tion between operators and their assigned tasks. Mental workload is an important measurement because it provides awareness about where increased task demands could hinder human performance.

In an attempt to address the changing demands of the manufacturing industry, the author developed a strategy that presents a framework for assessing mental workload in manufacturing processes. There are five essential steps to the framework, as shown in Figure 1: Study the manufacturing system, identify the cognitive elements, model the process, measure the mental workload (MWL) and mitigate work overload.

In step one, an ergonomist or process improvement team studies the manufacturing process to gain knowledge and insight about the system. For this, the evaluator completes a hierarchical task analysis to understand the process task activity. Next, in step two, the evaluator uses an applied cognitive task analysis to identify the cognitive task elements in the process. The hierarchical task analysis and applied cognitive task analysis collectively define the process steps and cognitive elements, which are employed as discrete events in modeling the process, which takes place in step three.

This study used the Improved Performance Research Integration Tool (IMPRINT) as the human performance modeling tool to predict mental workload. IMPRINT was developed by the Human Research and Engineering Directorate of the United States Army Research Laboratory to assess human-system function allocation, human performance and mental workload estimation.

The discrete events, with their estimated task times and multiple resource theory ratings for their associated mental resources, were the primary simulation inputs for this strategy. Multiple resource theory, as developed by Christopher Wickens, is a predictive model that supports understanding how well an operator performs while multitasking. According to multiple resource theory, when the human mind receives task demands (inputs), it can distribute its resources to handle these task demands either individually or collectively. Resources can come in various forms, including visual, auditory, cognitive, motor and speech.

Task demands that overlap leave the mind with fewer available resources. Multiple resource theory predicts that human performance will decline when multiple tasks require competing resources, which could decrease system safety and the effectiveness of your manufacturing process. IMPRINT applies a scale to the mental resources identified by multiple resource theory to assess the mental resource utilization for completing a process task’s discrete events. This step determines the multiple resource theory ratings for each discrete event identified in steps one and two.

With this data, IMPRINT measures MWL in step four, outputs the workload predictions and provides a workload profile for the task under analysis. If there is an MWL overload, ergonomists should use multiple resource theory to conduct an assessment to attribute mental resources that correlate to the mental overload. (If a mental overload task element is not measured, this terminates the process.)

In the event of a mental overload condition in step five, the ergonomics team should modify the manufacturing system based on multiple resource theory principles to mitigate the overload. This is done by decreasing the mental resources that are creating the overload and applying the multiple resource theory ratings again to compare the modified system resources to the baseline process evaluation.

Once again, the MWL is measured using IMPRINT. The process will recommence until an optimal MWL range is established. Once an optimal range is attained, the altered job element sequence can be tested and validated on the production floor.

Case study
To test the feasibility of the strategy, a pilot study was conducted in the medical device domain.

It was applied in the production of a medical surgical implant for humans. Production parts are laser welded and go through a post-processing procedure that cleans the parts and checks them according to quality specifications. The process is repetitive, such that the same procedure must be completed each cycle.

This study analyzed the parts cleaning portion of the process. Process steps for parts cleaning include mixing acids for proper formulation, dipping parts in chemicals and monitoring equipment settings to track proper processing times.