Good quotations can sum up the jewels of life’s wisdom. They often come from people with significant and prolific accomplishments that impact our collective history and culture. Even in the manufacturing world concepts from quotes and proverbs get incorporated into the fabric of our thinking and methods. The phrase “Necessity is the Mother of Invention” could be used to describe the motivation for lean processes. Since the phrase is frequently attributed to the ancient Greek philosopher, Plato, could Plato be the originator of the concept of continuous improvement?

However, quotes can be misattributed or expanded upon, and they often become the basis for ongoing commentary. The ones that stay alive, in whatever form, have their foundation in some common experience—allowing that “Aha!” or “Yes, that makes sense,” response. These quotes often make their way into everyday business jargon.

The saying “Necessity is the mother of invention” is frequently attributed to the Greek philosopher, Plato, from a volume his “Republic.” The slightly different version, “Necessity is the mother of all invention,” is sometimes attributed to Albert Einstein. Then, there is “If necessity is the mother of invention, then resourcefulness is the father,” by Beulah Louise Henry. From Jonathan Schattke, “Necessity is the mother of invention, it is true, but its father is creativity, and knowledge is the midwife.” More recently according to Gary Martin of Phrase Finders “Frank Zappa gave this phrase an extra lease of life when he chose the name of his inventive jazz/rock band in 1964 - The Mothers of Invention.” (Martin 1)

If Necessity is the Mother of Invention, Customer Need is the Impetus for Design Evolution

By Ann Pettibone

Plato once wrote that necessity is the mother of invention. In the realm of workholding for gear manufacturing industry, this means innovation is the basis for constant improvement and concept evaluation.
Whatever forms the concept, innovation is born of need. It defines the basis for continuous improvement in manufacturing and, of course, gear manufacturing. It also drives the work that experienced workholding design firms do every day. The customer’s needs—their “necessity”—become the impetus for design innovation and solutions. This innovation often takes the form of concept evolution. The process can begin with a basis concept or design and new designs evolve as customer needs and requests are creatively addressed.

What needs or necessities drive customers to seek help with innovation?

The drivers for this kind of change and innovation are often the same for both our large OEM customers that are producing their own gears and for customers that...
are gear suppliers to those OEMs. They are usually motivated by a corporate or financial directive driven by market conditions. Typically the improvement goal is based either in a need or desire to improve production speed and efficiency or driven by some market place or industry change. Like newly developed machine capabilities and/or process changes and improvement, e.g., the movement from grinding to hard turning.

Necessity for improvement is generated from changes in several different new specific situations and often the combination of those new circumstances including the following:

• The customer purchases of a new machine to enhance the performance of an existing operation. Usually, this new machine has faster speeds and feeds, more powerful metal removal capabilities, and/or is now automated or has different automation requirement than the previous machine. Because of these new criteria, the former workholding cannot be used. In some situations, the former workholding can be used, but the full value of the new machine cannot be realized without appropriate workholding.

• A company wants to use existing machines for a new process. For example, they may want to mill gear teeth on their existing machine that they formerly hobbed.

• A kaizen initiative requires production performance improvement of an existing machine or group of machines. These can include reduced set up time, improved run time and ergonomics, reduction of operator error, and the gain floor space.

• A process on an existing machine requires refinement. For example, a new tolerance requirements or their component receives a design change.

• Production on a cell level of factory level requires the creation of more tooling versatility; often this is initiated through good lean practices and sometimes kicked off when a new machine is purchased and more tooling interchangeability or universality will further increases the lean benefit.

• Lastly, making preparations for the future. Some progressive companies are now thinking ahead and combining the need
for improved manufacturing results on their existing machines and the purchasing of new machinery in the future. The goal is to create new tooling that will enhance current production. Customers are giving workholding firms the machine model specifications they plan to purchase in the next few years. This will allow current workholding purchases to be compatible with future machines.

Whatever circumstances create our customers’ needs, we need to be the mother or father of the innovations they require. These innovations can be totally out-of-the-box, clean sheet designs, but in many cases they evolve from basic concepts driven by specific customer requests. In some cases, customers are integrally involved, bringing their own thoughts and ideas to the design process.

For example, many manufacturers are familiar with the concept of a self-centering manual actuation vise that often use v-blocks. It is traditionally considered an effective way to hold small round parts.

The needs or necessities of gear customers have given birth to three different much larger variations on a basis v-block concept. In the first and least complex of the three different self-centering design evolutions, the customer wanted to hold bar stock to begin the production of splined gear shafts (See Figure 1). They wanted to face mill and center drill both ends of the stock so they needed to have the bar stock positioned and have both ends available for milling and drilling. They had a variety of bar stock diameters.
and lengths. Each size was a medium volume of parts. The customer needed a fixture capable of accommodating varying lengths and diameters with minimal or no change over to work with their horizontal machining center.

This design concept featured a base plate with two v-blocks to center and clamp the bar stock. The two v-blocks can be manually moved to accommodate different part lengths. Bar stock end location was set with a manually activated end stop that would slide up during loading and drop down after the bar was clamped. The clamping v-blocks themselves were hydraulic activated through a hydraulic quick connect. Only one set of jaws was required to cover the customer’s one- to four-inch diameter range of bar stock.

“I am face milling and center drilling the ends on gear shafts and gear pinions. We need a fast and easy way to change over a wide variety short runs of parts.” That was the request that initiated the second design variation of a v-block fixture (See Figure 2). The customer’s previous method consisted of using a collection of blocks, clamps, straps, and shims to build a fixture for each part. The diameter requirements here ranged from five inches to 15 inches with lengths up to 96 inches. Run quantities of two to eight pieces.

In this version of the concept, Drewco Corporation designed hydraulic power for clamping the v-blocks and also used hydraulics to power the motors for moving the v-blocks to different positions for various length parts. The whole v-block mechanism was mounted to a base plate which was mounted to the machine table. The large range of diameters was handled with a series of three quick change jaws. Set up sheets where made for each part to be run on this fixture to document the v-block position and the required jaw set.

In this third example, this customer wanted to address additional needs. Drewco was asked to design and build a self-centering fixture for milling keyways in large pinion gears in their new horizontal machining center. They wanted to reduce set up time, increase accuracy of set up, minimize
and standardize needed components, accommodate run quantities as low as one piece, and address the ergonomic ease and safe handling of large components. These aspects needed to be addressed while providing sufficient clamping force across the range of parts. The customer needed the fixture to hold shafts ranging from three to 14 inches in diameter with a maximum flange diameter of 24 inches, lengths ranging from 24 to 92 inches, and weights up to 6,000 pounds.

In this generation of the self-centering design concept, innovation met the customer’s necessity through an air floatation system. It is used to facilitate ease of set up in positioning the v-block for part length adjustment. No tools are required in adjusting the length because the design hydraulically clamps the v-blocks directly to the machine table. It uses the same manual diameter adjustment as the second version. In this case 3 interchangeable jaws grip the various diameter parts.

The design includes the use of two independent hydraulic v-block vises. One v-block mounted to the machine table is stationary. The other v-block uses a hydraulic cylinder for quick clamping to the machine table and can float on an air cushion for easy mobility across the table. The operator unclamps the hydraulic cylinder, turns on the air pressure and can easily move the v-block to a new position, then releases the air pressure and re-clamp the hydraulic cylinder at the new position.

This customer now has the capability of leveling and centering parts while gripping on two different diameters. Adjustable locators were used to rough locate the parts prior to clamping they provide for “hands free” loading and clamping as a safety feature. Again set up sheets were made for each part number to be run on this fixture to document the position of the v-blocks and the required jaw set.

Wherever the phrase “necessity is the mother of invention” originated, it embodies what gear manufacturers and workholding design firms do every day. The customer’s needs and improvement requirements become the directives. Whether ask to improve profitability, safety, flexibility, or delivery performance, the job is the same.

The job of a custom workholding company is to listen to the needs and requests of its customers, use its years of experience and its design library, stay abreast of market and process development, and to process evolved designs that meet the requirements of the customer. Enjoyably, it is work that never gets boring.

REFERENCES:

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