President Barack Obama asked Congress for more than $60 billion to help repair and rebuild infrastructure damaged by Hurricane Sandy in the Northeast. The House of Representatives finally voted Friday on a small down payment, roughly 10 percent.

As in the past, engineering experts will likely seek to build in added protections for the specific pieces of the infrastructure that failed in the storm – for example, flooded subway lines or power substations. What they don’t usually address, however, is how to protect networks as a whole.

Ignoring how everything works together is short-sighted. No matter how much money is spent, one part of the system can always go down again. As Sandy demonstrated, a failure at any point can have a cascading effect.

We must be aware of how these pieces fit together to form the larger transportation, energy or other networks that support our lives – taking a “systems engineering approach.” Then, we must
make sure that at least some recovery funds are spent to keep entire systems up and running – even if one part fails.

Hurricane Sandy offered plenty of examples that show how vulnerable our infrastructure is. For example, the critical Port Authority Trans-Hudson (PATH) rail line from the damaged Hoboken, N.J. station to Manhattan was knocked out of service for seven weeks – and is still on a limited schedule.

The problem, however, wasn’t just with the storm damage to this one line. Many of the 28,000 commuters who had taken the PATH each weekday faced considerably longer bus and ferry rides into New York City. Other commuters had to vie for seats on already overcrowded trains on the other cross-Hudson rail lines, or opted to drive in, further clogging the Lincoln Tunnel and adding to everyone’s commute time.

So this one point of weakness – the Hoboken line – led to continuing dysfunction across a large part of the overall transportation network between New York and New Jersey. During and after Sandy, similar cascading failures in infrastructure resulted in massive and persistent power outages, disruptions in telephone and Internet service, and overflows in sewage treatment plants that contaminated waterways and low-lying neighborhoods.

Using systems engineering, we can think instead about how to keep the overall system operating when one part goes down. This starts with the overall objective – making sure commuters can get from New Jersey to Manhattan every day, for example – and looks at how the various elements of a system need to work together to make that happen.
When we look at the larger picture, we see that repairs or improvements to one part of the system – though essential – may not be enough. In the PATH example, officials are now considering flood-mitigation measures, such as giant balloons to block water in tunnels, to help the rail line withstand another Sandy.

But what happens if the next super storm shuts down, say, the George Washington Bridge instead – creating a new set of cascading problems in the larger transportation network? We could be right back where we started – with a single weak link leading to system-wide failure.

The solution is to strengthen not just the parts of the transportation, energy and other networks that broke down during Sandy, but to strengthen the systems as a whole. If one piece of a system fails in a disaster, the other parts must be ready to pick up the slack.

This can be accomplished through measures such as building in redundancies and adding capacity to the larger systems. In the New Jersey-Manhattan transportation network, for example, it might mean purchasing extra rail cars that would not be used on a regular basis, but could be pressed into service if a bridge or rail line is shut down and rider capacity needs to be increased suddenly.

It is possible to build in system redundancies that increase capacity without adding a great deal to the overall rebuilding cost. Typically, only modest investments are needed. Yet this extra step is often overlooked.

If the billions to rebuild after Hurricane Sandy are to be well spent, however, a portion must be dedicated to keeping the larger systems functioning. Even if some of the individual pieces break down.

PHOTO (Top): A flooded stairwell down to a submerged subway tunnel beneath street level at the South Ferry-Whitehall Subway Terminal in lower Manhattan after Hurricane Sandy October 31, 2012. REUTERS/Mike Segar

PHOTO (Insert Middle): Flood waters in the Hugh L. Carey Tunnel in New York October 30, 2012. REUTERS/Metropolitan Transit Authority/Patrick Cashin/Handout
PHOTO (Insert Bottom): A massive wooden beam blocks the entrance to the South Ferry-Whitehall Subway Terminal in lower Manhattan, after Hurricane Sandy October 31, 2012. REUTERS/Mike Segar

John A. Thomas is president of the International Council on Systems Engineering and a retired senior vice president and chief systems engineer of Booz Allen Hamilton. Ali Mostashari is the director of the infrastructure systems program at Stevens Institute of Technology. Andrew McNaughton, chief engineer, High Speed Two Ltd, UK also contributed to this article.

Another target for such in Japan post-tsunami-areas, the huge funds collected there – and already being consumed just to rebuild in the greedy mode the past – wait for such systemic-intensive & network-centric cross-industry approach, to be able to deliver the required novel “aging well” society, with obviously novel & advanced forms of actor networks/ecosystems with quite non-traditional through-life commitment characteristics, quite distinct set of advanced capabilities, and infrastructure platforms (resources, structures & processes).

Enhancing the advanced Systems-of-systems engineering approaches into the vast triple-domain “emergence-desing-paradox” challenges in dealing such systematic way with the (1) required novel ecosystems’ strategy-to-operations through-life commitments, (2) the spectrum of such robust/recilient operational systems, and (3) programme/project vehicles, such advanced “incremental commitment model” oriented xSE-frameworks and approaches would bring real distinct capabilities spectrum to deal with such systemic-intensive and increasingly already time-critical mega-scale transformation cases.

A job to do ahead.

Posted by: holimeer | Report as abusive
This is a good article and on target. We need to start responding to disasters with the understanding it’s a complex system of systems problem. It’s the complexity that makes the recovery so hard. The authors make this point in their 3rd paragraph. By not considering the whole system often fixing one failure only exposes and exacerbate other problems extending the recovery in both time and cost. If a small portion of the $60B could be applied to the understanding and addressing the whole systems problem then not only would Sandy relief benefit (speed of recovery and relief to suffers) but serve as tool for future disaster recovery.

Posted by KevinR | Report as abusive

Re the Japan case, I was touching/involved a bit last Summer through my networks into such “systemic-intensive strategic-growth-governance case” into post-tsunami-areas challenges. Huge challenge there, huge funds collected into three mega-scale funds, but the century-old rigidities and siloed modes prevent effectively to bring in any far more effective & efficient modes which are required to scale/scope systemic & resilient-growth response (with huge/aggressive time-window-squeezing parallelization of a vast array of network-centric cross-industry-operations).

Such systematic way with the

1. required novel ecosystems’ strategy-to-operations through-life commitments (the business ecosystems strategic commitments perspective into a highly advanced network-centric growth mode).

2. the spectrum of such robust/recilient operational systems (as the vast array of such “emergence-design-paradox” type – i.e. very emergent/dynamic, chaotic, complex-adaptive operational systems-of-systems), and

3. programme/project vehicles (as Nth degree-complexity open-ended business-endavors to deal with the systemic transformation of the vast legacy-intertia vs. tabularasa/novel full-spectrum/through-life solution commitments balance)

to realize an “aging-well” society into such context was initially discussed among a set of stakeholders, but seemingly back then too big a challenge to be developed on even a case-level into a serious potential proposal & projected action agenda, as seemingly nowhere enough guts – or such required “incremental commitment elaboration” based multidisciplined xSE capability to engage into such challenge.

Interesting to see, if this kind of Reuters channel to wider audiences might create a serious systemic-intensive-aware response from a core set of key stakeholders to be able to create a proper demonstration case for the xSE potentials to deliver.
Just recall the main theme of the 2008 INCOSE/Utrecht Conference, i.e. “Systems Engineering for the Planet”. Broadened into such systemic thinking, “ex-ante/ex-dolo” architecting & engineering as much as possible in such multiply-ovelayed complex-adaptive-systems “emergence-design-paradoxes”, and bringing the benefits of the “agile-xSE” “incremental commitment orchestration” frameworks across such triple areas, there is huge potential in contemporary world’s systemic challenges to bring robust/resilient survival trajectories into many areas with diverse advanced modes of Systems-of-Systems through-life architectures & operations “engineering”.

http://blogs.reuters.com/great-debate/2013/01/04/rebuilding-post-sandy-whole-greater-than-parts/