# Custom Cars, *Mercury Rising*, and the Elusive Goal of Construction Productivity

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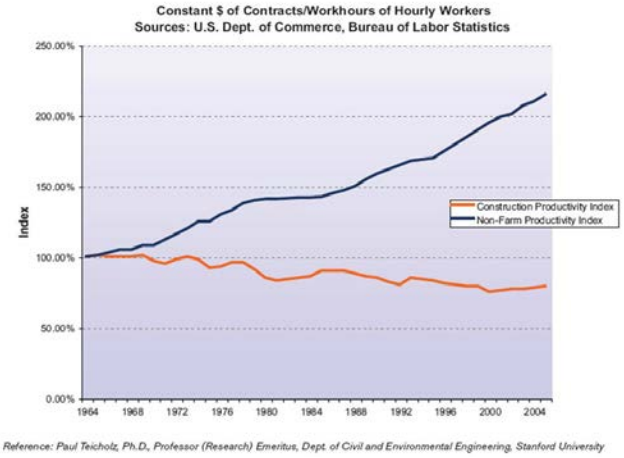
Imagine you want a car, a special car, one that's different from any other car available. You want your car to meet your particular needs, and you want it to be jazzier than anyone else's. So instead of just buying an off-the-lot car, you hire an automobile designer, who meets with you to gain an understanding of your unique desires. Your designer engineers your car from scratch and creates a virtual 3D model of it to better convey the design to you and to speed up production. You then hire a team of highly skilled individuals to build it. However, your designer's 3D model can't be used to help with fabrication as it isn't detailed enough to be useful to your builders, so they have to develop a 3D model of their own. Because this car is different from any other, it has to be approved by the Department of Transportation before it can be built. Once the car has been approved, you insist it be built outdoors, so you can watch its construction from your office window, under all weather conditions. After the car is built, you hire independent inspectors to test it to ensure it's operating properly and has been built to meet your expectations and the Department of Transportation's requirements. Finally, after what may well have been years of waiting—and a small fortune—you get your car.

Does this scenario sound familiar? For buying cars, certainly not. No one but a wealthy eccentric would even consider buying a car this way. Yet it's exactly how we go about designing and building buildings. And since the beginning of time, most designers, builders, and owners have accepted it as the norm. However, in the past few years, innovators in project delivery have been trying to improve on that, and often use the following graph to make their point. Perhaps you've seen it:




It was created more than ten years ago by the Department of Commerce to show how the construction industry's productivity lags behind all other non-farm U.S. industries. It's often used to show how some "new" process—lean construction, design-build, Integrated Project Delivery (IPD), Public/Private Partnerships (P3), or others—will turn the construction industry around and make it as productive as other industries. However, we've never been convinced that the people using the chart actually understood what it meant (and we, your humble authors, certainly didn't).

Well, it turns out that *somebody* understands it. In a 2013 article,[1] Stanford University professor Paul Teicholz examines the data that generate the chart, as well as the significant factors that cause poor productivity within the construction industry. These include the following:

- Buildings are mostly unique creations built under varying site, regulatory, programmatic, and weather conditions.
- Procurement is based more on competition than collaboration.
- BIM is often used inefficiently.
- The construction industry is dominated by small construction firms that can't afford to invest in capital-intensive methods to boost productivity.[2]
- A significant amount (around 35%) of construction work is renovation or remodeling.

As Professor Teicholz points out, most of these factors are endemic to the industry. Buildings will always, to some extent, be built under varying conditions; the industry may always be dominated by small construction firms; and renovation work may always be a significant portion of construction (in fact, renovation may increase relative to new construction as we increasingly try to reuse our existing building stock). He pessimistically, but probably realistically, admits that his recommended fixes—better use of BIM and IPD, greater use of prefabrication, and adoption of business models that support life cycle requirements—have little chance of raising the construction industry's productivity to the level of, say, the automobile industry's.

Rather than comparing construction to industries that rely on assembly-line production under controlled conditions (i.e., highly productive industries), what if we compared it to another non-farm U.S. industry that suffers from similar endemic handicaps—reliance on labor and dependence on weather—as construction? One comes to mind: filmmaking. In the 1930s and 1940s, most American movies were produced by a few large Hollywood studios that controlled all aspects of production and distribution, and were shot mostly indoors under controlled conditions; this allowed studios to crank out movies at a pace no studio today could match. (In fact, this assembly-line approach to Hollywood movies was often called "The Factory System.") Flash forward 50 years: In 1997, one of your authors watched the on-location Chicago shooting of the movie *Mercury Rises*.[3] For maybe two seconds of final footage, the film crew endured hours of faulty equipment and uncooperative weather. We don't have statistics to support this, but even with today's use of computer graphics, we suspect that movie making was much more productive in the 1930s than it is today.

Most other industries, such as the car makers, learned long ago that relying on human labor and good weather drags down efficiency. That's why cars are not built like our custom car example above. Consumers would never tolerate such costly and inefficiently made products. Owners, architects, and contractors, on the other hand, have for the most part accepted the loss of efficiency for the sake of unique solutions to unique programs and sites. But perhaps that's changing. While we may still be far from thinking of buildings more as manufactured products than as one-off, hand-crafted objects, we are starting

[1] http://www.aecbytes.com/viewpoint/2013/issue_67.html - "Labor Productivity Declines in the Construction Industry: Causes and Remedies" by Paul Teicholz

[2] According to Professor Teicholz, small construction firms (from 1 to 49 employees) constitute nearly 97% of the total firms, but account for just over half the construction volume.

[3] For most of you readers who have justifiably forgotten or never heard of this movie, it starred Bruce Willis as an FBI agent protecting an autistic boy from assassins.

to think of major building components as manufactured products. For example, it's no longer exceptional in hospital construction to prefabricate patient toilet rooms. They are the ideal building components to be treated like products: repetitive, transportable, and relatively easily plugged into the construction. Likewise, the use of prefabricated apartment and hotel rooms are becoming more common to reduce the on-site labor and to gain more consistency in the quality of the completed building. Similarly, more and more building elements, such as unitized curtain walls, are now the norm, with all the components prefabricated under controlled (and indoor) conditions and transported to the site in modules for quick field installation.

Some creative architects and contractors are working together to push this even further. A recent *Building Design+Construction* article[4] describes a "micro-apartment building" in New York that assembles modules into a structure reminiscent of Moshe Safdie's nearly 50-year-old Habitat 67. And in China, prefabrication has been taken to levels inconceivable in America, with new records in height and speed being broken every year.[5]

Innovations in technology may take us in directions we can't predict. Let's look at another analogy: One person's iPhone 6 is, except perhaps for the color, identical with everyone else's. But everyone has probably a unique combination of apps, so that his or her iPhone 6 performs differently from everyone else's. As design and construction become increasingly more digital and virtual (for example, large-scale 3D printing[6] and virtual reality[7]), is this how we might meet the seemingly contradictory desires of unique design and mass production? Your humble authors admit we have no idea. But we're fairly certain of this: Short of making our buildings truly mass-produced *products*, raising construction productivity to that of other industries will likely be an elusive goal. Innovations such as BIM, Lean design and construction, and integrated project delivery will not, on their own, make the construction industry as efficient as other industries. However, this doesn't mean we shouldn't adopt them in our design and construction practices, because any of them will certainly make us *more* productive, and maybe, for now, that's achievement enough.

***Disclaimer:*** *The viewpoints expressed in this article are those of the author(s) and are not necessarily approved by, reflective of or edited by other individual, group, or institution. This article is an expression by the author(s) to generate discussion and interest in this topic.*

[4] http://www.bdcnetwork.com/my-micro-ny-will-soon-be-new-yorks-first-micro-apartment-building?eid=216308868&bid=1217648

[5] http://www.bdcnetwork.com/must-see-57-story-modular-skyscraper-was-completed-19-days

[6] For some interesting applications of 3D printing, see http://3dprint.com/77550/dubai-3d-printed-office/

[7] For a typical story about virtual reality in construction, see http://fortune.com/2015/08/25/mccarthy-construction-vr/