how to improve throughput in component conformance and maximize output

Today's fast-paced industrial scenario demands a drastic reduction in the timeline of a new product - from the design phase to component release.

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contents

Abstract

Today's fast-paced industrial scenario demands a drastic reduction in the timeline of a new product - from the design phase to component release.

Component conformance, where a part is certified to suit the physical dimensions of the end product, takes up a major chunk of any industrial product timeline.

This technical paper examines the impact of this extended timeline on production, and discusses ways and means to resolve this perennial problem by focusing on the throughput of the component's conformance.

About CMM

Component conformance is a process where the physical dimensions of a manufactured component is verified against those specified by the designer. This conformance can be measured at the intermediate stages as well as the final stage of the component's manufacture.
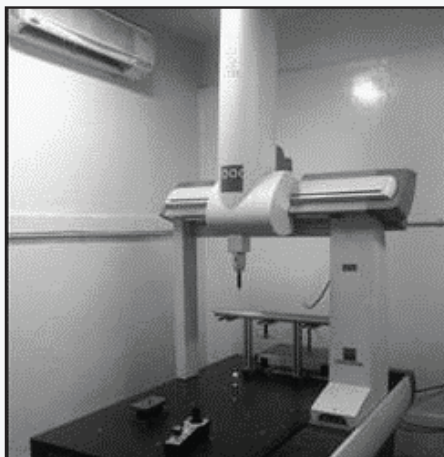
CMM Measurement

The stringent dimensional specifications and the level of tolerances required for the end product today require the implementation of a CMM (Coordinate Measuring Machine), which is a computer controlled, probe defined and 3D machine used for accurately measuring the geometries and tolerances of a component.

This machine is driven by a set of instructions called programs, generated by the operator or programmer to perform a specific task, which can be repeated as needed.

Programming and Validation

The programming is mostly done using an existing part to map the geometrical features. Tolerances are then applied for the feature, and measured to specify its limits. Once the programming is complete, it is validated by running it over the part again. The skills required for generating the program are comparatively higher than those needed for executing it.


3D Co-ordinate Measuring Machine (CMM)

Typical/Traditional Measurement Process

Traditionally, the CMM uses an actual physical part to generate the first program. This means it can only be initiated after the first part in the manufacturing phase is complete, even though the dimensions and tolerances of the parts are known immediately after the stage/design drawings are finalized.

Here's what a typical new component measurement process in a manufacturing setup after completion of the process planning looks like:

TRADITIONAL MEASUREMENT TIMELINE

FROZEN ENGG/STAGE DRAWINGS	Part Manufacturing Phase	CMM Programming Phase	Validation	Result
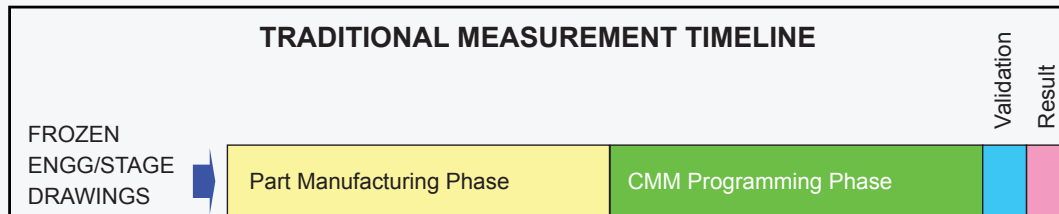
Hindrances Affecting Throughput

A study of the major factors which impact throughput of component conformance reveals the following bottlenecks:

1. Sequential program development

In a typical measurement process, the CMM Programming is initiated after the first part is obtained for the activity, which means the program generation is dependent on the availability of the manufactured part.

2. Productivity downtime

The traditional measurement process uses the same machine for part programming, program validation and measurement. Since programming takes much more time than the measurement of the same part, the machine productivity is sacrificed to a great extent during this period.

3. Non-scalability for part families

The current design process leverages the concept of part families to reduce the designing time frame. Unfortunately, traditional methods of CMM measurement use the unique part for programming, although it might belong to a similar part family. This prevents scaling easily from one part to another when measuring components from the same part family.

4. Pipelined tasks

Given the density of component production, task piling is a common occurrence. Combined with the issue of machine occupancy for new programming, this sometimes leads to deadlines being missed because of delayed throughput.

5. Less room for optimal programs

With the limited part flexibility and iterative methods in the traditional methods, and the strict and pressured timelines the programmer faces, it is rare to find new ways to optimize the program, and thereby improve throughput.

6. Quick changeover

Dynamic industry demands occasionally forces the measurement to be switched over to a different CMM. This usually involves reprogramming the whole part from scratch, nullifying the time and effort spent doing the same thing earlier on another machine.

A New Methodology

After the detailed assessment of these challenges, it is proposed that Offline CMM Programming be implemented to not just improve throughput, but also to achieve scale and prevent bottlenecks found in the traditional system.
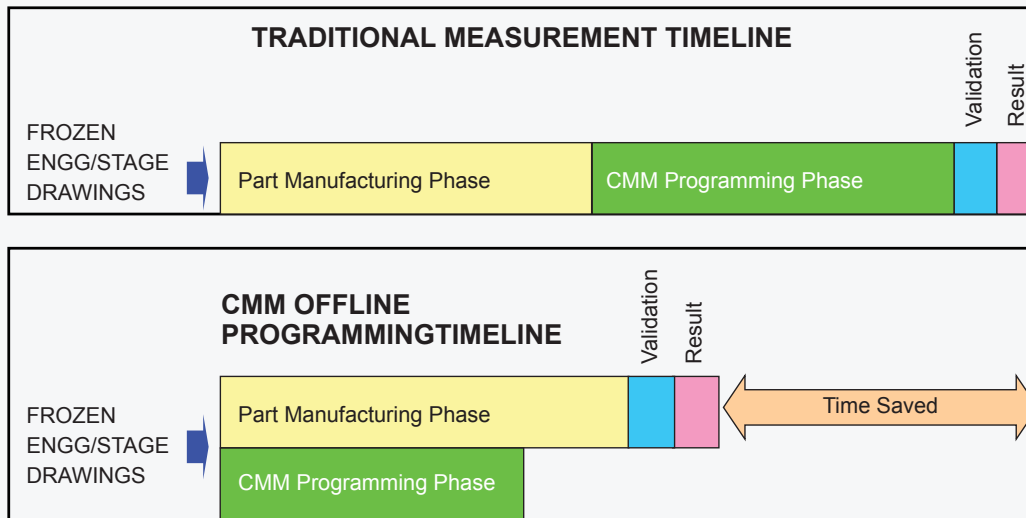
Offline CMM Programming

In this method, the programming activity is offloaded from the CMM to a separate offline computer terminal. This terminal runs the programming software, which is tailored for the machine used for measurement, and has facilities for simulating and verifying the program generated for the part.

A 3D CAD model generated from the frozen design/stage specifications is used, which frees the dependency on the manufactured part. Since programming is the major time consuming operation of measurement, and requires higher skills, separating this process from the machine addresses most of the challenges mentioned earlier, dramatically improving throughput and thus profits.
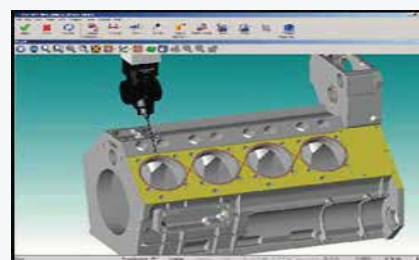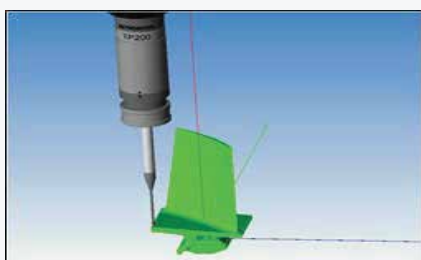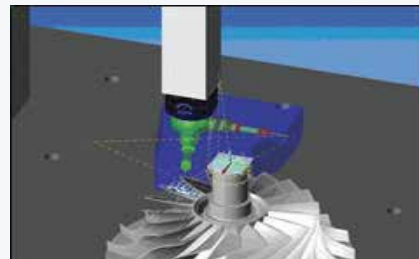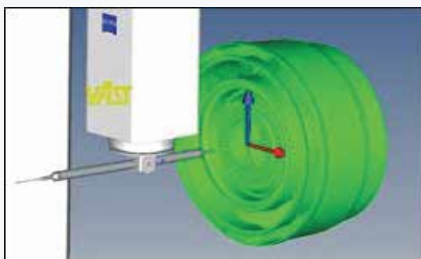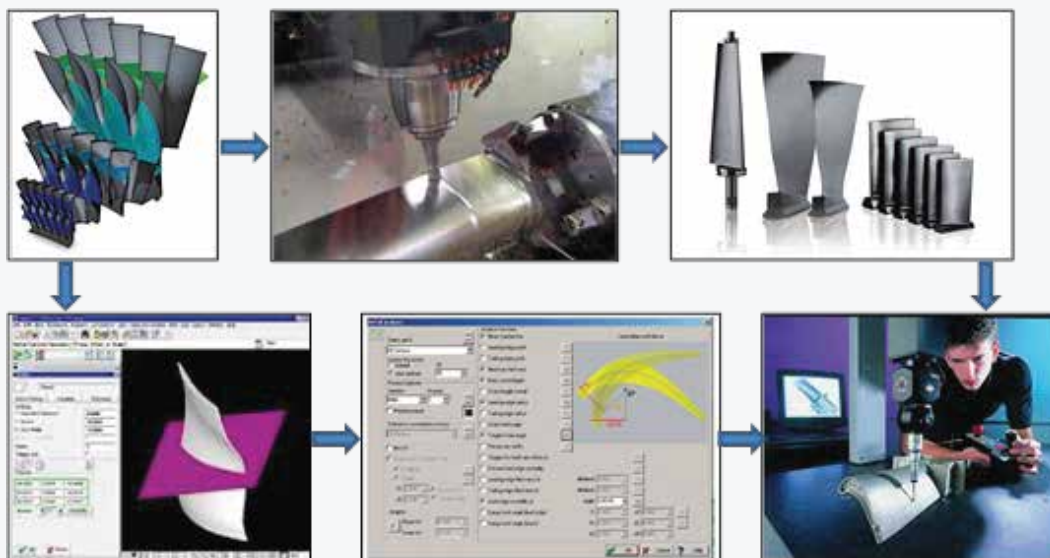

Programming With 3-D CAD Models

Traditional vs. Offline Timelines

Implementing offline CMM programming therefore saves critical time because the programming and the measurement can be done in parallel, optimizing the CMM use.

Improving the Conformance Throughput

Offline CMM programming brings the following improvements in throughput:

1. Concurrent engineering in part measurement

Offloading the whole program activity not only saves time, but also allows concurrent engineering. Since manufacturing and CMM programming now utilize the same frozen engineering drawing, CMM programming can happen concurrently with the manufacturing operation. This also helps in a better communication about the part throughout the facility.

Programming With 3-D CAD Models

2. Machine streamlining and utilization

Implementing the offline program system saves valuable machine time, leaving the CMM to utilize most of its time on part measuring activities. This also helps in streamlining the part planning activity, since the time required for measurement is known prior to loading the first part.

3. Program scalability

The offline CMM programming uses computer manipulated data, which allows far more flexibility in transferring the programming aspects from one part to another. This not only helps scale the existing program, it also drastically slashes programming time for the whole family of parts.

4. Parallelization of multiple tasks

Unexpected scenarios which intensify the programming requirement for the CMM can be addressed better with the aid of offline programming, because multiple parts can be programmed across computer terminals for the same machine, which was not possible earlier.

5. Optimized output and room for further optimization

The offline programming system has various iterative methods of measuring the same feature, and the built-in simulation helps us understand the program behavior without disturbing the machine. This helps to optimize the program well before it reaches the machine. Moreover, simulating the program later allows room for optimization of the program already in execution.

6. Interchangeability and interoperability

Since the software is computer driven, the data and method can be transferred from one part to another, one machine to another in far less time than traditional measuring techniques. This helps save time and effort, and reduces the repetition of work done for the same part earlier.

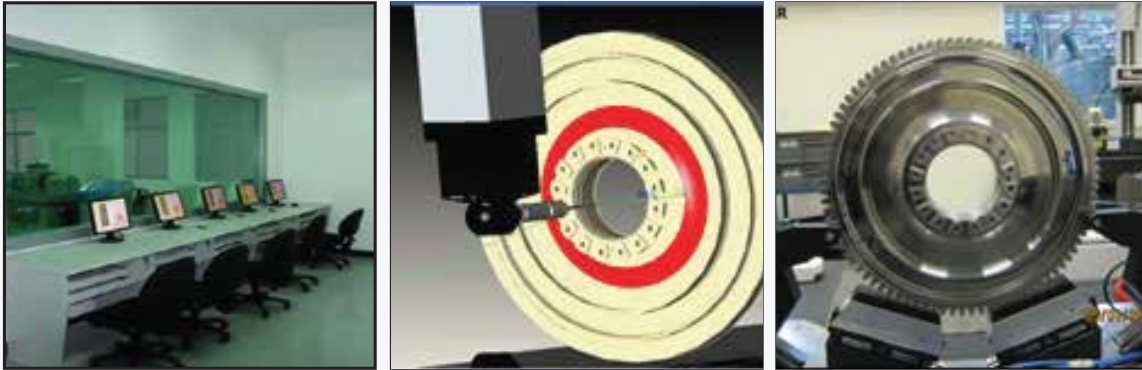# CMM Programming - Outsourcing

The recent surge in globalization and outsourcing allows industries to save costs and get better, faster services, which is tough to achieve in - house. A well established engineering service would comprise a CoE (Center of Excellence), consisting of domain experts with broad and vast experience. Such a facility gives customers considering outsourcing tasks more confidence.
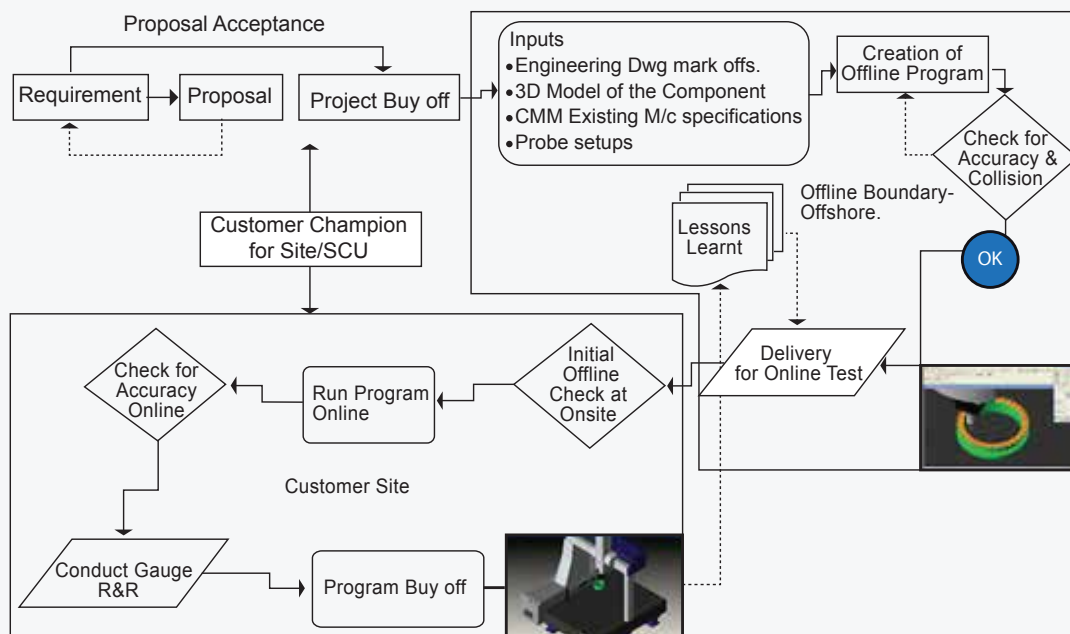
An assessment of the offline programming method also shows huge benefits of outsourcing the programming activity – traditionally done in - house – to a well established engineering services organization.

Virtual - Physical Programming Environment

Benefits of Outsourcing

Some of the benefits of outsourcing operations to engineering services are

1. Knowledge sharing and proven techniques

Since the CoE team of an outsourcing firm has a vast and broad expertise, various tried and tested techniques used on previous projects can help optimize the program in a far better way. Capturing the knowledge base and sharing across other teams also helps in visualizing and predicting unanticipated problems much earlier.

2. Focus on core activities

Outsourcing tasks helps in-house members to focus more on core activities since it frees them from the other tasks. A lot of productive and beneficial work can be executed in-house which helps members conceive new ideas for their firm.

3. Resource dynamics

An in-house unit might find it difficult to employ or deploy additional resources for a temporary task. But resources in an engineering service firm can be managed dynamically, allowing flexibility and sharing of resources for a sudden surge in requirements.

4. Better value

Outsourcing services to engineering firm delivers better value compared to the same task performed in - house, since these firms optimize financial planning for each project without extraneous compulsions.

Conclusion

To keep pace with the growing industrial sector, and maintain a competitive edge over other firms by drastically cutting the timeline from design to actual production, the throughput on component conformance needs to be drastically improved.

This can be achieved by implementing offline CMM programming and outsourcing the task to an established engineering services firm, thus ensuring time and cost cuts, and better profits for the industry.

Author Profile

Vijay Anand

Vijay Anand is accomplished in operational excellence in the diversified field of Manufacturing Engineering (ME). This encompasses quality assurance, quality control, metrology, vendor

quality, design of quality check line gauges, design of fixtures and process development of die casting.

Vijay has a Diploma in Mechanical Engineering from Sri Jayachamarajendra Polytechnic in Bangalore and a Bachelor of Engineering degree from B.M.S. College of Engineering in Bangalore.

Vijay has approximately six years of experience at QuEST and holds the privilege of being the first member of the ME team which is currently supporting Rolls-Royce at various sites. He has previously worked for Kirloskar Toyoda Textile Machinery Pvt. Ltd. for 10 years in the fields of quality control, quality assurance, metrology, and process and was actively involved in ISO 14000 and TS 16949 certification. He has also worked in the quality sector at BFW for a short stint of a year.

Vijay is credited with the following achievements:

- Trained Internal Auditor of TS 16949 Quality Management System by LRQA-UK
- Trained Internal Auditor of ISO 9001-2008 Quality Management System by BIS

At QuEST, his role includes:

- Managing a team of 50 plus individuals in charge of a diversified portfolio of Manufacturing Engineering Programs accountable for QCD
  - Project implementation using the latest technologies
  - Training of QC-7 tools as well as core TS16949 tools

Author's note: Conceptualizing this white paper could not have been possible without the help of two dedicated team members: Thirumal Kumaram V (QI_2583) and Asish V Krishnankutty (QI_2830). Their contribution has been invaluable in presenting this paper. Thank you both.

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About QuEST Global

QuEST Global is a focused global engineering solutions provider with a proven track record of over 17 years serving the product development & production engineering needs of high technology companies. A pioneer in global engineering services, QuEST is a trusted, strategic and long term partner for many Fortune 500 companies in the Aero Engines, Aerospace & Defence, Transportation, Oil & Gas, Power, Healthcare and other high tech industries. The company offers mechanical, electrical, electronics, embedded, engineering software, engineering analytics, manufacturing engineering and supply chain transformative solutions across the complete engineering lifecycle.

QuEST partners with customers to continuously create value through customer-centric culture, continuous improvement mind-set, as well as domain specific engineering capability. Through its local-global model, QuEST provides maximum value engineering interactions locally, along with high quality deliveries at optimal cost from global locations. The company comprises of more than 7,000 passionate engineers of nine different nationalities intent on making a positive impact to the business of world class customers, transforming the way they do engineering.

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