Moving

Rendering of the Hong Kong-Zhuhai-Macao Bridge and one of its tunnel landings

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Transportation megaprojects face bigger hurdles and, potentially, bigger payoffs.

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BY MATT ALDERTON

HIMAN HIMAN

egaprojects are the fabled giants of the project world. These large-scale, high-budget initiatives have earned a reputation as ill-fated—continuously late and constantly over budget. They seem to be clumsy Goliath-like projects, as opposed to the smaller, more nimble Davids.

But that reputation may not be entirely deserved, suggests a University College London study. In its analysis of 30 US\$1 billion-plus global transportation infrastructure projects, it found that half were delivered at less than 10 percent over budget, and half were on time or less than a year behind schedule. Moreover, these initiatives fulfilled objectives that went beyond the triple constraint of schedule, scope and cost, succeeding on social, political and environmental merits.

"Traditional criteria relating to cost overruns, completion dates ... and rates of returns to investors are inadequate measures of success in the 21st century," the study states. "Decision-making for [megaprojects] should transparently include a much wider set of complex considerations"—such as the megaprojects' societal and economic implications.

Here are five global transportation megaprojects contending with those complex considerations, illustrating that giants can be as effective as they are enormous.



Staying On Track

Project: California High-Speed Rail Location: California, USA Budget: US\$68 billion Projected completion: 2029

As the population continues to boom in the U.S. state of California, more people could fill the roads with more cars. California is already home to three of the 10 cities with the country's worst traffic congestion: Los Angeles, San Francisco and San Jose. So



the state government proposed a different transportation plan: Put those people in high-speed trains.

When complete in 2029, California's high-speed rail system will stretch 520 miles (837 kilometers) at an estimated cost of US\$68 billion. The line will connect San Francisco to Los Angeles, reducing travel time from six hours by car (in light traffic) to two hours and 40 minutes by train. Eventually, the electric trains, which will travel at 220 miles (354 kilometers) per hour, will go even farther, terminating in the southern California city of San Diego and to the north in Sacramento.

"What we're embarking on is the equivalent of starting the state highway system," says Jeff Morales, CEO of the California High-Speed Rail Authority, a



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—Jeff Morales, California High-Speed Rail Authority, Sacramento, California, USA state agency based in Sacramento.

"Our transportation system is already bulging at the seams," Mr. Morales says. The most populous U.S. state, with approximately 38 million people, California is projected to see its population swell by 32 percent to 50 million by 2050. "We will not be able to accommodate that sort of growth, improve our air quality and maintain our quality of life unless we make a major investment in an expanded transportation system. High-speed rail is a part of that."

Project planning officially commenced in 1996, when the rail authority was created. In 2008, California voters approved initial funding for the project, which finally proceeded to implementation in July 2012. While construction was initially scheduled to begin in September 2012, the groundbreaking has faced delays associated with securing permits and land, lawsuits and publicized complaints from citizen stakeholders who will lose their property to the rail line. California farmers claim the project will seize and destroy thousands of acres of viable farmland.

"Because of the importance of agriculture to our state, we have worked hard to understand and address those concerns," Mr. Morales says. "We're working with counties like Merced and Madera to help ensure that our program preserves more agricultural land than it impacts." The project team consulted with independent experts, including farmers, concerning the rail's environmental impact, and it worked with farm bureaus and state and federal agencies to develop preservation plans.

Despite delays, the overall program remains on schedule and under budget, Mr. Morales says. The rail authority has made significant progress toward breaking ground on the first portion of the line, which he says will still be completed by 2018, extending 30 miles (48 kilometers) between the towns of Madera and Bakersfield at an approximate cost of US\$6 billion. This first construction segment has received an environmental clearance, settled a number of lawsuits challenging its environmental documents and awarded a design-build contract.

To keep the project on track, the rail authority



"The only way to successfully manage a project of this size is to ensure you have people out front who can make decisions concurrently without a siloed or bottlenecked effect."

—Frank Vacca, California High-Speed Rail Authority, Sacramento, California, USA managed the program's sheer size by dividing it into nine matrixed project sections.

"The key here is not technical in nature; the engineering aspects are manageable," explains Frank Vacca, rail authority chief program manager. "The key is management. Mr. Morales has put together an organization with leading experts in their fields. The only way to successfully manage a project of this size is to ensure you have people out front who can make decisions concurrently without a siloed or bottlenecked effect."

While matrix management will ensure the decision-making is rapid, thorough risk management will keep it effective.

"We have put into place a state-of-the-art risk management program," Mr. Morales says. "We have a detailed risk register that runs the gamut from legal issues to funding issues to detailed engineering issues. We're looking at virtually anything and everything that could influence the progress of the program."

If the program progresses, so will California's environmental and economic objectives. Highspeed rail, it's hoped, will reduce air pollution and catalyze economic growth by stimulating intrastate commerce.

"This is not just a transportation project; it's a transformational program," Mr. Morales says. "By connecting economies, we can make them all more efficient and make the state more competitive."



Locking in the Future

Project: Panama Canal Expansion Location: Panama Budget: US\$5.3 billion Projected completion: 2015

When it was completed in 1914, the Panama Canal was the world's largest engineering project. Fast-forward a century, and one of the seven wonders of the modern world has hit its limits. A US\$5.2 billion project intends to raise them.

The canal, which spans 48 miles (77 kilometers), connects the Atlantic and Pacific oceans for maritime trade, primarily between the U.S. East Coast and Asia, and the U.S. West Coast and Europe. Originally host to about 1,000 ships annually, it now sees more than 14,000 every year.

"The capacity of the existing canal was pretty much reached," says Ilya Marotta, executive vice president, engineering and program management, the Panama Canal Authority. "Also, there were a lot of larger ships out there that could not fit through the existing locks. So not only did we need more capacity, but we needed a new product."

In 2006, Panama voters approved a national referendum that cleared the way for construction to start in September 2007. The expansion's most significant components include two new locks—one each on the canal's Atlantic and Pacific sides—widening and deepening the entrances and existing navigational channel to accommodate larger vessels, excavating a new access channel and increasing the maximum operating level of Gatun Lake.

"It's a pretty complex project," says Ms. Marotta, adding that complexity pertains to both the engineering and the project man-

agement. "Logistics-wise, it's humongous. There's a lot of coordination that needs to be done."

Coordination has proven especially difficult as the project is divided among numerous contractors around the world, all of whom must collaborate across cultures with each other and with the project team.

A program management information system

and a centralized project management office (PMO) helped keep all the pieces connected. "We created a self-contained team that's inclusive of everything in the project—safety, environmental, legal, contracts, engineering," Ms. Marotta says. "We created a small office dedicated just to the expansion program. That helps to overcome chal-



"There were a lot of larger ships out there that could not fit through the existing locks. So not only did we need more capacity, but we needed a new product."

—Ilya Marotta, Panama Canal Authority, Panama City, Panama

PHOTO BY RUBEN PARRA



lenges because it's easier to work through hurdles when you have a close-knit organization."

As part of that close-knit group, Panama Canal Authority project team members work side by side with employees of CH2M Hill, a U.S.-based corporation contracted to provide program management consulting. "We wanted to work with CH2M Hill as an integrated team—not them running the project or us," Ms. Marotta says. "We did mentoring and team building so that now we're one team with one mission."

With that unified sense of mission, the project team effectively addressed vocal opposition from critics, including environmentalists who expressed concern about the project's impact on land and wildlife, and labor advocates, who claimed the project would not generate enough employment to justify its cost. "We've done a lot of environmental [mitigation] and have generated over 30,000 jobs, including more than 13,000 people who are working on the project right now," Ms. Marotta says.

The team's communication and collaboration have helped prevent budget overruns and sidestep potential contractor-related schedule overruns. However, a six-month concrete-pouring delay in 2011 means the project won't be finished until June 2015—eight months behind schedule.

The delay is inconsequential to stakeholders,



according to Ms. Marotta, who says the project's long-term benefits outweigh its short-term delays. "Right now, the biggest container vessel that can come through the canal can carry between 4,000 and 5,000 TEUs [20-foot-equivalent unit shipping containers]. The new locks will be able to carry between 13,000 and 14,000 TEUs. Because the Panama Canal charges by carrying capacity of the vessel, that will mean an increase in revenue," Ms. Marotta says.

"I cannot say that the project isn't successful because it won't be finished on time. That's not the driver," she says. "The driver is generating increased income for the country of Panama."

Connecting Communities

Project: Atlanta BeltLine Location: Atlanta, Georgia, USA Budget: US\$3 billion Projected completion: 2030

The city of Atlanta, Georgia, USA hopes the key to the future lies in the past.

Atlanta BeltLine, a 25-year, US\$3 billion urban redevelopment and mobility program, will turn 22 miles (35 kilometers) of historic rail corridors into a network of public transit, parks and trails.

Established in 1837 at the nexus of two rail lines, Atlanta grew with rail, and then declined with it.

"As industry migrated from the rails to the inter-

state highways, it left a lot of blighted and abandoned rail corridors and industrial sites looping Atlanta, roughly three miles [five kilometers] from the downtown core," says Lee Harrop, program management officer, Atlanta BeltLine Inc. "You've got people living in neighborhoods right across the tracks from each other who-because the rails predated the roads-aren't well connected. The BeltLine uses old rail lines to connect those neighborhoods."



"You've got people living in neighborhoods right across the tracks from each other who because the rails pre-dated the roads—aren't well connected."

—Lee Harrop, Atlanta BeltLine Inc., Atlanta, Georgia, USA

student first proposed the BeltLine in his master's thesis. When local politicians heard about it, they

In 1999, a local graduate

thesis. When local politicians heard about it, they embraced the vision, establishing a tax-increment financing district to pay for the project in 2005,



followed by the formation of Atlanta BeltLine Inc. in 2006.

So far, Atlanta BeltLine has opened four parks and seven miles (11 kilometers) of trail. Yet at its conclusion in 2030, the program will include 22 miles (35 kilometers) of light-rail transit, 1,300 acres (526 hectares) of parks, 5,600 units of affordable housing and 33 miles (53 kilometers) of multi-use trails—all throughout 1,100 acres (445 hectares) of remediated brownfields.

Therein lies the challenge: The BeltLine program will encompass as many as 120 projects across a diversity of communities, all of which must be managed simultaneously as they progress at different speeds through different stages with different stakeholder partners.

Because the program still has 16 years of implementation ahead, Mr. Harrop says his most significant challenge isn't delivering projects. It's communicating progress—not only to program partners, but also to the 45 communities that will



"There's a real sense of ownership by the community that I think is rare in public infrastructure projects."

—Ethan Davidson, Atlanta BeltLine Inc., Atlanta, Georgia, USA be served by the BeltLine. The project team's expansive communication plan includes social media, a weekly e-newsletter, a detailed program website, frequent community meetings and special events, such as fitness programs and art exhibitions.

"By using a combination of digital tools, direct community outreach and fun programming, we're able to reach a really wide range of people and cut across all kinds of demographics, neighborhoods and interests," says Ethan Davidson, director of communications, Atlanta BeltLine. "There's a real sense of ownership by the community that I think is rare in public infrastructure projects."

Given the criticism the project has encountered, stakeholder management will be indispensable. Opponents have questioned the use of taxpayer money on projects they say will benefit mostly private developers. Public money, they argue, should be used for schools, not parks. Others say the project will displace low-income families from BeltLine neighborhoods.

According to Mr. Harrop, Atlanta BeltLine has worked to address these concerns by actively engaging local constituents at every stage of project planning. "We've got a 2.5-person communityengagement staff, and all they do is work with the community through meetings, advisory boards and planning efforts," he says. "Every critical document and plan created to date has been done with extensive community involvement. We're listening to the community, and we're addressing their needs."

To maintain the community's sense of ownership—and thus ensure the program's successful reception—the team has delivered and publicized as many early deliverables as possible, including economic development and job creation in and around the BeltLine neighborhoods.

"One of my biggest challenges as a program management officer is making sure our first projects out of the gate have the resources they need to be as successful, as impressive and as fulfilling of the vision as they need to be to maintain our momentum going forward," Mr. Harrop says.

Filling the Gap

Project: Hong Kong-Zhuhai-Macao BridgeLocation: Hong KongBudget: US\$6.2 billionProjected completion: 2016

Transportation megaprojects not only move people from point A to point B, but they can also move economies from stagnant to flourishing.

That's the hope propelling the US\$6.2 billion Hong Kong-Zhuhai-Macao Bridge (HZMB) project. A joint endeavor among the local governments of Hong Kong, Macao and Guangdong Province, China, the initiative will bridge the economic gap literally—between Hong Kong and the western Pearl River Delta (PRD) region of mainland China.

As a global economic hub, Hong Kong is an economic linchpin for much of southern China. Thanks in large part to its border crossings with Hong Kong, for instance, the mainland Chinese city of Shenzhen in the eastern PRD has become a major manufacturing hub that's home to about 10 million people.

By contrast, the sleepier western PRD, anchored



"The main bridge is the longest bridge-cumtunnel sea crossing in the world."

—James Chan, Hong Kong Highways Department by Macao and Zhuhai City, has struggled to attract population, investment and industry.

That's in large part a matter of transportation: Traveling between the western PRD and Hong Kong requires either an hourlong ferry ride or a four-hour drive up and around the northern edge of the delta, where the Pearl River flows into the shipping-centric South China Sea. Neither route provides the quick, convenient connection needed to stimulate economic development in the western PRD.

The HZMB aims to change that.

"The HZMB will significantly reduce transportation costs and time for travelers and goods," says James Chan, principal project coordinator of the HZMB Hong Kong project management office in the Hong Kong Highways Department. "Upon its completion, the western PRD will fall within a reachable three-hour commuting radius of Hong Kong. This will enhance the attractiveness of the western PRD to external investment, which is conducive to the upgrading of its industry structure."

Construction on HZMB's main bridge, which began in December 2009, is on schedule, according to Mr. Chan. When complete, the six-lane carriageway, designed in part by London, England firm Arup, will span 18.4 miles (29.6 kilometers), encompassing two artificial islands, approximately 14 miles (22.5



kilometers) of viaducts and a 4.2-mile (6.8-kilometer) undersea tunnel.

"The main bridge is the longest bridge-cumtunnel sea crossing in the world," Mr. Chan says. "Upon completion of the HZMB, the journey time between Hong Kong International Airport and Zhuhai will be reduced to about 45 minutes."

Spanning three governments and a major marine trade route, the project has had to meet a variety of standards and regulations, Mr. Chan says. "The design and construction standard of the main bridge not only need to satisfy the requirements stated in Mainland's relevant regulations, but also have to suitably take into account Hong Kong and Macao construction standards," he says.

Government regulations aren't the only project challenges, Mr. Chan says. During construction, the team also faces "frequent typhoons, crisscross navigation, airport height restrictions, high environmental standards and an extremely tight construction program."

So far, those obstacles have been overcome through close collaboration and thorough plan-

"This is the first time this new construction method has been used in Hong Kong."

ning among the three government partners. In 2010, they established the Joint Works Committee of the Three Governments and the HZMB Authority to handle HZMB decision-making and implementation, respectively. The result aims to be not only on-time, on-budget completion, but also shared benefits in the form of economic growth and diver-

—James Chan

sification across the PRD region.

Yet critics claim the project will harm wildlife and the environment. In response, the government partners have instituted strict environmental standards. "With a view to minimizing the environmental impacts caused by dredging and dumping, the Highways Department together with its project consultants have developed non-dredge reclamation for reclaiming the artificial island for border crossing," Mr. Chan says. "This is the first time this new construction method has been used in Hong Kong." The non-dredge method will reduce the dredging and dumping of marine deposits by 97 percent, he says, which will mitigate adverse effects on water quality, marine ecology and marine traffic.

"Stakeholders such as legislators, district councilors, investors and local residents expect the project will bring much positive impact on tourism and more opportunities for commercial investment in the territories," Mr. Chan concludes.



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Maintaining the Lead

Project: Maasvlakte 2
Location: Rotterdam, the Netherlands
Budget: €3 billion
Projected completion: 2035

The Netherlands has the largest port in Europe. But it still isn't big enough.

Each year, the Port of Rotterdam handles more than 30,000 seagoing and 90,000 inland vessels. It covers about 26,000 acres (10,522 hectares) stretching 25 miles (40 kilometers) along the Nieuwe Maas River. Yet the municipality of Rotterdam and the Dutch government determined the port was nearing capacity, so in 2004, they launched a project to enlarge the Maasvlakte harbor, which, in the 1960s, had expanded the port into the North Sea by way of land reclamation.

By 2035, the \in 3 billion Maasvlakte 2 project will expand the port by 20 percent, almost 5,000 acres (2,023 hectares). Half of the expansion will consist of industrial ports, while the other half will comprise sea defense and public infrastructure, canals and basins.

"The Port of Rotterdam is very important for this region and for the Netherlands," says René van der Plas, vice president of project organization, Maasvlakte 2. "To make sure this port stays a world-class port in the future, it's absolutely necessary to expand it."

Commenced in 2008, phase one entailed the construction of sea defenses, initial port sites, 1.8



miles (2.9 kilometers) of quay, and 6.8 miles (11 kilometers) of roads and railways into the Maasv-lakte 2 area. It was completed in May 2013 at a cost of US\$2 billion.

"We are right on schedule, and we finished the first phase of the project 10 percent below budget," says Mr. van der Plas.

The project's success thus far can be attributed primarily to the project team's diversity and continuity, Mr. van der Plas says. "We tried to make the team in such a way that we have all kinds, styles and knowledge. And we still have many people who've been with us for the last eight to 10 years, which means we all know the history of the project."

The project also benefited from proactive stakeholder management. At its outset, Maasvlakte 2 faced considerable criticism, mostly from environmental advocates concerned that the project would displace wildlife and increase air pollution.

"We invested very early in stakeholder management so we could address complaints and worries in our design. If there was impact, we tried to mitigate it," explains Mr. van der Plas, whose team published a 6,000-page environmental impact assessment prior to construction. At Maasvlakte 2, terminal operators must meet strict sustainability standards. "Now, after 10 years, there are hardly any detractors left."

Like other transportation megaprojects, Maasvlakte 2's ambition exceeds project completion. "The success of this project is much more than time and budget," Mr. van der Plas says. "The real success of this project is if the Port of Rotterdam in 20 years' time is considered the most sustainable port worldwide." **PM**

Steady growth in maritime shipping is spurring new investment in port projects around the world.

Rotterdam isn't the only city working to build a bigger, better port. A rise in global shipping combined with an anticipated increase in ship size has ignited a flurry of port projects the world over.

In fact, shipping-container traffic moving through ports more than doubled from 2000 to 2010, according to Nripesh Kumar, director, capital projects and infrastructure practice, PwC India, a PMI Global Executive Council member, Delhi, India.

"As a result, the port sector saw massive investments with significant new port capacity being built in key trade lanes and within key trading regions," he says.

PwC estimates the sector attracted more than US\$150 billion in investment for 700 deals in the last decade, though the firm expects the future project landscape to be somewhat uneven. "European growth remains weak; growth within Asia is expected to be higher and likely to reach close to pre-crisis levels over the next five years or so," Mr. Kumar says. "Similar trends are visible in other regions."

THE PANAMA FACTOR

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In many cases, growth in port projects is being triggered by the need for bigger, deeper terminals to support the new generation of mega-ships—up to 1,200 feet (366 meters) long and 49.9 feet (15.2 meters) deep—that will be coming through the retrofitted Panama Canal.

"The Panama Canal expansion project is influencing projects on both sides of that country," says Jürgen Sorgenfrei, PhD, director of consulting services, supply chain solutions, IHS Global Insight, Frankfurt, Germany. "The most important impact is the widening of the canal to accommodate bigger vessels."

Many shipping destinations are pushing expansion projects through in order to support these supersized container ships. Outside of London, England, for example, Felixstowe, the United Kingdom's biggest container port by capacity, announced plans to extend one of its berths to accommodate simultaneous passage of two extra-large container ships. Work on the 11-month project is scheduled to start this year.

"Handling ... large container ships will become a must for European ports if they want to compete," Lars Jensen, CEO of Copenhagen-based SeaIntel Maritime Analysis, told *The Wall Street Journal*. "In the next few years only ships above 12,000 TEUs will operate in the main Asia-to-Europe trading route."

Bigger vessels moving through a widened Panama Canal also open up the possibility for new shipping destinations, says Paul Levelton, director of global infrastructure advisory, KPMG, a PMI Global Executive Council member, Vancouver, British Columbia, Canada. "Everyone is trying to position themselves as the preferred port of container trade with ships from Asia," he says. "But only hubs that can handle a 50-foot [15-meter] channel depth are in competition."

As a result, harbor-dredging projects are on the rise, including five U.S. projects that have been allocated US\$1.4 billion from the Water Resources Reform and Development Act in October. The harbor-dredging projects span from Savannah, Georgia to Port of Canaveral, Florida and Freeport, Texas.

Costa Rica, another country scrambling to accommodate bigger ships, is preparing to begin construction on a US\$1 billion deep-water megaport project in Moín. "With the amount of investment that goes into Moín, we fully expect it to be a first-world port at the completion of construction," Marco Vargas, a former member of President Laura Chinchilla's Cabinet and a former transportation minister, told the *Tico Times*. "This is a project that has been delayed for many years, and we expect it to finally begin taking shape."

PORT PARTY

China is also driving port infrastructure upgrades. Its ports have seen strong project investments over the last decade, which has led to the emergence of new global port operators, including China Merchants, Shanghai International Port Group and Cosco.

> "In many parts of Asia, port projects have been going strong for years," Dr. Sorgenfrei says. "Especially in the more developed countries, like Malaysia and China, where the work never stopped."

New operators are also launching port projects in key regional markets to expand their reach, Mr. Kumar says. "China Merchants is one of the key players driving investments in the African port sector and other emerging economies."

Australia is making steady investments in port

A STORM OF PORTS

SAVANNAH HARBOR EXPANSION PROJECT

Delayed for 14 years, this project got the green light in October 2013, thanks to funding from the U.S. Water Resources Reform and Development Act. The project will deepen the Savannah, Georgia, USA harbor from 42 to 47 feet (12.8 to 14.3 meters) to accommodate new supertankers expected to come from the Panama Canal.

LIMÓN MOÍN CONTAINER – PORT PROJECT

The current port can handle around 2,500 TEUs, a far cry from the 4,500 TEUs Panamax ships can carry. So in 2011, APM Terminals launched a US\$992 million project to upgrade and expand the port, allowing it to handle around 15,000 TEUs. This is the largest infrastructure project in Costa Rica's history.

projects, though progress is slower than it was prior to the recession, says Mr. Levelton. "Port projects to support mining operations are dropping off, but in the container sector many projects in Melbourne and Sydney are underway," he says.

In the Middle East, the value of projects relating to ports in the Gulf region is US\$30 billion, with US\$8.6 billion worth of projects in the United Arab

"Handling ... large container ships will become a must for European ports if they want to compete."

—Lars Jensen, SeaIntel Maritime Analysis, Copenhagen, Denmark

LONDON GATEWAY PROJECT The US\$2.4 billion, decade-long project located 25 miles (40.2 kilometers) east of London, England finished in November 2013. "This is the first port to be built in the U.K. in a generation," DP World chairman Sultan Ahmed Bin Sulayem said in a statement. "There is nothing else like this."

QATAR NEW PORT PROJECT

More than 7 million cubic meters (247 million cubic feet) of sand and rock will be excavated to create this container port that will replace the existing Doha Port. Launched in 2007, the US\$7.4 billion project is the largest port-development project in the world to be built on unused land. The project entered its construction phase in 2011 and is expected to be complete in 2015.

COLOMBO PORT

Sri Lanka launched a US\$500 million Chinese-funded port project in August 2013, in a move to develop Colombo into a strategic shipping hub. The project plans include a new breakwater and deeper basin that can handle 18,000 TEUs.

Emirates alone, according to project-tracking company MEED Projects. Some of the largest projects are taking place at container ports, to support shipping lines through the Arabian Gulf.

Mr. Kumar anticipates a surge of new port projects in Africa and Latin America over the next decade, as well as renewed activity in the bulk sector.

"Projects with a clear business case and

strong promoters are likely to find access to banks and other funding easier than marginal projects with weak support," he says. "Therefore, projects in emerging markets are likely to continue to face funding constraints and will have to rely on strong promoter support." But if they can find that, it should be smooth sailing ahead. —Sarah Fister Gale