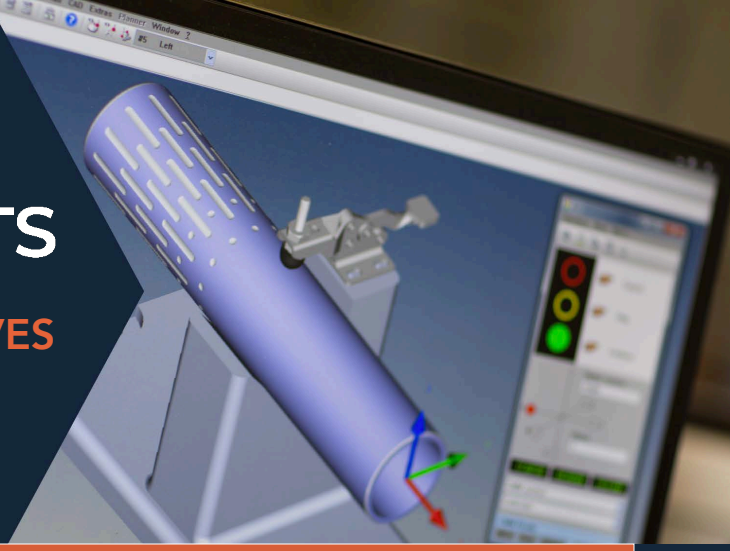
CENTRAL SCREW PRODUCTS

PARAMETRIC PROGRAMMING IMPROVES QUALITY & REDUCES COSTS

ENGINEERING CASE STUDIES 06



INTERNAL MACROS DEVELOPED FOR STANDARD GEOMETRIC SHAPES SIMPLIFY PROGRAMMING AND IMPROVE QUALITY

Manufacturing Mastery Since 1924

Central Screw Products Company (CSP) is a 3rd generation machining company, founded in 1924.

CSP leverages the latest in robotics and automation technology to achieve one of the machining industry's most efficient engineering to production ratios. The result is mastery and control of the manufacturing process, maximum customer value, and unparalleled quality.

We machine Titanium, Inconel, and other hard materials to precise tolerances for the most demanding industries such as defense, medical, aerospace, and automotive.

Our global supply chain provides a reliable single source for diverse secondary operations and value added logistics.

CSP is ISO 9001:2015 Certified, AS 9100 Compliant, ITAR Registered, and a proud recipient of a number of industry and OEM supplier quality awards.

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The original purpose of standard macros was to reduce program variables for repetitively used geometric shapes.

Computer Aided Manufacturing (CAM) provides ultimate flexibility, but machine programmers often use that flexibility unnecessarily. By developing standard macros for boring holes and machining (extruded) bosses, Central Screw Products reduces cycle times and improves control of critical dimensions including diameters and concentricity.

By identifying the value and potential of parametric design, CSP develops in-house macros for all standard geometries.

Many Engineering CAD packages have made an impact on manufacturing by promoting parametric design capabilities. They allow for the design of a family of products around parameters or variables that can be automated to produce infinite variations of the same core design. By identifying the value and potential of parametric design, CSP develops in-house macros for all our standard geometries.

Now entire families of components can be fabricated in the same work cell without requiring re-programming by a standalone department. This practice saves time and cost while also streamlining manufacturing operations to meet modern parametric design practices.

PARAMETRIC DESIGN: AN ITERATIVE APPROACH

For example, imagine a simple shape such as a cylinder defined by two variables: length (L) and diameter (D). Most modern CAD packages, like Solidworks, Unigraphics, Creo, or Catia, allow us to create a solid model declaring L and D as variables and script the creation of child parts using values from an Excel spreadsheet. The primary benefit here is automation and simplicity; a family of components based on math variables is easy to maintain and change in industries that have small variations over time, much like car model design changes in the automotive sector.

Savings, in this case, are generated by requiring fewer staff hours to design each component manually. Historically, machine shops have not embraced this logic and typically rely on a dedicated programming department to program each part completely. This non-iterative approach results in longer lead times, higher manufacturing costs, and recurring opportunities for errors affecting quality.

CSP has honed our craft by following parallel paths with the advances in modern parametric design. We developed multiple macros that take our example cylinder mentioned above and read L and D as variables in a macro-based program directly on the machine controller. CSP uses the intelligence of a layered program architecture to create "master" and "sub" programs that exchange macro values that increase the sophistication of our programs exponentially. Imagine a typical cylinder, where we have L, D, and some quantity required for each variation. Our program architecture is created to not only read in L and D macro values but also to iterate quantities. Using a Schedule Program logic on our Okuma LB3000, we can specify the quantity required of each variation, then read in new L and D macro values. We can produce an entire family of parts with only a single machine set-up.

Where a standard programmer and Mastercam would typically generate hundreds of lines of code, we now use a single line macro.

```
V11=-72.0                          (STARTING ANGLE OF 1ST VANE)
V12=-67.58217                      (ANGUALAR DIPLACMENT ALONG VANES)
V13=18                             (SPACING BETWEEN VANES)
V14=289                            (FINAL VANE ANGLE)

N100
G0 X1.250                          (CLEARANCE PLANE)
G0 C0.0 Z2.0                       (START POSITION)
M16                                (DIRECTION OF ROTATION FOR C-AXIS)
G0 C=V11                           (FIRST VANE)
G1 X1.0 F=V106                     (READ IN FEED FROM VARIABLE LIBRARY) (PLUNGE)
G1 X1.0 C=[V11+V12] Z1.840 F=V106  (FULL SLOT IN C AND Z AXIS)
G0 X1.250                          (RETRACT TOOL)
G0 Z2.0                            (START POSITION)
V11=[V11+V13]                      (ITTERATE ANGLE)
N200 IF[V11 LT V14]GOTO N100       (LOGIC FOR LOOP)
M2
```

Among the macro programs developed at CSP, we have isolated some of the most significant time contributors to machine programs: milling cylindrical ODs, milling cylindrical IDs, helical boring, and polygon surfacing. Where a standard programmer and Mastercam would typically generate hundreds of lines of code, we now use a single line macro. These Macro programs have been developed and verified through hours of testing on actual production jobs and have shown a dramatic improvement in cycle time. Additionally, since the behavior of the tools is always predictable, we have seen increases in tool-life forecasting accuracy across all materials, and reductions of in-process quality issues on critical diameters.

CSP has committed to using custom macro libraries as a standard practice. We have gone the extra mile to ensure consistency across different part lot numbers by using macro variables for speed and feed libraries in every material and work offsets as macros for every job. Our program architecture ensures we are always using our best practices and continually improving our process recipe for the next customer project.

The latest work by CSP saw the creation of complex helical vanes, staggered across a titanium cylinder. This program typically would have required over 400 lines of code but was simplified through effective macro variable logic down to only 9 code lines – a staggering 97.8% reduction! Just imagine the effectiveness of your manufacturing supply chain if it required 97.8% less labor!

Our program architecture ensures we are always using our best practices and continually improving our process recipe for the next customer project.

CONCLUSION: PARAMETRIC PROGRAMMING INCREASES PRODUCTIVITY AND REDUCES COSTS

Intelligent manufacturing improves quality by using parametric programming macros which mitigates human coding errors. Parametric programming increases overall productivity and reduces cost by reducing valuable coding time. CSP passes these savings on to our customers in the form of lower part pricing.

CSP is at the forefront of modern manufacturing by recognizing the promise of parametric design resides on a parallel path with intelligent manufacturing. In the case of our major OEM customer for complex titanium tubes, the foresight to program with macro variables has reduced lead-time and cost for all similar tubes from this customer. CSP is not only working to manufacture the parts you need today, but also the parts you will need tomorrow!

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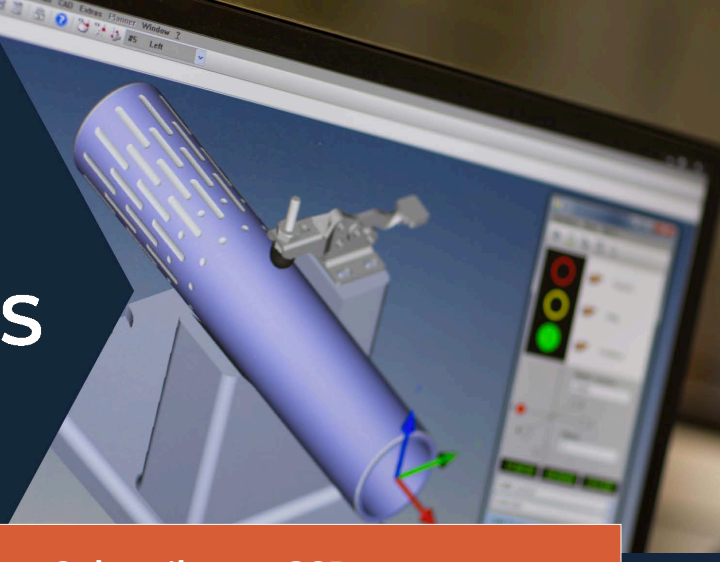

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