

INTERVIEW

**NATIONAL LEAD FOR
USACE ENGINEERING
WITH NATURE INITIATIVE
DR TODD BRIDGES**

‘THERE ARE JUST SO MANY
WAYS IN WHICH **NATURE**
IS THE SOLUTION TO
THE PROBLEMS THAT AIL US’

There is a fantastic opportunity, I believe, worldwide to incorporate nature into engineering in a more tangible and substantive way.

From an early fascination in oceanography, nature has played a defining role in the career of Dr Todd Bridges. With a decade's investment in the Engineering With Nature[®] initiative, he has seen that sustainability and engineering can go hand-in-hand providing economic, environmental and social benefits. His focus now is to build on that foundation – to encourage and facilitate collaboration across sectors, public and private, to advance and accelerate Engineering With Nature practice.

How and why did the Engineering With Nature initiative begin?

The U.S. Army Corps of Engineers (USACE) formally started the Engineering With Nature (EWN) initiative in 2010. The short answer to why we started EWN was that it was time. In the 1960s, there were several ideas beginning and maturing. For example, Howard Odum, started the idea of ecological engineering, combining ecosystems with society and human need. Ian McHarg, a landscape architect, published his seminal work *Design with Nature* in 1969, combining natural systems and approaches with the practice of landscape architecture. Over the decades, those approaches have matured and grown. When we consider the challenges and opportunities that present themselves to the world in the 21st century, we need to apply these ideas as we pursue infrastructure development. In the 20th century, we built a lot of infrastructure with steel, concrete, rock and asphalt. In the 21st century, how will we pursue investment and development of infrastructure? There is a fantastic opportunity, I believe, worldwide to incorporate nature into engineering in a more tangible and substantive way – to diversify and

really expand as well as increase the value that can be generated from such projects.

Your career with USACE spans nearly 30 years. How did your background spark your interest to work on the initiative?

It all began when I was a boy. When I was growing up, I watched Jacques Cousteau on television. I was completely captivated and fascinated by the ocean and in particular, the biology of the ocean. I consciously remember at the age of 10 or 11 deciding that this was what I was going to do. I went to college and got my bachelor's and master's in biology, and then did my doctoral work in oceanography. So, I had a natural sciences background with a focus on the ocean and marine systems, and then I came to work for an engineering organisation, the U.S. Army Corps of Engineers. It was here that I benefited from daily interaction and collaboration with engineers. They have a different educational foundation and a different way of thinking about their work, problems and solutions that I've come to really appreciate. When scientists and engineers work together, it can be a very powerful

combination that is complimentary in so many regards. Over the years, with my education and professional experience, Engineering With Nature came together in my thinking in terms of what a solution could look like. A solution being something that combines engineering and nature together.

Not everyone can say their passion turned into their work.

No, to be able to combine what you do many hours a day with work that provides you with personal satisfaction and fulfilment, I mean, that's the ideal. There's nothing that compares.

There have been so many USACE projects over the past decade. Is there one that stands out for you and why?

It's so difficult to choose. With the publication of both volumes one and two of the *Engineering With Nature Atlas*, there are a total of 118 projects from around the world described in those books. 50 of those projects are USACE projects that go back many years. We started the Engineering With Nature initiative formally in 2010, but we did

so recognising that there are decades of prior practice we could look to for examples. We're working to elevate this approach to solution development and, as I've said many times, to make the exceptional projects of the past commonplace in the future.

What has been accomplished over the last several years is not contained in one project, more a network of activities. In coastal New Jersey, we have worked for several years with many organisations, including our Philadelphia District of the Corps of Engineers, state agencies, the non-profit world, the private sector and academia. Through that collaboration, an initiative called the Seven Mile Island Innovation Laboratory (SMIIL) was formed. This group is building first of their kind projects, drawing from the principles and practices of Engineering With Nature. It's a beautiful thing to behold when

alignment occurs across organisational boundaries and mandates to really deliver nature-based solutions.

I'd also like to mention another more recent example, where Engineering With Nature has been working closely with the U.S. Air Force. At Tyndall Air Force Base on the Gulf Coast of Florida, Hurricane Michael did a huge amount of damage when it struck in 2018. Right now, the U.S. Department of Defense is investing nearly US\$ 5 billion to rebuild this 30,000-acre military base in a way that is resilient with respect to future conditions, climate change and future storms. Part of the approach that we're taking there through Engineering With Nature is to make investments in the natural landscape. There's a beautifully complex, natural landscape there that includes islands and beaches, dunes and back bay environments, reefs

and wetlands. Our aim is to invest in those natural landscapes to provide resilience to the mission. It's a prime example of the connection between nature-based solutions and national security infrastructure.

There must be many opportunities and challenges in undertaking projects within an organisation such as USACE. Can you share some of them?

There certainly are. USACE, like the Rijkswaterstaat in the Netherlands, has a long history stretching back more than 200 years. It's interesting to look at the comparisons between the two organisations. We maintained our connection to the military, within the U.S. Army and the U.S. Department of Defense, whereas the Rijkswaterstaat evolved out of that structure. I think one of the chief advantages of working for the Corps is the



Meet Dr Todd Bridges

Dr Todd Bridges is the U.S. Army's Senior Research Scientist for Environmental Science. He leads research and applications for the U.S. Army and U.S. Army Corps of Engineers in the areas of sustainable infrastructure and environmental management. Todd is the National Lead for the USACE Engineering With Nature initiative, which includes a network of research projects, field-scale projects and communication activities to promote sustainable, resilient systems. He led the focus on Natural and Nature-Based Features (NNBF) within USACE's North Atlantic Coast Comprehensive Study from 2013–2015 following Hurricane Sandy and currently leads an international collaboration to develop guidelines on the use of NNBF for coastal and fluvial systems. Todd is also the Programme Manager for the Dredging Operations Environmental Research programme, one of the Corps' largest civil works R&D programmes, where he directs the execution of more than US\$ 6 million in research annually. He has chaired international working groups and guidance development for the United Nations' International Maritime Organisation and the World Association for Waterborne Transport Infrastructure, where he currently serves as Chairman of the Environmental Commission.

**We have the possibility to deliver
for future generations, something that
is very different from what infrastructure
looked like in the 20th century.**

sheer scope of our programme and our engineering for the nation. Over the last two years, our total programme equates to a US\$ 60 billion portfolio of work.

With a programme that size, there is clearly an opportunity to be involved with and to deliver projects on a significant and large scale. There is also so much to be done to prepare ourselves for and to really support our society for the remainder of the 21st century. When you consider the types of infrastructure investments that are needed and the reinvestment that's going to be made in infrastructure, there's so much possibility. Then the excitement comes from thinking what is that infrastructure going to look like? How is it going to work and how is it going to incorporate nature? We have the possibility to deliver for future generations, something that is very different from what infrastructure looked like in the 20th century.

Can you touch on some of the challenges?

Like anything that involves people, change can pose a challenge for large organisations, whether public or private. Government organisations have a reputation for being very averse to change, but I think any large organisation struggles with change management. For an engineering organisation, the standards of practice can become very established, even calcified. There can be resistance to change, which creates a tension.

Within the Corps we recognise the need to innovate. With that in mind, USACE organised and conducted its first Innovation Summit in 2019. It brought together representatives from government, industry and academia to talk specifically about innovation. The second Innovation Summit will be held virtually this

October. So, we are trying to be purposeful about it within the Corps to address this issue of change, but it is a challenge.

I also think there might be a bit of a blind spot in organisations where technical matters, i.e. engineering and science, are so dominant in the culture. What can sometimes be left out is the social element of the equation. It is not necessarily the case that the best technical argument wins. If you have not set the social conditions for change, it doesn't matter if you have a better way of slicing bread. It's not going to get implemented if you didn't give proper attention to the social science of your problem.

The COVID-19 pandemic has had considerable impact on world trade. What impact has it had on USACE, its work and the type of projects currently undertaken?

It has certainly been a roller coaster for everyone. At a personal level, I spent several months last year nearly exclusively focused on COVID-19. USACE had a US\$ 2 billion mission related to the response to the pandemic and engineering related to supporting what we call 'Alternative Care Facilities'. I led a technical team of scientists, mathematicians, engineers and public health professionals within USACE to develop modelling tools, including an epidemiological model that we built more or less from scratch. This model enabled us to project the dynamics of the disease and anticipate the kind of logistics issues we were going to face. It was quite consuming and some of that work continues today.

What will be the learnings we take away from the pandemic in relation to Engineering With Nature?

I feel there are some very important lessons and takeaways from the pandemic that are certainly related to Engineering With Nature. Something that everyone would recognise,

if they pause for a moment and think about it, is that humanity is connected to nature. In respect to something like a pandemic you're talking about the downside of being connected, i.e. the origin of the virus. The other point of this is that because we are connected to nature in this way, there are common vulnerabilities. Rich or poor, we can all get sick, we are all vulnerable. However, some populations and groups within our countries, within our societies, are particularly vulnerable. I think there is a renewed interest in these topics, of social equity and vulnerabilities that exist, that are variable across our society. Infrastructure development in particular needs to be attentive to that. Who are we serving and who is the infrastructure serving? Is it serving people and different groups of people adequately? These are important questions. Engineering With Nature and nature-based solutions are very important because people benefit, whether they consciously realise it or not, from nature.

People need more nature in their lives, not less. There is a great deal of science documenting the importance of this, both in terms of physical and mental health. People need to be connected to nature. When I think about that, I'm excited about the idea that while we've had this reminder on a grand scale that we as humans are connected to nature, we need to look for ways to create benefit and value from that connection. Infrastructure development should be a vehicle for providing that connection to nature, because concrete doesn't satisfy every human need.

In the recently published volume 2 of the Engineering With Nature Atlas, there is a wonderful Chinese proverb quoted that says, 'One generation plants a tree, another gets the shade.' In thinking about the future, what do you consider are the key elements to advancing engineering practice with Engineering With Nature?

Yes, I was struck by that proverb. It tells us that we need to look ahead, which isn't always easy to do, but we must plan for the long term. One of the conversations I've been having with my colleagues involves asking them, What are your big ideas? What should, for example, our coasts and our rivers look like by the end of the century? By 2100, how should these systems work? What kinds of services and functions do we want them to deliver? With respect to our

INTERVIEW

On 7 April 2021, USACE held a virtual book launch for the release of *Engineering With Nature, An Atlas, Volume 2*. The event included speakers from a range of US and international partner organisations.

work within the Army Corps of Engineers, what projects need to get built for them to operate that way? We have to ask questions that get us to think about the future, especially when you consider that by the end of the century there are going to be 10 billion or more people on the planet, which increases the demand for services provided by infrastructure. And when you add climate change on top of that – there are some big challenges ahead.

The other side of this is that we spend too much time and give too much consideration to the boxes that we build for ourselves. By that I mean the mental boxes that we build for ourselves using concepts or business practices, or even technical approaches, that we employ to develop projects. We construct these boxes and they represent constraints for how we will do things and of how we will think. It's a cliché, but we really need to think outside the box, but that has to be a deliberate choice on our part. When you're turning the crank really fast to deliver a project, that time to think outside the box might be minimised or set aside for a while. There's a real danger there because if you don't give yourself, or your organisation doesn't give itself, time to think outside the box, it's unlikely you'll be able to innovate and to deliver solutions you will need in the long term.



Countries around the world are facing the challenges of climate adaptation. When it comes to nature-based approaches to protecting urban shorelines, what have been the most important lessons that you have learned since launching the initiative?

I think there is growing recognition of the realities that we face. For example, I mentioned the Tyndall Air Force Base case. When you have such an important facility and military installation that suffers damage to the extent that it did, that's very real.

What's encouraging to me is how robust the dialogue is internationally about the role of nature-based solutions as a part of climate adaptation. The solution set that we need to draw from must be diverse. It's clear that the solutions that we employed in our approach to engineering in the 20th century are not aging well and the statistics bear this out. Since 1980, there have been 285 weather or climate disasters in the United States, which produced at least US\$ 1 billion of damage. If you look at the cumulative costs, the total damage for those 285 events exceeds US\$ 1.8 trillion dollars. In addition, 14,000 people lost their lives.

So, when you have a problem on that kind of scale, arguably our approaches are not aging well. Not at all. The question is how do we reduce those kinds of impacts? We must have a diversified solution set in which nature is a part of the solution. There's no doubt in my mind – and there's no doubt in the minds of many people around the world – that nature will be part of the long-term solution.

Sustainability has become an important concept in engineering over the last two decades. What is the key to sustainability for you?

That's a good question because there has been a lot written about sustainability and there are a lot of nuanced definitions. Some people get a bit concerned about a term as 'flexible' as sustainability. I don't find that a problem. I think it's actually advantageous because it can lead to some very good dialogue and conversation about what we're trying to achieve.

To me, sustainability is about the distribution of costs and benefits across the three legs of the stool – the economic, environmental and social domains of our system. We recognise that there are costs, but we also need to recognise that solutions have to carry benefits with them. That's why we're putting them in place. What's the return on our investment in a particular solution? There's certainly much renewed interest in the United States and within the Army Corps of Engineers to understand more about this distribution across the three legs of the sustainability stool, and in particular the benefits.

I believe there are benefits being generated by infrastructure projects now that we have not described or maybe don't understand, because in the past there's been more focus on economic benefits. However, the environmental and the social benefits, whether they are monetised or not, need to be understood as well because they're real. You may not be able to put a dollar symbol next to it, but that does not make the benefit less real. What I think, in regards to sustainability, is how to decrease the costs and increase and diversify the benefits, over the long term, across those three categories of economic, environmental and social outcome. That's what sustainability is for me.

How do you think the dredging industry as a whole is addressing the task of sustainability and innovation?

Without sounding overly critical, I think there's work to do. We've been dredging in 'mechanical' ways for 150 plus years and dredging has been such a vital approach to economic development. That has been its primary role across countries and still is even today. It supports port infrastructure and coastal and riverine infrastructure related to navigation, as well as flood risk management. I think it's generally understood what the relationship is between dredging and the dredging industry, and economic development. Less well captured, I believe, is how dredging, whether it's the equipment that we're using or how we operate that equipment, can be used to support more directly the other two categories of environmental and social benefits. More attention needs to be given to how dredging practice and the industry itself can support, modify and innovate to deliver more diversified and combinations of benefits.

There is of course innovation within the industry. However, if you were to look at photographs of dredgers from 100 years ago and compared them to dredgers of today, they look a lot alike. Yes, there are differences in the energy systems being used, the technology and how the machinery operates, but in large measure, it looks very similar. I think the timing is more than ripe, I would say overly ripe, to have a broad discussion about innovation within the dredging industry.

There is an obvious partnership between green financing and sustainable waterborne infrastructure projects, but work is needed. What do you see are the challenges and the potential solutions to making Engineering With Nature projects viable and interesting to investors?

Yes, I think this is also a source of hope. When we think about 20th century practice with respect to infrastructure and especially infrastructure associated with water systems, it's been dominated by public investment, i.e. government agencies and public investment. However, what we've seen emerge in recent years is interest in the private sector, including that portion of the private sector that actually owns and needs to protect its own assets, such as the chemical industry.

It's clear that the solutions that we employed in our approach to engineering in the 20th century are not aging well.

For example, Dow made a very substantial internal commitment to generate US\$ 1 billion of value in nature as a part of its business practice. This is business value it's generating, which might take the form of building a wetland to provide water treatment value. In fact, Dow has projects in the second volume of the *Engineering With Nature Atlas* that illustrate part of its approach to this.

Now we're seeing this interest in the private sector, the next question is how does the private sector and the public sector collaborate and work together to deliver nature-based solutions? Which brings us to financing. There are also very positive developments in the insurance sector with respect to nature-based solutions and in companies giving attention to and trying to understand the role of nature. There's a coral reef off the coast of Mexico that's now insured because of the protection value it provides to the coastline. So, there are many positive developments. This is an issue where innovation in the area of financing will be needed because it involves policies and laws at a public level that can be difficult to change.

The value that can be delivered to society and humanity as a whole through these approaches is just tremendous.

Do the Engineering With Nature, Working with Nature and Building with Nature organisations share ideas, experiences, successes and failures?

Yes very much so. There's been sharing since the beginning of these formalised initiatives. There are Building with Nature projects in the *Engineering With Nature Atlas*, volumes one and two. I've served on panels and advisory groups for Building with Nature. So, it's definitely a collaborative engagement and there's a lot to be gained by all concerned in terms of sharing.

Experience and ideas are vital to accelerating the innovation that is needed in this space, as well as the implementation of these practices on the ground. It comes back to what I mentioned earlier about the challenges of change. While you want to put newer

approaches into practice, there are naturally going to be some obstacles to doing that.

To share experiences, case examples and practice can often help provide the evidence that you need in order to move forward. I've personally benefited, in so many ways, by being able to travel around the world (back when we could do that) to engage with other organisations. Even though an organisation or project is located on the other side of the planet from where you sit, you will see, more or less, the same set of problems, the same challenges, the same context that you experience. So, when you can see and experience that, it brings a clarity to what the key factors are in that problem and also what the key elements are to the solutions. It really brings a clarity that you only get by seeing projects in different places and making these kinds of comparisons.



Incorporating the value of nature into decision making

The Ecosystem Services Identification and Inventory (ESII) tool allows users to better understand the benefits that nature provides and informs decisions to protect, restore or monitor specific natural assets. Developed in

collaboration by Dow, The Nature Conservancy and EcoMetrix Solutions Group, the tool is a free application available online and as an iPad-based app. It can advise a broad spectrum of stakeholders (including non-ecologists) as they make decisions on various land-use alternatives with corresponding quantified ecosystem services. Understanding how various designs impact the ecological performance of a piece of land helps drive adoption of nature-based solutions. As in many of its projects, Dow has incorporated the ESII tool into its land management strategy.

People using the ESII field app to collect site-specific data. Mercy Corps' Transform Project, Semarang, Indonesia. Photo © Morgan Erhardt, EcoMetrix Solutions Group.

What are your future ambitions and plans for the Engineering With Nature initiative to evolve?

I could say more of the same, but it's not really more of the same. This past year we started the Network for Engineering With Nature (N-EWN). We established a virtual space where organisations can come together with the idea of collaborating with each other to advance and accelerate Engineering With Nature practice. It started last year with the Army Corps of Engineers and the University of Georgia, and now other organisations are joining the Network. It's a way of encouraging and facilitating collaboration across sectors, public and private. Those sectors are able to come together and to share not only their interests, but also to contribute to this enterprise that is engineering with nature. That's the kind of the future that we're looking to build upon.

In fact, I'm currently at the University of Oklahoma in Norman, Oklahoma, meeting with professors and university leadership about their engagement with Engineering With Nature. While there are a lot of opportunities and needs in our coastal systems, we also need to think about the middle of the country, including the portion we call the Great Plains. The University of Oklahoma is located in that part of the country. We want to discover and deliver solutions for engineering with nature across the Great Plains and understand what these kinds of solutions look like. For example, what can we accomplish with a large and significant commitment to reforestation? How does that provide value in the form of restored hydrology and reduced risk to flooding and even enhanced drought resilience? There are just so many ways in which nature is the solution to the problems that ail us.

After 10 years as National Lead, what inspires and motivates you to keep moving forward with the initiative?

Well, there are many sources of inspiration. I'll describe one of them at a personal level. Walter Andersen was a Mississippi artist and writer. He was born in 1903 and he spent most of his life on the Gulf Coast and called Ocean Springs, Mississippi, his home. He was a wonderful artist. I have a print of one

of his watercolour paintings of blue crabs in my office. Anderson spent a considerable amount of time during his life being alone in nature and contemplating nature. At one point he said, "I wonder how long it will be before nature and man accept each other again." When I look at that painting on the wall in my office, I think Engineering With Nature is a step on that path. Simply put, the potential is huge. That's the drive for me.

The future is bright for Engineering With Nature. I truly believe that. The value that can be delivered to society and humanity as a whole through these approaches is just

tremendous. When you know what's possible and you think about future generations that will benefit from the shade of the tree you planted, that's inspiring and motivating. It creates a sense of urgency within me that simply says, let's get on with it. But you have to pair a sense of urgency with a sense of patience, because you don't get to snap your fingers and just make it all happen immediately. It requires investment and commitment. Now that we've entered the promise of our second decade of Engineering With Nature, I can reflect back on the first decade of investment and say that it's all been worth it.

Resumé

United States Army Corps of Engineers (USACE)

2006–Present

Senior Research Scientist, Environmental Science

Leads research, development and environmental initiatives for the U.S. Army and USACE supporting resilience, sustainability and environmental management.

Areas of research and application include: 1) science and engineering of sustainable infrastructure development; 2) risk and decision analysis methods applied to infrastructure and environmental systems; 3) management of sediment and environmental contaminants; and 4) natural systems engineering.

2010–Present

National Lead, USACE Engineering With Nature initiative

Leads a network of multi-organisation collaboration, research and development, field-scale application and communication activities to advance sustainable, resilient infrastructure systems through nature-based solutions.

2006–Present

Programme Manager, Dredging Operations Environmental Research Programme

Leads research, development and application in infrastructure science and engineering, dredging, and sediment management for USACE's US\$ 2+ billion navigation programme.

1992–2006

Research Biologist and Team Leader

Led research, development and application in ecotoxicology, environmental assessment and sediment assessment and management.