

Green Light Lag, Yellow Light Drag

What lies at the heart of an engineer? What differentiates an engineer from a scientist, architect, craftsman, or artist?

Is it the desire to learn how things work? Perhaps, but an engineer is grounded in the practical; leaving black and worm holes to the lab coats.

Is it the desire to create and design? Perhaps, but few engineers are offered the luxury of the architect's blank design sheet. Our task begins, rather than ends, with design.

The craftsman within an engineer wants to get his hands dirty. Mechanical engineers grind a gear or two. Civil engineers parade their hard hats and steel-toed shoes. Electronic engineers have their soldering guns holstered at the ready. Even software engineers—who produce untouchable products—are often caught looking under the hood of their computers, peripherals and servers much to the chagrin of system administrators. Still engineering is more than tactile tinkering.

Like the artist, engineers see beauty in their creations, however our muse is not aesthetic but functional. We prefer client awe and satisfaction to critical adoration.

At the heart of an engineer is the desire to create solutions. We take pleasure in transforming raw materials into innovative and useful gizmos, thingamajigs, and whatchamacallits.

It starts early in an engineer's life with Building Blocks, Tinker Toys and Lincoln Logs. You quickly graduate to Legos and Erector Sets. You master the designs on the box and in the instruction manual. Then the real fun comes in creating your own designs.

The desire and thrill never leaves. One night I conjured up a new game with my son Matt. I went to the pantry and pulled out a package of plastic cups and divvied them out evenly between the two of us. The challenge? Build the highest cup tower with the least amount of cups. Raw materials, strategy, skill, and trade-offs; heaven.

My latest toy? Buckyballs! Not the spherical fullerenes but a set of 216 magnetic balls. Each five-millimeter ball has a neodymium core charged to a magnetic flux of 50. The small

size and strong magnetism allows one to create interesting patterns that form building blocks for larger objects. Combining objects changes their polarity and adds design dilemmas and opportunities.

Such toys awaken an engineer's inner master builder to solve straightforward problems. Straightforward problems are not necessarily simple or easy but their solutions are characterized by a set of instructions that can be taught and repeated with equal success.

For example, if I give you a single string of 216 Buckyballs and ask you to form a 6x6x6 cube it would take you several hours. It's not intuitive or easy. However, if I spent 5 minutes teaching you step-by-step how to form the cube from the strand, including some techniques in handling Buckyballs you could master the cube and teach others.

Early engineering education focuses on straightforward problems that can be mastered, repeated and shared. However, engineers are not hired to execute recipes; we are hired to solve complex problems.

Complex problems increase in scale, interconnectivity and discipline. They tend to overwhelm the inner master builder's skill and capacity. Complex problems have to be broken down into subsets of straightforward problems and solved by specialists in various disciplines. Building the next generation fighter jet requires a variety of engineers and craftsmen working in concert. To succeed at complex problems engineers need to evolve from master builders to conductors where timing and coordination are critical. This transition is sensed in a phenomenon I call the Green Light Lag.

Picture yourself alone at a traffic light when it turns green. What happens? You start moving immediately with no delays. Now picture yourself ten cars back at the same traffic light. Now what happens when the light turns green? It takes eight to 10 seconds before you can move your car. Why?

Theoretically when the light turns green all 10 cars should start rolling simultaneously without mishap. If the Thunderbirds and Blue Angels can move tightly together in high speed 3-D why

can't we do so in low speed 2-D? What happened? Due to a lack of trust, preparation, practice, communication and coordination each car in line waits for the car ahead to move before acting thus contributing to the green light lag.

In the same way, if a project team lacks trust, preparation and coordination the project will suffer green light lag. It is the role of the conductor, the engineer leading the project, to build team trust, open communication and reinforce coordination. The evolution from a straightforward engineer (builder) to a complex engineer (conductor) requires the development of skills engineers do not bargain for when they entered the field like scheduling, negotiation, collaboration and leadership skills.

With the explosion of the information age we now face yet another level of problems. This new breed of problems are not only complex but animated, volatile, fickle, and ever changing. In a word they are mercurial.

Mercurial problems require a conductor to increase trust by pushing most decisions to the periphery, giving super specialists the room to adapt to rapid changes and unexpected problems based on their expertise. In turn this puts more emphasis on effective coordination.

Mercurial problems are particularly prevalent in software engineering. You build a complex payroll system for a mainframe processor only to be told the system now needs to run on multicore processors with a browser interface taking advantage of a parallel design. Can your engineers handle that? What do you do?

With mercurial problems your old designs, processes, and workforce often fall short. Sure you can protest requirements creep, lack of a stable baseline, or unrealistic expectations, however, in the future successful engineers will be mercurial engineers—adaptive, animated, lively, and quick-witted. They will augment their building and coordination skills with the assemblage of highly specialized, skilled and adaptive teams.

Back to the intersection. There is another phenomenon that occurs when the traffic light transitions from green to yellow. Tepid drivers impulsively stop and wait. Lackadaisical drivers are caught by surprise, brake late and block the intersection. Vigilant drivers do the yellow light drag—accelerating through the light before it turns red.

Where are you driving your engineering skills; green light lag, yellow light drag, or blocking the intersection?

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