HOTSEAT

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Three barriers prevent the state of perfectly achieved heat treat evolution: material handling, energy source, and capital cost.

LET'S TALK ABOUT EVOLUTION. I don't mean Darwin's escapades on the HMS Beagle, but the evolution that has influenced the development of the OEM and heat treating industry, primarily carburizing and quenching. In July's column, I presented operating cost, not capital investment, but utility usage for the batch vacuum process LPC/HPGQ, batch gas nitriding and a continuous pusher/endo carburizing system with press quenching. Some may take offense at the cost difference between LPC/HPGQ and the other processes; welcome to the "Greening of America."

The evolution I'm referring to is the continuous drive to evolve carburizing and quenching from behind the fire door to direct integration onto the machining or manufacturing floor otherwise known as "The Factory of the Future." Vacuum furnaces were supposed to do that. I grant you they have moved closer to the manufacturing floor. However, three barriers stymie that state of perfectly achieved evolution: material handling, energy source, and capital cost.

MATERIAL HANDLING:
How gears get to the heat treat and how they leave is usually the last item manufacturing engineering (ME) tackles when setting up for a new heat treat production system. From my experience, ME believes heat treat material handling will be the easiest issue to conquer primarily because many times ME believes heat treating is like any other manufacturing process. It's not.

The factory of the future's ideal production model is based on continuous production or an ideal "Takt Time" (TT). Takt Time is the time one finished item exits the production line, every minute, every hour, every 20 seconds, and in an ideal world, the time for each individual manufacturing step. More complex manufacturing procedures require more thought and more steps for each process. If production calls for more gears per hour for a particular size, generally each size requires a different machining center so that tool changes can be kept to a minimum.

The "fly-in-the-ointment"—the barrier that separates heat treating from other manufacturing processes—is heat and the soak time. If a batch process is used like nitriding or LPC/HPGQ, more parts per load are required and/or more furnaces. Continuous furnaces like pushers require more trays and/or more rows.

Carburizing and quenching of gears in a sense is a contradiction onto itself: Carburizing due to the time for carbon diffusion requires many minutes to many hours of time, thus several gears are processed simultaneously while quenching is best done one at a time.

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ENERGY SOURCE:
Vacuum furnaces are electrically heated because it's always been done that way. Some early vacuum heat treating furnaces had moly or tungsten rod or round heating elements, some had moly flat ribbon elements, but all were electric. In those early days, vacuum furnaces processed small loads and were primarily used for higher temperature processes like brazing or hardening tool steels, processes that were awkward at best when applied to gas-fired batch atmosphere furnaces requiring protective atmospheres. In addition, alloy radiant tubes back then couldn't withstand the higher brazing or high-speed tool soak temperatures. Eventually vacuum furnaces became larger and, in the seventies, graphite really changed the way vacuum furnaces were designed and used. Graphite was much easier and cheaper to manufacture and much more reliable. Graphite insulation became the standard—air or oxygen was not a threat anyway, so it made sense.

No one gave the slightest thought to heating vacuum furnaces with natural gas even though natural gas was very cheap and many heat treating processes were within the alloy material range. In addition, all vacuum furnaces were single-chamber systems where cooling is required to remove the parts to avoid oxidation. Perhaps if someone had invented a gas heating system years ago, the additional mass would likely have negatively affected the cooling time.

Since vacuum furnaces were essentially smokeless, it raised the possibility of moving these furnaces closer to the machining centers located in the middle of the manufacturing floor. Most manufacturing flow is set up so raw materials enter at one end of the operation and the final product exits at the opposite end, depending on how the freight bay access is accommodated. Either way it seemed a logical way to go. Simultaneously eliminating fluids from the manufacturing process was also desirable employing hard turning. One more step to the factory of the future—no more smoke, no more fluids—combined with high-pressure gas quenching (HPGQ)... an all-electric heat treat. What a concept! That is, until the green revolution, a very noble and desirable goal, starts to shut down all of the coal fired power plants and their source of energy. Generating electricity by way of natural gas is the next logical solution, but how long will that take? And will wind and solar take up the slack? Not a chance. Green is my favorite color; it's on golf courses, and it's the color of our money.

Only three industries like heat treating: commercial heat treaters that provide the service; furnace manufacturers; and the electric utility companies. OEM's—the ones that make the gears and gazillions of other parts—hate it. "Scorch and warp," as it's been described, but there's no other option.