A Structural Engineer's Manifesto for Growth

Part 3

By Erik Nelson, P.E., S.E.

This is the third installment of what I am calling my manifesto, which presents some of my thoughts about our profession and how we can grow as individual designers. For steps 1-11, please see Parts 1 and 2 in the April and May 2012 issues of STRUCTURE®.

12: Draw with a Pen

Sketch ideas of structural systems or buildings. Buy a sketchbook and use a pen, so that you cannot erase your mistakes. Mistakes are important reminders that you are fallible (like everyone else). The best preparation for life as an engineer is the understanding of our ignorance.

In the terrific book, *Structural Engineering: The Nature and Theory of Design*, William Addis states:

> *Up until the turn of the century, it was standard practice for engineers to keep their own notebooks containing annotated sketches of hundreds of interesting designs and details they have seen in their travels; this formed a body of knowledge upon which a designer could draw and provided an important link to the past. Also, until the present century, engineering textbooks and encyclopedias often used to contain many examples of successful designs, both ancient and modern. Nowadays, young engineers are generally brought up without a good knowledge of precedent and to believe that mathematics of engineering science encapsulates all they need to know.*

13: Simplify Your Analysis Models

The best structural engineers do not need complicated models. It is commonly said that computer software can be a valuable and reliable tool only to those who otherwise do not need it. This is true. In your work, make this true.

Software writers who work on integrating BIM with analysis models do not seem to understand this. They mistakenly think that it is useful for engineers to model the entire building – every floor slope or offset, every little filler beam around slab openings, etc.They believe that this is how we do our work! I tried to help reduce this misunderstanding when writing *BIM and the Structural Engineering Community* in the December 2008 issue of STRUCTURE. Computers should be used as a tool to make design decisions, they should not *make* the decision. We can model base plates and foundations as shell elements, or we can do a three-second hand calculation or quick spreadsheet. This is not about trying to take shortcuts. This is about knowing what the software can and should provide, and what it cannot or should not.

If you already know that the software cannot come close to mimicking reality, where do you draw the line? Is the concrete you are modeling genuinely Hookean (linear-elastic)? Do plane sections really remain plane? Is that foundation or base plate a true pin or a fixed point? Is the soil perfectly stable and uniform? Do our buildings never decay? Does our concrete not continue hardening over time? I am not suggesting that we do not need to know about the state of the art in analytical modeling, I am just pressing the point that they will never achieve reality. Often complex finite element modeling is unnecessary and does not contribute to good design decisions.

14: Get into the Details

Become super-technical, because actively understanding our codes and science is essential. It is also unlimited.We cannot possibly know all that is in the endless codes that we need to use. So, you can add them all as PDF files on your e-reader (Kindle, Nook, etc.) and read in bed. If you have trouble sleeping, there is nothing better! Also, you wake up with new knowledge.

Memorization is less important, since engineering is not knowledge-based, it is know-how-based (See *What Is Engineering Exactly?* in the February issue of STRUCTURE). Where to look for knowledge may be more important than the facts themselves.

15: Constantly Prod Yourself

We need to keep asking questions like, "Why did you choose this over that?" or "What factors led to the decision to do that?" Avoid getting lost in the codes, details, or loads prior to looking at the full picture. If you have trouble looking at the structure as a whole (or connection as a whole, or weld as a whole), then you are not effectively managing your time. You will have trouble seeing what you need to focus on. Determine which areas of the project need special attention and which do not.

16: Know Engineering and Architecture History

Knowing our history, our leaders, our heroes, and our world's engineering and architecture is not something that needs an explanation. How is this not part of the curriculum? History helps us use our long tradition of building structures to push new boundaries in our workplaces. We can stand on the structures of the past and learn to improve future design. We need to try to work daily towards rejecting the status quo, but only after we fully understand why. History will help us.

17: Seek Honesty to Achieve Beauty

How do structural engineers design beautiful works of "structural art"? Pier Luigi Nervi states the importance of structural honesty or correctness:

> *Every improvement in the functionality and the technical efficiency of a product brings out an improvement in its aesthetic quality… truthfulness is an indispensable condition of good aesthetic results.*

This idea of working with honesty and clarity is similar to step 7 of this manifesto (Forget About Goals). Like the last phrase of the poem I wrote about Nervi (*The Structure That Sings*, in the March 2008 issue of STRUCTURE): *Truth in form as the means, and beauty as the end* can be our contribution towards improving the aesthetics of the built world.▪

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