Engineering

Boot camp for the brain

By John Bologna, PE

The practice of engineering relies on uncompromising principles of science and math, which can be applied to running a successful business. This may seem contrary to right-sided business management principles that rely on an understanding of basic human instincts and desires; many of which may be difficult to quantify. Basic outcomes such as customer satisfaction, workforce alignment and community service corroborate an important set of desirable yet illusive ideals that are difficult to quantify and nearly impossible to consistently sustain over a long period of time. Businesses run on engineering principles produce measurable results and quantifiable data to measure success, rather than just relying on an arbitrary sense or feel.

Engineering relies on critical thinking skills and a holistic approach to problem solving. Engineering principles mean the ideas, rules, or concepts that need to be kept in mind when solving a engineering problem. However, there is no one specific list of engineering principles that can be written down or posted up on the web. That is because the concepts used to solve a problem will often be different depending on the type of problem encountered.

Some principles I learned in engineering school and in 30 plus years of practice are:

- Plan your work thoroughly,
- Know your fundamentals
- Maintain equilibrium
- Understand the importance of tactics and logistics
- Understand the materials you work with and their limitations
- Build a good foundation
- Make your business efficient and effective
- Know and understand your metrics
- Sweat the details
- Maintain integrity
- Keep it simple
- Understand the human element

Plan your work

An adage I learned from an engineering school mentor: Plan your work thoroughly, then thoroughly work the plan. All businesses need to have orderly systems in place: you have to be organized, and your business has to be well organized to succeed. Think about what you like from the people you do business with. Most likely they:

- are well organized and punctual,
- provide consistent delivery of product and service, and
- are reliable, meeting deadlines and deliverables.

None of this can be accomplished if you don't have certainty in your systems and processes.

Successful companies can accurately predict the outcome. Why? Because it is process-driven. In engineering, it's the scientific principle – a process, repeated with the same elements and conditions, will consistently yield the same results.

Know your fundamentals

In engineering, you need to know the fundamental principles of the discipline before you can apply them to solve problems. You cannot solve the upper-class problems of engineering mechanics until you have mastered differential equations, and you won't understand calculus if you don't understand basic math and arithmetic. In business, you need to know your fundamentals: understand what you do and how you do it. How do you make your money? What are the key functions of your business and what metrics do you use to measure them? Internalize them and make them second nature. Then you can build on your knowledge base and expand your repertoire. Higher mastery of skills will set you apart and allow you to focus creative energies on more important things.

Maintain equilibrium

Isaac Newton, one of the foremost scientific intellects of all time, discovered that every action has an equal reaction and, in order for an object to maintain stability, forces need to be balanced in either static or steady state equilibrium. According to the well-known story, it was on seeing an apple fall in his orchard that Newton conceived that the same force governed the motion of the Moon and the apple. He determined the need to maintain mathematical equilibrium and calculated the force needed to hold the Moon in its orbit as compared with the force pulling an object to the ground. In business, as in engineering, things have to be in balance in order to function properly. Books have to balance, accounts reconcile and business functions need to be in steady state equilibrium to keep from spinning out of control. Balance between functions needs to be in harmony with its operations. It's also important to maintain a proper work/life balance. The human machine needs its downtime to recharge the batteries and maintain proper functionality.

Understand your tactics and logistics

Have the right strategy and understand the importance of tactics and logistics and know the differences. Strategy is the grand scheme – it's what the generals do in a war campaign. Tactics are executed by ground troop leaders as part of the greater strategy to reach the objective. Logistics are how the troops are managed and supplied. Solving an engineering problem requires not only an understanding of the engineering principles that govern the behavior of materials, but it also requires an understanding of how systems work so you can devise an approach that will guide you through the problem-solving process. This requires proper strategy to achieve the design objective, tactics for defining the problem, and logistics for assembling the raw materials needed. Engineering is likewise a strategic enterprise – it teaches how to think critically and how to solve problems.

Understand the materials you work with and their limitations

All materials have certain physical properties that dictate their performance. Steel, for instance, has a strong weight-to-strength ratio. It also has very predictable behavior under load. Steel strength is measured in its capacity to resist load with respect to the material's yield stress. The material functions normally as long as the load does not over stress or strain the material. The ratio of stress and strain describes the material's elastic properties. As long as the load is in the normal elastic range, below the yield point on the stress-strain curve, the material will perform. Exceed those limits and the material goes into a failure mode, and ultimately will fail. Not a good thing. People and business relationships are the same way.

Build a good foundation

You can't see it, but it governs everything above it and the strength of the building relies on it. The building foundation is the first basic element of the building and it's important to have it done right; a sound foundation is needed if the rest of the building is going to work properly. Same is true in business as it is in life. You need to have a good foundation if the building is going to stand up in strong weather.

Make your business efficient and effective

Good engineers strive to make their designs efficient and effective. That means understanding that there is no perfection, so designs need to be pragmatic as well as functional. A good design performs well without excess use of materials or energy in the production or performance. Engineers, to be successful, need to

be efficient and effective. Work to make your systems more efficient, but also understand the nuanced difference between being efficient and effective. Peter Drucker stated "Efficiency is doing things right; effectiveness is doing the right thing." This requires a system to stay within its operating range, perform under the established design criteria, and be cost effective to manufacture and operate.

Know and understand your metrics

Engineers rely on measurements to quantify what they do. Engineering performance is measured in many ways and parametric relationships are quantified in order to fully understand how things work. In business, it's the MBA's axiom: That which cannot be measured cannot be managed. In any successful business, processes must be calibrated by metrics. Process metrics are important because they communicate process performance characteristics to those involved in the process who, in turn, are responsible for constantly improving the process. Metrics are generally assigned to organizational elements, not to processes. This makes it difficult to align organizational rewards with process performance. If process metrics cannot be assigned to the reward system that motivates organizational elements supporting the process, those organizational elements will not execute the process effectively.

Sweat the details

Modern Architect Ludwig Mies van der Rohe was fond of saying that "God is in the details." In design, it is an idiom that expresses the idea that whatever one does should be done thoroughly and thoughtfully. Steve Jobs was obsessed with the design details and every aspect of his products' design, from the hardware to the software to the packaging that the devices were shipped in. According to Jobs, design is not just about how a product looks, it has to also reflect the product's essence. Engineering seeks to optimize the design for the highest yield; good engineering seeks optimum design with excellent performance and quality. Likewise, a successful business will put out an excellent product or service that reflects the essence of what the business is all about.

Maintain integrity

Just like a building needs to be designed to have structural integrity, otherwise it will fail, so too your business must be based on integrity, internal and external, or it will fail. You cannot run a business on a false premise, just like you cannot design a building on false assumptions. The laws of physics will not allow an engineer to deviate from the realities of the physical world- his designs will simply not work, or worse, will result in injury or harm if not done properly. Likewise, the laws of nature will not allow a deceptive business to survive long. The truth is like the cream, it always rises to the top. Successful businesses operate on honesty and integrity.

Keep it simple

Engineers are taught Occam's Razor Principle early in their education: In scientific investigations, select the simpler of two explanations. Remember the KISS principle (keep it simple, stupid). The engineer must consider the most important features of a design before beginning a project. Simplicity is the ultimate sophistication. However, do not underestimate the complexities either. Steve Jobs aimed for the simplicity that came from conquering complexities, not ignoring them. He said, "It takes a lot of hard work to make something simple, to truly understand the underlying challenges and come up with an elegant solution." Engineers must remind themselves not to overcomplicate products that few people are able to use. Remember to "human engineer" a product – think of the end user and their needs; sometimes "simple" does not meet the need of the customer, in which case a corollary to KISS is to "keep the target customer in mind."

Understand the human element

Finally, after all the analysis, calculations and engineering formulations, do not forget the human element. Much to the chagrin of the engineering geeks, James T. Kirk was chosen captain of the Starship Enterprise, not Spock. Kirk was able to balance the human emotional sentiments of Dr. McCoy and the technical intellect of Spock. Feelings are funny things and difficult to quantify. Recognize there are ethereal and metaphysical elements of our human existence that are beyond the trivialization of slide rules and micrometers. Humans are tripartite creatures, possessing body, mind and spirit. An understanding of these three parts and of their particular functions is therefore essential in any attempt to explain any aspect our humanity. Steve Jobs shared similar sentiments in his biography. "I always thought of myself as a humanities person as a kid, but I liked electronics." One of his heroes, Edwin Land of Polaroid, talked about the importance of people who could stand at the intersection of humanities and science. Jobs goes on to say, "I decided that is what I wanted to do." The rest, as they say, is history. CPB

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