

Real cost benefits from automated CAM/CAD

► Introduction

Global economic pressure is eroding margins and profit. Not only do manufacturers have to compete with companies on the other side of the world, but the total requirement for manufactured goods has recently dropped significantly. Furthermore, OEMs are frequently demanding regular and ongoing price reductions.

To remain profitable and competitive in the current climate necessitates an examination of every aspect of a business. Automation can play an important role, shortening manufacturing lead times and improving quality and consistent performance while requiring less skilled, less expensive resources.

Automating the CNC programming of complex parts is an area which can produce some significant savings. However, companies need to minimize risk by ensuring that their system will cope with the majority of its CAM/CAD work yet be flexible enough to deal with every eventuality.

► Risk reduction

To establish the level of risk involved in installing an automated system requires an assessment of the current risk levels. For CNC programming, it may be the ease of use of an existing system, the level of human interaction required and the quality and reliability of the software itself. To assess the risk benefits of an automated system, the factors which should be examined include ease of use, reliability and consistent performance, how much of the work can be completed automatically, and the degree of flexibility for programming exceptional cases.

Manual CNC programming and on machine programming both rely heavily on the skill of the operator, so the risk of error is clearly very high. Programming systems which require the user to interact and make continual decisions about how a job is to be machined are also error prone. These will eliminate mistakes produced by misinterpreting the geometry of the part, but will rely on the skill of the operator to correctly apply the most appropriate machining paths.

Sescoi's WorkNC differs in that the machining strategies are automated and include default safety parameters which have already been optimized to produce the ideal toolpath and cutting conditions. 20 years of research, development and real life

application have gone into the testing of these strategies, ensuring their safety and efficiency thereby minimizing risk levels.

Uniquely, the automation available in the WorkNC software extends to 5-axis machining, a process which has hitherto been the precinct of specialist programmers. For parts which do not fit the normal profile, WorkNC gives the operator the ability to use specific toolpaths and to edit the cutterpath to achieve the exact results required.

Many systems, including WorkNC, have the ability to extract 2D CAD data from an imported model and automatically apply 2D toolpaths. The advantage of WorkNC is that it can produce the same results where complex 3-axis and 5-axis toolpaths are required.

This is not to underestimate the importance of automating 2D cutterpaths. Many applications such as press tools require extensive drilling and boring operations on holes which must line up for the successful operation of the finished tool. Gathering hole data directly from the CAD file eliminates human error and ensures that the correct hole size, type and position is always selected for each plate. The alternative is a painstaking manual approach with extensive checking to ensure accurate and reliable results. The benefit for WorkNC users is that they can complete these tedious tasks as well as machining the complex forms, in one system, with high levels of automation.

► Cost and availability of skilled workers

To keep costs down, companies are having to broaden the skills of existing staff so that they can fulfil a wider range of tasks. Having to employ a specialist is costly, and for many employers it may be difficult to find a suitably qualified or experienced person. Furthermore, the company is then reliant on that specialist which will then introduce another level of risk into the operation. Automation will remove the reliance on specific skills and make it much easier to train more people to complete a task, increasing flexibility and making the manufacturing process more robust and reliable.

This problem is commented on by market analyst CIMdata who, in 2008, stated, 'In most parts of the world, including North America and Europe, there is a shortage of skilled workers. This deficit is increasing as mature toolmakers retire and are not being replaced by younger people choosing to become skilled craftsmen. In this situation, companies often

utilize more automated tools that are easier to learn and use. Vendors must provide software that is directed at lower skilled workers and permits them to operate as higher skilled workers.'

WorkNC is frequently used on the shop floor, where machine operators can import and manipulate complex CAD files themselves and automatically apply toolpaths. Autonomy on the shop floor removes reliance on CAD operators for patching surfaces, adding run off surfaces, or creating split lines. This saves waiting time and ensures that any geometry modifications fit with the requirements of manufacturing. The ability of machine operators to then apply the machining toolpaths ensures their skill and knowledge of the machining process are utilized without introducing unnecessary complications.

Adam Roby, of CAD-CAM Solutions (UK), where WorkNC is routinely used in the workshop said, *"Additions such as run off surfaces necessary for manufacture are all completed on the shop floor in WorkNC, which is very beneficial for the company."*

The type of components machined with WorkNC will frequently have a long cycle time due to their complexity. Machine operators can use this time productively in setting and monitoring other machines and in preparing new programs in WorkNC. Not only will this reduce lead times and increase the productivity levels of existing staff, but it will save the cost of specialist engineers and improve the job satisfaction of the machine operators.

► **Knowledge based manufacture**

Automation necessarily has knowledge built into the system to make decisions for the user, reducing the skill levels required and eliminating repetitive operations.

Within WorkNC there are many levels of intelligence in the machining strategies which will consider, for example,

1. Where material is remaining thereby eliminating air cutting and automatically only machining these areas.
2. Considering the level of tool engagement and automatically introducing trochoidal moves to keep tool loads constant.
3. Checking machine kinematics and tool lengths to avoid collisions, automatically introducing unwinding operations on rotary axes, and suggesting the tools necessary to complete the job.

In systems where these levels of checking and intelligence are absent, operators need to be much more vigilant and skilful to get reliable results and programs are likely to be significantly more error prone.

For machining hard material, WorkNC's trochoidal toolpaths, which add spiral moves whenever full engagement of the tool is detected, are particularly valuable to Reich Tool (U.S.). Eric Neumann, CNC Specialist, said, *"These cutterpaths are excellent. You can select climb movement, which results in a good surface finish and smooth cutting with no squealing of the tool in corners. We run at around 260 inches/minute with a 5/16 inch cutter. The tool life is also tremendously extended, we have achieved 2 hours in-cut on Rockwell HRC 60 material."*

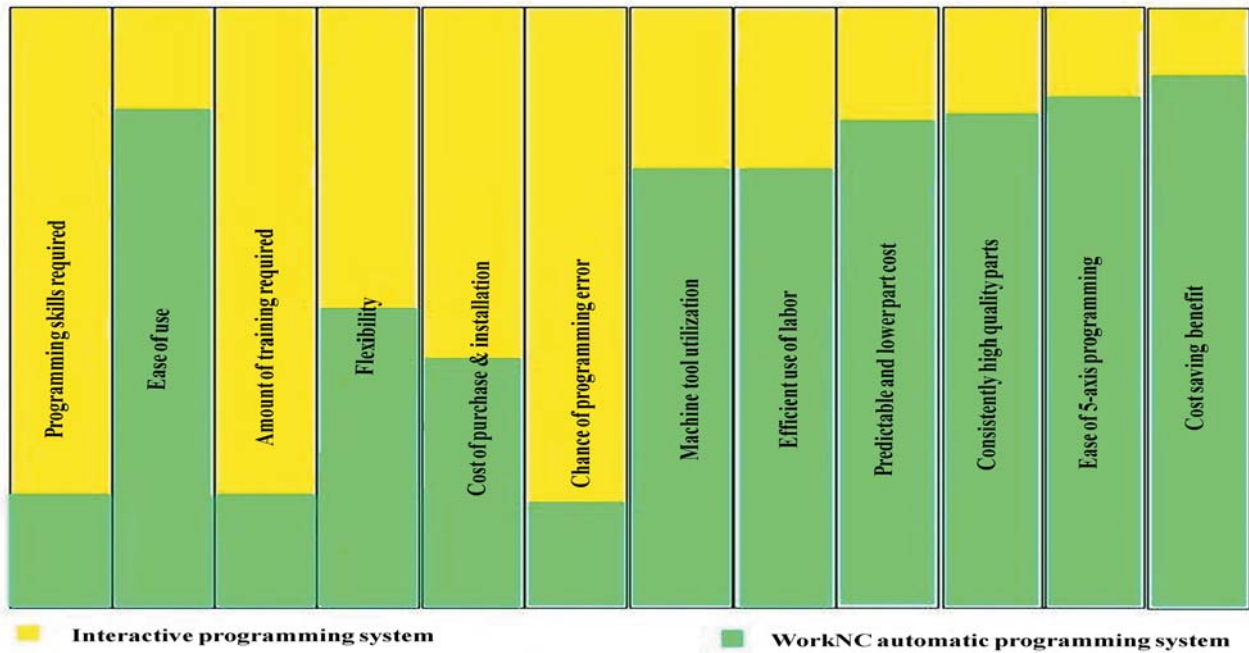
As well as providing reliable results, the built in knowledge of automated systems improves the consistency of results. For particular types of component a complete machining sequence can be recorded in WorkNC including roughing, re-roughing semi-finishing and finishing operations. Every aspect of each operation is pre-set, including feeds, tools, holders, lead-ins, clearance heights. For a new part, this complete sequence can be applied to the new CAD model and the toolpath set to calculate with one mouse click. Automation and intelligence within the system then produces a safe toolpath which uses the same consistent methods as on previous jobs. The advantages for the company are that significantly less time is taken up by programming as it has all been automated; the same tools have been used for every job, minimizing resetting and consolidating the range of tools required; and quality is maintained at a high level, as the same tried and tested methods are always being used. Finally, production times can be reduced and will remain constant, eliminating costly machining overruns.

Automation brings predictability, taking out the risks associated with operator error, inconsistent machining methods and times, excessive tooling costs and quality failures. The knowledge based automation in WorkNC encourages best practice methods, building on existing skills and quality standards.

The diagram at the top of the next page illustrates the potential advantages of automated programming compared to an interactive programming system.

Mr Kiayama of Tatematsu's Business & Planning Department (Japan), explained the benefits, *"WorkNC's automatic programming was very attractive to us. Previously, finishing an inner panel mold took an average of 14 days – we were able to reduce that time by 20 – 30 hours."*

POTENTIAL ADVANTAGES OF AN AUTOMATIC PROGRAMMING SYSTEM



► Productivity benefits

Systems which require an interactive approach to CNC programming will require the user to have higher skill levels to achieve a satisfactory result. The automation available in WorkNC eliminates this skill requirement and, as a consequence, speeds up the programming task. As well as automated 3 and 5-axis programming, WorkNC has several other automated system options including multiple electrode creation, machining directly from the model, and layer machining for rapid prototyping.

Jochen Babilon, Managing Director at Babilon (Germany) produces 400 electrodes every month with WorkNC, "The software is easy to use and we were able to create roughing, finishing and mirrored versions of each electrode with little effort, including the associated machining toolpaths. The time saving in programming alone is considerable."

5-axis machining has some clear benefits; more of the part can be machined in one setting, raising the productivity of the machine tool while eliminating inaccuracies due to fixture changes; shorter and more rigid cutters can be used, improving surface finish; and parts which would be difficult or impossible to machine in 3 or 3+2 axis can be successfully machined in 5-axis.

Most 5-axis programming systems require high levels of skill to achieve a reliable result. Users need to be able to decide which is the most appropriate strategy and at the same time consider the physical limitations of each of their 5-axis machine tools. WorkNC automates this complex task with its Auto 5 system. Programmers simply have to program the part in 3-axis as they would do normally, and then apply the Auto 5 algorithms. WorkNC then automatically turns the 3-axis paths into 5-axis.

In its calculations the system considers the kinematics of the machine, adding flip and unwind movements when axis limits have been reached. Similarly it works out minimum tool lengths and has collision avoidance technology incorporated to completely and safely cut the part.

For special applications such as blades and tube machining, WorkNC includes dedicated strategies, while for parts which fall outside the capabilities of Auto 5, it has individual 5-axis cycles, rather like a conventional interactive system. This gives WorkNC the power and flexibility to machine any type of part while at the same time, through the use of Auto 5, removing the complication and skill levels normally associated with this process.

Drazen Vincekovic, CAD Manager, Adelaide Pattern (Australia) said, "Programming in 5-axis with Auto 5 is easier than programming in 3+2 and is a very important feature for us. We can achieve better quality and a quicker turnaround which, we anticipate, will result in more work, as well as opportunities in other markets such as aerospace. For example a 300mm square x 100mm pattern which requires 50-70% of the material removed can be ordered on Friday and delivered on Monday."

As well as making best use of human resources, the automation in WorkNC makes it very easy to implement it on the shop floor. Intuitive operation and an ergonomic interface have greatly reduced the training requirements for new users. Similarly, the automated cycles are written with machinists in mind, so that they can quickly understand how each will work on a practical level.

According to CIMdata the benefits of shop floor programming include 'more efficient use of machine tools as less time is spent waiting for programmes

from the CAM room, more efficient use of the machinist's time as the machinist is programming while the machine is cutting, no communication problems or operational differences between a programmer and machinist as they are the same person, the use of very knowledgeable people (perhaps the most knowledgeable) for programming, for small shops with only one dedicated CAM room programmer, having multiple machinists able to program eliminates the dependency on a single person.'

These benefits are only enhanced by the automation in WorkNC, which makes it much easier to program the most complex parts, right up to full 5-axis, on the shop floor without the danger of a machine tool collision.

► **Flexibility**

In an interactive CAM system the continual decision making required by the programmer makes the system very flexible. The disadvantage is that high levels of skill will be required to achieve the desired results, and the input required is likely to be repetitive and unnecessary. WorkNC's automatic cycles cover the vast majority of applications but, where further flexibility is needed it can provide the required levels of flexibility by moving outside its automatic programming strategies. Powerful toolpath editing enables the user to trim and revise individual cutterpaths created with the automatic routines.

For the vast majority of parts, WorkNC's standard automatic routines will provide 3 and 5-axis roughing and finishing toolpaths ideally suited to the job, machine tool and material, but for the occasional exception, the editing facilities in the software provide ample flexibility to make the necessary changes.

Jürgen Höller, WorkNC user from Brandstätter, manufacturer of Playmobil toys (Germany) explained, "With error free 3D CAD data, the machining strategies are applied and the calculation started – that's it." He continued, "Through the combination of the simple programme operation with the intelligent processing strategies, a high level of accuracy is guaranteed, enabling us to minimize costly errors in our CNC programmes. The automatic features in WorkNC save us effort, while giving us more time and the flexibility to respond to the special circumstances which arise in some of our more complex tools."

► **Ease of use and reliability**

Automated processes should of course be easy to use. WorkNC incorporates an ergonomic interface which is intuitive, so engineers become proficient after only one or two days' training. Once the sequence of processes has been set up for a particular type of component, toolpath generation can be initiated with just one mouse click, meaning that virtually anybody can operate the system safely. Programming times produced by these methods are a fraction of those possible on other CAM systems.

To further speed up operation and improve flexibility and ease of use, WorkNC includes batch mode calculation. Unlike many systems, the software has the capacity to continue programming new parts while the toolpath calculation continues in the background. The benefit for the user is that more engineers can be productive on a single seat of WorkNC, as they will not be waiting while calculation progresses. Furthermore, for complex parts, several jobs can be queued and the process can continue out of office hours, adding to productivity levels.

WorkNC user Playmobil, particularly remarks on the ease of use and reliability of the system.

Gerhard Ammon, Moldmaking team leader, Playmobil (Germany), commented, "*WorkNC opened up new possibilities, allowing us to achieve more than we had ever anticipated. Ease of use has resulted in faster training, and we have succeeded in greatly increasing our electrode production rates using the software. An additional big plus for us is the stability and reliability of WorkNC.*"

For automation to be effective, results must be reliable, otherwise the corrective action necessary will negate the potential benefits, causing disruption to the production schedule and an increase in quality non-compliance. All of the automated features in WorkNC have been designed to produce fail safe results, so features such as collision avoidance, constant tool loading, safe clearance heights, and consideration of the machine kinematics are all an integral part of the process.

Reliable results will enable machine shops to operate their machines unmanned, overnight and at weekends with total confidence. For 5-axis machining, the benefits can be even greater. More of the part can be completed in one setting, meaning that more operations can be cut, one after the other, in one long machining cycle. To add to the productivity the software's automatic strategies minimize air cutting,

ensuring that metal is being removed for the vast majority of the time that the component is on the machine. Additionally, combining operations will eliminate a large proportion of the setting and resetting time and hence produce much greater machine tool utilization. Not only will the machine pay for itself quicker, but the cost of each individual part will be less as overall machining times will be greatly reduced.

Zedes (France) Managing Director Pierre Gauthier can cite some impressive results. "We have halved the time required to create an electrode, and with WorkNC's HSM strategies we save the same time again when machining. The number of errors has also fallen, freeing up operators to work on more important tasks. With WorkNC we can now rough machine with bull-nose cutters, which had previously been impossible. Furthermore, cutter breakage rates have plummeted due to the toolpath reliability and collision prevention in the software."

► **Better, faster service**

For manufacturers, the improvement in quality and faster production produced by automation will help them to retain customers and acquire new ones.

Modern manufacturing features short delivery times, greater complexity, low quantities, squeezed prices and rapidly changing components. Automation which is capable of adding value under these circumstances will have a very significant impact on profit margins.

Manual or interactive CAM systems are not geared up to meet these demands. Lengthy program preparation will require high skill levels and extensive checking to produce a reliable toolpath. Where the parts are continually changing, the time lost can have a serious effect on delivery schedules. If there is a danger of a program error, unmanned machining will be difficult to achieve, reducing machine tool efficiency levels and further extending delivery dates and increasing costs.

By contrast, automatic programming with WorkNC minimizes the programming time, is responsive to the changes in component type and is reliable, allowing lights out machining with confidence. As the software ensures that consistent methods are being used, it has the added advantage of maintaining high quality and accuracy levels, and promoting shorter lead times.

Companies which can offer this type of service to their customers will be sought after as preferred suppliers and will be able to demand a premium for their products.

Kimio Honma of Nissan (Japan) said, "*We quickly recognized WorkNC's ease of use. It was surprisingly easy and simple to learn and our man-hours immediately reflected the installation. It dropped to*

1/3 instantly, which was a remarkable improvement. Delivery dates now are less than half those of 3 years ago. Cost wise? Way lower than half. As you see, man-hour and cost reduction are our never ending challenges."

► **Rapid ROI and lifetime cost**

Surprisingly, WorkNC automated CAM/CAD software has a lower purchase price than many interactive programming systems. Shorter training requirements due to its ease of use and the utilization of spare time available to existing staff to do the programming, further cuts the cost of running the system. For companies, the lower capital investment required and the minimal operating costs will have a dramatic effect on their return on investment. Continual development of the software brings new enhancements every year, making additional efficiency improvements for users, factors which all contribute to a low lifetime cost for the system.

By contrast, interactive programming systems are likely to cost more at the outset, and because of the skill levels required have higher running costs due to the use of specialist programmers. Some systems also have high compulsory subscription and maintenance charges, further adding to the lifetime cost of these systems.

► **Conclusion**

Automation of CNC programming can produce very significant cost reductions through efficiency, quality, and delivery time improvements.

The increasing complexity of components, the lower quantities required, and the rapid changes in design put a strain on companies wishing to meet their customer's demands for responsiveness, flexibility and cost reduction.

Manual CNC programming and interactive programming are high risk and time consuming, and require skilled personnel. Additionally, for the most complex tasks such as 5-axis programming, the engineer needs even higher skill levels to achieve reliable and satisfactory results. Despite this many interactive CAM systems are frequently high priced

CIMdata recognizes the importance of automated systems in reducing skill levels and the benefits of moving programming onto the shop floor. Interactive systems only provide limited benefits due to the level of decision making required by the operator, which increases variability and the chance of error.

WorkNC's automation extends from 2D right through to 5-Axis programming. Its ease of use make shop

floor programming highly practicable, reducing reliance on specialists and increasing the efficiency of the machine operators. Automated cycles allow programs to be prepared with one mouse click, greatly reducing programming time. Furthermore, consistent methods within the cycles ensure quality levels are maintained and that machining times are predictable.

Reliability and the removal of risk are key to the success of automation. The machining produced by WorkNC is failsafe in its design, with routines to minimize tool load and increase tool life, avoid collisions and check tool lengths. The software's Auto 5 automated 5-axis routines take this a stage further. Perceived as difficult by most programmers, 5-axis programming is easy in WorkNC, which automatically translates 3-axis toolpaths into 5-axis. With Auto 5, companies can get all the productivity benefits of 5-axis machining without the complicated programming.

WorkNC enables companies to reap the benefits of automated programming on virtually all their parts yet still have sufficient flexibility to machine the exceptions. Customers are reporting halving of delivery times and 50% cost savings. It is a highly productive yet low risk solution, helping manufacturers to achieve cost and time reductions through the efficient use of staff, predictable and faster production methods and high levels of quality compliance. It also gives companies the technology to economically and automatically machine highly complex parts with 5-axis techniques which will further cut delivery and machining times and potentially open up new markets.

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