economy and its location, allowing the economic, social, and ecological health of the barrier island communities to persist and migrate flexibly over time. This project was imagined to be piloted in the area around Seaside Heights, Toms River, and Berkeley Township.

Along the Jersey Shore, the public amusement pier is currently limited to a small infrastructure along the beach. However there is an opportunity to deepen the experience of rich barrier island ecosystems and encourage development to shift to stable, higher zones on the mainland. A new inland "pier" will be an eco-tourism link that reconnects fragmented ecosystem patches, encourages tourists to explore the bay and estuary, and allows ecological structures to migrate over time as salinity levels change, creating a "Habitat Engine" (further described below). Biotic movement and connections from estuaries to the pineland forests secure ecological functions while also supporting a new eco-tourism destination that helps migrate the tourism economy safely inland over time.

Figure 7: Increasing Connections between Inland Forests and the Barrier Islands

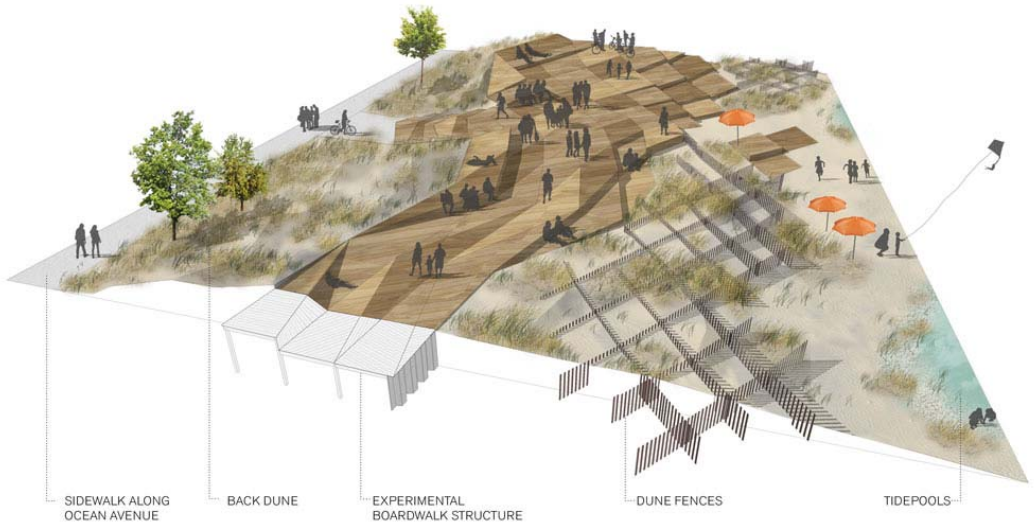


Headlands: "Boardwalk-Dune"

The headlands are the most exposed stretch of the New Jersey shore, with open ocean views subject to the direct action of wind and wave.

New Jersey's Headlands were the first major tourism sites along the North Jersey coast, and as areas that are higher than the barrier islands, they are well poised to serve a renewed purpose for recreation. Resorts, hotels, and vacation home communities sprung up in the late 19th and early 20th century. It is here that the Shore's iconic boardwalk is located—attractive to tourists, but not supportive to habitat. Our team's design explores a more organic boardwalk form. The new boardwalk provides infrastructure to capture sand and form dunes, creating protection while also serving as habitat area for beach wildlife to attract visitors. The design improves inland lakes and green infrastructure to absorb surge and improve urban character, allowing year-round residents to more readily access the beach front. The site for this project is Asbury Park, New Jersey.

Figures 8 and 9: Innovative Boardwalks redefine the Beach Experience by contributing to ecological function



Inland Bay: "Marina-Marsh"

The Inland Bay is the most complex region of the New Jersey shore, with a legacy of industrial uses, densely-populated maritime communities, increasing levels of integration into the Greater New York City economy, and a rich estuarine environment.

New Jersey's Inland Bay communities have grown around the Raritan Bay's protected, brackish, and contaminated waters. The bay's complex conditions create different risks for storms and sea level rise, making New Jersey's Inland Bay resistant to a singular form of intervention. A system of creeks, wetlands, and small lakes that line the shore are prone to flooding from upland areas. Building on their recreational and commercial role, there is an opportunity to restore and re-use these water bodies to enhance coastal protection while providing new sources of recreational value. Union Beach and Keansburg are waterfront towns that border Natco Lake and were heavily impacted by Hurricane Sandy through storm surge and bowl conditions. To create long-term resiliency in all dimensions, our idea is that Natco Lake, an "accidental lake" created by industry, and the surrounding marshland will be nurtured and transformed into an ecological system that helps manage storm surge and water inflow, while also providing a destination for recreational boating and wildlife viewing.

Regional ecological ideas: The Habitat Engine

Enhancing the beach's ecological function is foundational to regional resilience. Defining the coastline as deeper than the water edge allows the experience of the beach to reach miles inland to encompass a more diverse ecology. Along the Jersey shore, this transect reaches from the Atlantic Ocean inland to the Pine Barrens, a heavily forested national reserve of coastal plain that is nearly the size of Grand Canyon National Park.

To maintain critical resources, all elements of habitats will have to move to appropriate conditions as sea levels rise. Our team's ideas included the **"Habitat Engine"** to facilitate migration of species over time in the face of climate change (Handel, 2015). In this strategy, inland ecologies are preserved and prepared for changing conditions, providing stepping stones of habitat for current species to move and adapt over the coming decades. Although it is difficult to know the precise speed or scope of sea change, the Habitat Engine sets the stage for the inevitable movement of coastal resources by modifying the landscape so that it can work in sync with changing hydraulic conditions. Like a mechanical engine, the Habitat Engine will draw along living communities as the vegetation structure matures and conditions for species become available.

Innovative Implementation

Today, the Shore is comprised of dozens of small, discrete municipalities that range in size from a few thousand people to around 90,000 people. One of the most difficult issues facing shore communities, as compared to New York City, is the limited local and political capacity for resiliency planning and the individualized governance structure of small communities along the Shore. Coalitions of non-profits, citizens, and governments must be formed that can scale up or down, serve as resource sharing platforms, and be mechanisms to support disaster response in emergency situations as well. With a collection of coalitions, it can be difficult to mobilize to request support and funding from the state and federal governments. In addition, planning in towns with lower average incomes (Union Beach) and racially diverse populations (Asbury Park) present special challenges for public participation and political cohesion

One of the innovations of Rebuild by Design was linking these communities to interdisciplinary design teams so they would work together to develop resiliency strategies. The idea was that this collaboration could contribute to building a new type of resiliency—one that not only protects the beach, but also enhances social capital and connectivity.

One example of this collaboration, including its challenges and long-term success is our team's work with Asbury Park, a headland community where the idea was to transform the shore's iconic boardwalk into a more diverse infrastructure that would contribute to long-term ecological health of the beach. Asbury Park is an engaged, informed, activist community which has thrown its support behind our project in a compelling and inspiring way. While

the city's leadership was at first difficult to reach, efforts at grassroots outreach produced unprecedented returns in terms of open dialogue, sharing of issues and concerns, high attendance at public events, strong local identity, and a community who surprised us by turning our questions around and asking: "How can we help? How can we do more?"

A public workshop and a community parade facilitated conversations around risks and opportunities for the Headlands region. They were also a way to identify key stakeholders for involvement as part of the resilience network. The public meeting was held in the City's art house theater The Showroom, offered by the theater's owners as a showing of support for the project. Attendance exceeded our expectations, requiring us to quickly adjust and conduct two meetings in a row that evening to accommodate everyone who wanted to attend. The local Environmental and Shade Tree Commission, select City Council members, advocacy groups like NJ Surfrider and the American Littoral Society, and local residents all came together to promote the event, resulting in its impressive success. The community has followed up by producing letters of support and offering clear, critical and constructive feedback on our ideas to make them compatible with community goals.

At the conclusion of Rebuild, our team's proposal was not one of the seven projects that received funding. However, in the year that has followed Rebuild's conclusion, the Asbury Park community has shown that the seeds of increased collaboration and greater resiliency planted during the competition have had lasting impacts. After Rebuild, the community leaders most involved in the competition successfully ran for office locally. They have now created a Resiliency Task Force for the community, which in turn is able to advocate and plan for even greater resilience. This outcome points to the long-term opportunities for increased local capacity through innovative partnerships.

5. CONCLUSIONS - Lessons Learned / Tools we found effective:

Case study results discussion

Our experience in these two competitions confirmed the value of interdisciplinary collaboration in innovation. Working with others from different backgrounds helped us see the challenges differently, and ultimately develop richer ideas than any single discipline could have working in isolation. The balance of designers, social scientists, and others with more technical backgrounds helped our solutions combine qualitative and quantitative approaches at multiple scales, as well as clearly communicate our ideas to a broad range of audiences. This combination also holds promise for implementation: by approaching a challenge from multiple outlooks, our solutions are more robust from technical, policy, social, and economic perspectives.

However, we noticed that some aspects of design competitions can be challenging, especially for interdisciplinary teams. How can we ensure that competitions involving interdisciplinary teams are sustainable methods for generating more innovative ideas, capable of tackling the complex problems of today's society? Based on our experience, our team offers the following **four suggestions for improving the likelihood of innovative ideas in interdisciplinary competitions**:

1. ***Challenge: The timeframe of competitions can be too short to develop effective interdisciplinary relationships.***

   Opportunity: Focus on team bonding and discussion early to jump-start collaboration, or build teams with members who have prior experience working together when possible.

   Developing an effective interdisciplinary team is not an immediate, easy task. Because competitions are often only several months, they do not always include the time needed to form a cohesive team. While it is unlikely that an entire pre-existing team would have the exact suitable combination of knowledge and skills for a newly announced competition, it can be helpful to build a team ensuring at least some team members have previous experience working with one another. Many members of our Changing Course team, for example, had worked with one or more other team members previously, helping teamwork go more smoothly from the start. In Changing Course, our team also took advantage of a longer selection process to

begin the team-building process. Team conference calls and other discussions helped us gel as a team early, allowing us to hit the ground running at the official beginning of the competition.

We also found that in-person meetings are especially valuable for the team-building process. When teams are built for a particular complex challenge, team members are likely to be geographically dispersed, but finding opportunities for in-person meetings periodically is important.

2. ***Challenge: Tension between "doing the right thing" and "winning the competition"***

   Opportunity: Broaden evaluation methods and provide wide-ranging decision-making criteria from the outset

   With a common structure of "winner take all," competitions can provide mixed motivations for teams. The "right" idea might not be the "winning" one. With very complex problems, innovative solutions are not always the straightforward or attractive ones. By fully understanding the challenge, an interdisciplinary team will be aware of the inherent tradeoffs and tough decisions that may be needed to move towards a balanced solution. This solution might be the "right" answer over the long-term, but may not look as alluring to a traditional jury decision. How do we make sure that competitions continue to tackle tough problems and reward truly innovative thinking? In resilience discussions about the coast in particular, policy solutions such as managed retreat from the shore or development incentives are options favored by experts for many coastal sites but a difficult topic to broach within the confines of a competition's goals, timeline, and outreach processes.

   Decision-making criteria and jury composition influence competition outcomes. Are there opportunities to think beyond the traditional jury to allow a more balanced evaluation? Could competitions set out goals or metrics in advance and require teams to include an evaluation of their ideas? This method could improve transparency in jury decision-making and ensure resilience values are clear.

3. ***Challenge: Innovative, but complex, interdisciplinary ideas may not fare well against more focused, disciplinary approaches in competitions.***

   Opportunity: Frame competition goals broadly and provide holistic selection criteria that promote interdisciplinary systems-based thinking.

   On a similar note, jury decision-making, or implementation funding choices in general, can overlook interdisciplinary ideas in favor of more single-minded approaches.[19] A team may choose to focus on one discrete aspect of a challenge, and then develop a solution that performs extremely well for that one topic; however, that strategy leaves interdisciplinary value out. This approach can lead to measurable benefits, but these benefits come at a high opportunity cost. By tackling complex problems by disparate and contained approaches, bigger opportunities and synergies are lost. Complex problems need systems-based, integrated solutions. The near-term successes promised by more focused solutions can look more appealing to a jury - or to others - evaluating with a more traditional disciplinary mindset. We need platforms that make space for both the near-term, singular solutions and the messy, complex ones. Perhaps competition awards could make room for different kinds of winners, including most innovative or best solution for a messy problem, not just recognizing "First Place."

   Ensuring all teams are pursuing challenges in an interdisciplinary, holistic manner can help avoid jury selection bias. The competition brief and structure could help frame the challenge in an interdisciplinary manner and show that interdisciplinary thinking would be an essential evaluation criteria. Competitions

[19] The challenges of getting interdisciplinary work recognized and celebrated in today's discipline-structured culture is a challenge cited by others for individuals (Brewer, 1999; Brown et al., 2015; Blackwell et al., 2009). Publishing and promotions can be more challenging for interdisciplinary individuals, and this can be similarly true for teams in a competition setting. Depth often wins over breadth in traditional evaluations. In addition, as new, untried ideas, innovative approaches can seem riskier, which can put them at a disadvantage for funding/implementation in many settings.

could also require teams to include diverse disciplines on teams. The goal would be to reward teams that address many aspects of the challenge, rather than only a narrow one, encouraging innovative, interdisciplinary collaboration.

Another opportunity could be to include jury members that have interdisciplinary experience, or at very minimum represent a broad range of disciplines, including design, social science, and engineering/science. In this way, jury thinking would be more likely to reflect input from many perspectives. A very novel opportunity could even be to embed jury members within teams so they could better understand the evolution of ideas and depth of thinking.

4. ***Challenge: Even if ideas "win" the competition, implementation may not occur.***

   Opportunity: Design competitions to create a bridge to additional idea refinement and implementation.

   In order for innovative ideas to have real impacts, they must go beyond ideas. Competitions may be appealing because they present fewer regulatory challenges than "the real world," but this difference can impact implementation. Environmental and other permitting requirements as well as municipal boundaries and funding may be barriers to comprehensive designs. On the other hand, regulations can be changed as technologies develop.

   The competition format can also present additional hurdles relative to other implementation paths. Contracting practices of governments (whether closed-bids or preapproved lists of contractors) may exclude the winning teams from implementation stage. Chosen contractors may see the projects differently and remove elements beyond their own expertise.

   The jury and client teams of competitions could be structured to include members who would recognize innovation / potential and also have a stake in implementation. Competitions could have a follow-up phase for the winning team with additional funding to further refine idea to prepare it for implementation. Rebuild by Design is a good example of a competition that provided implementation funding to winning teams.

   Another opportunity for real-world impact is to spread the competition ideas widely (and not just the winning ideas). Whether the projects are built as offered, team members, sponsors, other designers, community leaders, and members of the public may take ideas presented in competitions and apply them elsewhere.

Lessons Learned

Our participation in these two competitions has helped us see interdisciplinary collaboration from a new perspective. Key takeaways from our collaboration include:

- **The power of effective storytelling**: Complex solutions that effectively address complex problems can be tough to explain, yet sharing the potential of the ideas is critical to obtain buy-in and funding for implementation. Being able to explain complex ideas in a simple, compelling, and understandable manner is key. We found that graphic visualizations could be a powerful tool to increase understanding, especially when paired with key technical statistics. Together, numbers and images build a strong case for many different kinds of learners.
- **Structured brainstorming can help overcome disciplinary boundaries, develop a common language, and remove the judgement that can result when different disciplines approach an idea from different perspectives (a barrier to innovation).** Our Changing Course team found de Bono's Six Thinking Hats (1999) to be an effective tool for facilitating group brainstorming and ensuring that when "green hats" (creativity/new ideas) were on, other disciplines did not prematurely judge and instead helped elaborate and consider unusual ideas.

- **Need for designers, engineers, scientists, and social scientists.** These diverse perspectives help ensure ideas will be technically sound, socially considerate, and clearly communicated.
- **Expert, collaborative, and curious core team members:** Team members need to be experts in their disciplines to bring deep knowledge to the team, but they should also have a curious and collaborative personality. These attributes are important for overcoming communication barriers caused by different disciplinary perspectives, backgrounds, and training.
- **What seems simple to one discipline is ground-breaking for another**
- **Different disciplines operate at different scales**
- **Don't underestimate the power of an interdisciplinary team (especially your own!), the outcomes might surprise you**: Tough challenges can seem impossible, but with the right group of people, a path forward may emerge. Set targets that are such a reach they might seem unattainable. The goals can help push the team to stretch, promoting innovative ideas. In Changing Course, we were originally chided for suggesting we were trying to find a solution with positive outcomes for all stakeholders, a Delta for All, but without that goal we would not have reached our solution.

With today's complex world, it's increasingly difficult for a single person to have the knowledge necessary to tackle the toughest problems. As Nissani says:

> By now, most of us no longer think it possible to become a Renaissance Scholar a la Leonardo da Vinci. Gradually during the nineteenth century, the ideal of the unity of knowledge--that a genuine scholar ought to be familiar with the sum total of humanity's intellectual and artistic output--gave way to specialization. (1997, p. 202)

While the era of the Renaissance man (or woman) may be past, perhaps this century can be the era of "Renaissance Teams" – where diverse skills, knowledge, and personalities combined through interdisciplinary collaboration shape the next generations of innovative ideas.

References

Architectural Record /Van Alen Institute Design Competition Survey (2015). Retrieved from https://vanalen.org/projects/architectural-record-van-alen-institute-competition-survey/

Blackwell, A. F., Wilson, L., Street, A., Boulton, C., & Knell, J (2009). Radical innovation: crossing knowledge boundaries with interdisciplinary teams. Technical Report Number 760. Cambridge, UK: University of Cambridge Computer Laboratory. Retrieved from https://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-760.pdf

Brewer, G. D. (1999). The challenges of interdisciplinarity. *Policy Sciences, 32*, 327-337.

Brown, R. R., Deletic, A., & Wong, T. H. F. (2015). How to catalyse collaboration. *Nature, 525,* 315-317.

Chatenier, E. D., Verstegen, J. A. A. M., Biemans, H. J. A., Mulder, M., & Omta, O. (2009). The Challenges of Collaborative Knowledge Creation in Open Innovation Teams. *Human Resource Development Review, 8* (3), 350-381.

Changing Course. Competition Website. http://changingcourse.us/

Coastal Protection and Restoration Authority of Louisiana, Louisiana's Comprehensive Master Plan for a Sustainable Coast (2012). Retrieved from http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/

Davis, M. L. & Masten, S. J. (1996). Design Competitions: Does "Multidisciplinary" Contribute to the Team Building Experience? . Proceedings of the 1996 26th Annual Conference on Frontiers in Education, Salt Lake City, UT, pp. 276-279.

de Bono, E. (1999). *Six Thinking Hats* (2nd ed.). Boston, MA: Back Bay Books.

Fudge, C. & Roca, J. (2012). Ten Tips for Successful Innovation Teams. Retrieved from http://innovationmanagement.se/wp-content/uploads/2012/04/Ten_Tips_for_Successful_Innovation_Teams_Fudge_Roca_im.se_.pdf

Handel, S. N. 2015. Jump-Starting the Habitat Engine. *Ecological Restoration* 33(1):1-2.

HUD (April 3, 2014). HUD'S 'Rebuild By Design' Teams Unveil Final Proposals In Regional Resiliency Design Competition. HUD No. 14-031. [Press Release]. Retrieved from http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2014/HUDNo.14-031

Lampel, J., Jha, P. P, & Bhalla, A. (2014). Test-Driving the Future: how design competitions are changing innovation. In Chartered Management Institute (Ed.), *Winning Ideas: The Management Articles of the Year.* Chartered Management Institute. (pp. 14-24). [originally published in 2012. Academy of Management Perspectives, 26 (2)] Retrieved from

http://www.managers.org.uk/~/media/Research%20Report%20Downloads/Management%20Articles%20of%20the%20Year%202014.ashx

Ledford, H. (2015). How to solve the world's biggest problems. *Nature, 525*, 308-311.

Nissani, M. (1997). Ten Cheers for Interdisciplinarity: The Case for Interdisciplinary Knowledge and Research. *The Social Science Journal, 34* (2), 201-216.

Oskam, I.F. (2009). T-shaped engineers for interdisciplinary innovation: an attractive perspective for young people as well as a must for innovative organisations. 37th Annual Conference–Attracting students in Engineering, Rotterdam, The Netherlands (Conference Paper). http://www.sefi.be/wp-content/abstracts2009/Oskam.pdf

Paulus, P. B. (2000). Groups, Teams, and Creativity: The Creative Potential of Idea-generating Groups. *Applied Psychology, 49* (2), 237-262.

Rebuild by Design. Competition Website. http://rebuildbydesign.org/

Sovacool, B. K . (2014). Energy studies need social science. *Nature, 511*, 529–530.

Stock, P. and Burton, R. J. F. (2011) Defining Terms for Integrated (Multi-Inter-Trans-Disciplinary) Sustainability Research. *Sustainability*, 3, 1090-1113.

Stokols, D. (2011). Transdisciplinary Research in Landscape Architecture: Prospects and Challenges*. Landscape Journal: design, planning, and management of the land, 30* (1), 1-5.

Szostak, R. (2002). How to Do Interdisciplinarity: Integrating the Debate. *Issues in Integrative Studies, 20*, 103-122.

Taylor, A. & Greve, H. (2006). Superman or the Fantastic Four? Knowledge Combination and Experience in Innovative Teams." 2006. *Academy of Management Journal, 49* (4), 723-740.

Van Noorden, R. (2015). Interdisciplinary Research by the Numbers. *Nature, 525,* 306-307.

West, M. A. & Sacramento, C. A. (2006). Chapter 3: Flourishing in Teams: Developing Creativity and Innovation. In J. Henry (Ed.), *Creative Management and Development* (3rd ed.).(pp 25-44). *London, UK: Sage.* Retrieved from: http://www.corwin.com/upm-data/11445_03_Henry_Ch03.pdf