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Statistical analysis evolution refines process for injection molded keyhole part

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Producing injection molded plastic parts can be fraught with dimensional variations resulting from machines cycling through warm-up times, combating environmental issues such as temperature and humidity, and inconsistent operator decisions.

This case study involves the manufacture of a plastic keyhole part that was used as part of packaging in the food industry. The product often failed quality dimensional tests for the customer application. Scrap rates ranged from 2-3 per cent and would occasionally go as high as 10 per cent when anomalies such as humidity were introduced. (Note – although this example is fictitious, some of the data and information was obtained from real customers).

The process then underwent the six steps of the POSy-System from Paradox Engineering & Technology and the results were entered into the system program. The program would determine the precise set-points necessary to achieve the goals of the customer, improve the efficiency of the process and reduce the scrap rate at the same time.

The machine used was a Wittmann Battenfeld injection molding machine and the material was Polyethylene Terephthalate Glycol (PETG). The tool used had 16 cavities. The cycle time was 32 seconds and four (4) million parts were required annually. It typically took 97 to 100 days to complete the order for the customer.

The POSy-System is a new and innovative technology that is engineered to improve efficiencies, reduce waste products and improve quality by determining the precise set-points necessary to achieve the goals of the customer.

A servo-hydraulic injection molding machine. The Fig. 1A flow chart below illustrates the POSy-System methodology.

There were two alternative methods that were previous tried. The first was the trial-and-error method where technicians from each shift entered their own set of set points in an effort to make the quality parts required. This practice created variation of quality and increased waste product, particularly at the start of the process requiring approximately 90 minutes to stabilize the process until it was acceptable.

The second method was one using statistical analysis. This method was very slow and time consuming where the results only improved performance slightly. Further iterations of statistical analysis method were necessary to improve results further, but time limitations due to production requirements prevented extensive and continued research.

The POSy-System was introduced as a new and innovative technology that was designed to improve efficiencies, reduce waste products and improve quality by determining the precise set-points necessary to achieve the goals of the customer. Through 1 or 2 iterations all of the set-points could be determined fairly quickly and the process efficiency, waste product and quality would be improved. The POSy-System was engineered to improve production results quickly through a similar trial method to that of statistical analysis, but with a different methodology/algorithms, and has maintained an accuracy of 95 percentile. The engineering within the background of the POSy-System was designed to always produce improved results and make them optimal.

There were 11 variables that needed to be optimized with another 6 variables predetermined and maintained as constants. The number of variables presented a solution of what is termed as an L12 with 12 trials and 11 variables. The measureables were the specifications and scrap rate. A design of experiments through an array of trials

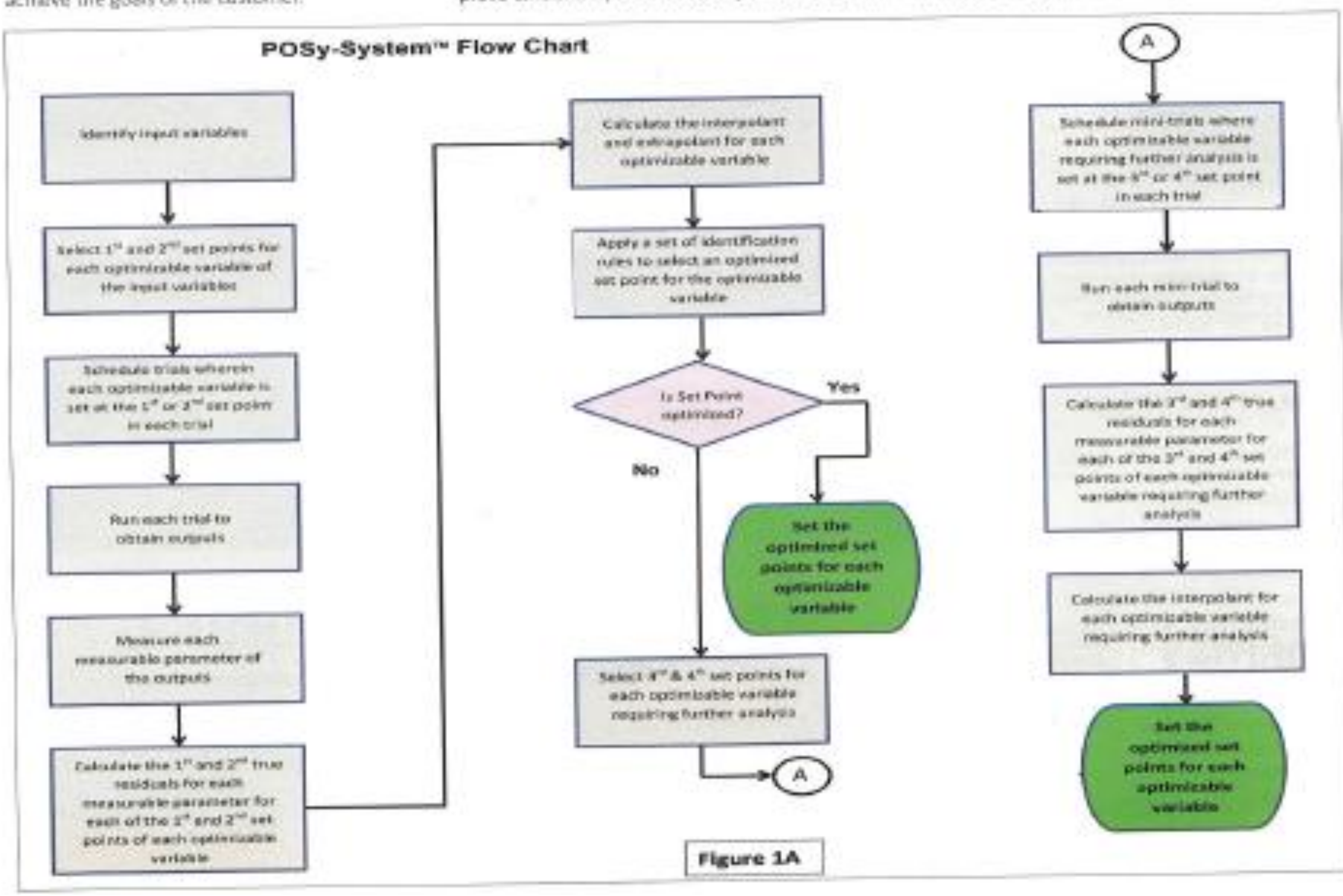

Figure 1A

versus variables was presented to the customer along with a blank list of trials versus measureables sheet. After inspecting the machine to ensure that all components were operating properly, the customer ran the trails and entered the data into the measureables' sheets. The data was then transcribed to the POSy-System program and the specifications entered as well.

The results showed that all but 3 variables were optimized in this single round of trials. The 3 variables that were not optimized during this initial set of trials were entered into an L4 design of experiments with the interpolant and extrapolant numbers, determined during the L12 experiments, bracketed just outside the two options as alternative set points. This quick set of trials determined definitively the last remaining optimized set poins for the 3 variables. The final optimized set points were entered into the machine and were tested for quality and waste produced.

The final assessment of the newly determined optimized set-points showed that the cycle time was reduced to 25 seconds, or a 21 per cent efficiency improvement. The customer was able to complete their order in 73 days versus 98 days. At the same time the waste product was reduced to under 0.5 per cent. The improvements allowed the customer to increase machine loading. These results definitively show that the POSy-System algorithms significantly outperform other methods of optimization previously used.

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