

# production part approval process

Production Part Approval Process (PPAP) is a well-accepted and organized system in the automotive industry. PPAP is part of the bigger process - Advanced Product Quality Planning (APQP).



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## Abstract

Production Part Approval Process (PPAP) is a well-accepted and organized system in the automotive industry. PPAP is part of the bigger process – Advanced Product Quality Planning (APQP). In the automotive industry, the number of parts, variety of engines and complexly-knit supply chain is greater and bigger than any other industry.

APQP is an organization wide platform to manage all the requirements through a window, which entails PPAP. Time saving, systematic, avoiding errors, data capturing, retrieving is easy, standardisation, improved on time delivery, early warning signals of problems helps in quick resolution and not allowing the problem to become crisis and Quality is the result of using APQP. Therefore it is the right solution for current challenges in the Aerospace & Defence (A&D) industry. International Aerospace Quality Group (IAQG) established under SAE International is adopting proven models from Automotive industry to Aerospace.

Aerospace industry is seeing unprecedented growth, which will continue through the decade. Along with it, the demands for producing at a higher rate and continuity of supply become paramount. Speed and Quality are the top imperatives! Hence, a systematic and robust process to approve parts for productionizing is the need of the hour.

Currently the way Quality Management System (QMS) of Aerospace & Defence (A&D) business is organized would not support the above need much. Moreover Supply Chain, which is huge and multi-layered, is adding to its existing challenge. The aerospace industry is facing challenges in terms of resource, pressure to save cost and the implementation of this APQP / PPAP being new. Thus the need is for a proven system, which is resourceful and addresses all the aforementioned challenges.

## Background of APQP and PPAP Submissions

### About

Advanced Product Quality Planning (APQP) is a system to help suppliers (internal and external) and subcontractors to work seamlessly, and to develop a product that will please the end customer. The drivers or key success factors, for the successful implementation of APQP are Cross Functional Team (CFT), Management Support and Project Planning which is illustrated in figure 1. These are identified as the “Pillars of APQP”. The launch of the first APQP manual was in June 1994.

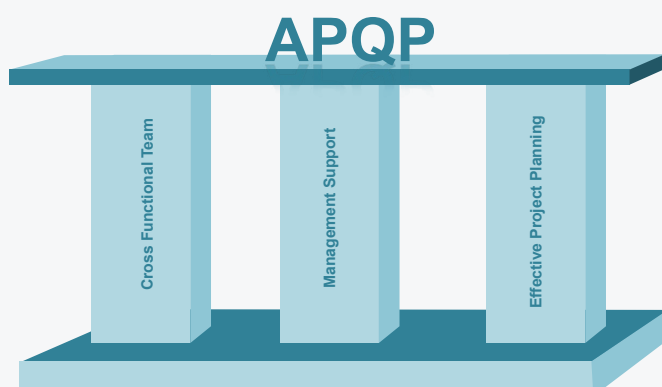


Figure 1: APQP Pillars

Production Part Approval Process (PPAP) as a terminology has its origins in the automotive industry. In 1982 automotive giants General Motors, Chrysler & Ford founded AIAG (Automotive Industry Action Group). AIAG developed Production Part Approval Process (PPAP) to affirm product quality planning. The first manual on PPAP was published in February 1993. PPAP is the fourth phase of APQP cycle where it is complied, approved and made available for customers to review and approve.

For every part to be manufactured, the need is for a PPAP to be approved for the established process to run until the next change in process. The need is not only to approve externally supplied components for quoted volumes under agreed quality standard requirements, but also do it internally as well.

**PPAP Elements as per 4th Edition of AIAG PPAP Manual**

1. Design records	10. Material performance results
2. Engineering change documents	11. Initial process studies
3. Customer engineering approval	12. Qualified laboratory documentation
4. Design FMEA	13. Appearance Approval Report
5. Process flow diagrams	14. Sample product
6. Process FMEA	15. Master sample
7. Control plan	16. Checking aids
8. Measurement System Analysis (MSA)	17. Records of compliance
9. Dimensional analysis	18. Part Submission Warrant (PSW)

There are 5 levels of submissions based on the OEMs' requirements.

**PPAP Submission Levels:**

Level 1 - Part Submission Warrant (PSW) only submitted to the customer.

Level 2 - PSW with product samples and limited supporting data.

Level 3 - PSW with product samples and complete supporting data.

Level 4 - PSW and other requirements as defined by the customer.

Level 5 - PSW with product samples and complete supporting data reviewed at supplier's manufacturing location.

PPAP aims to assure customers that the component manufacturers have thoroughly understood the achievability of customer requirements. Examples of requirements are evidenced in Engineering Design Record, Customer Specifications, etc.,

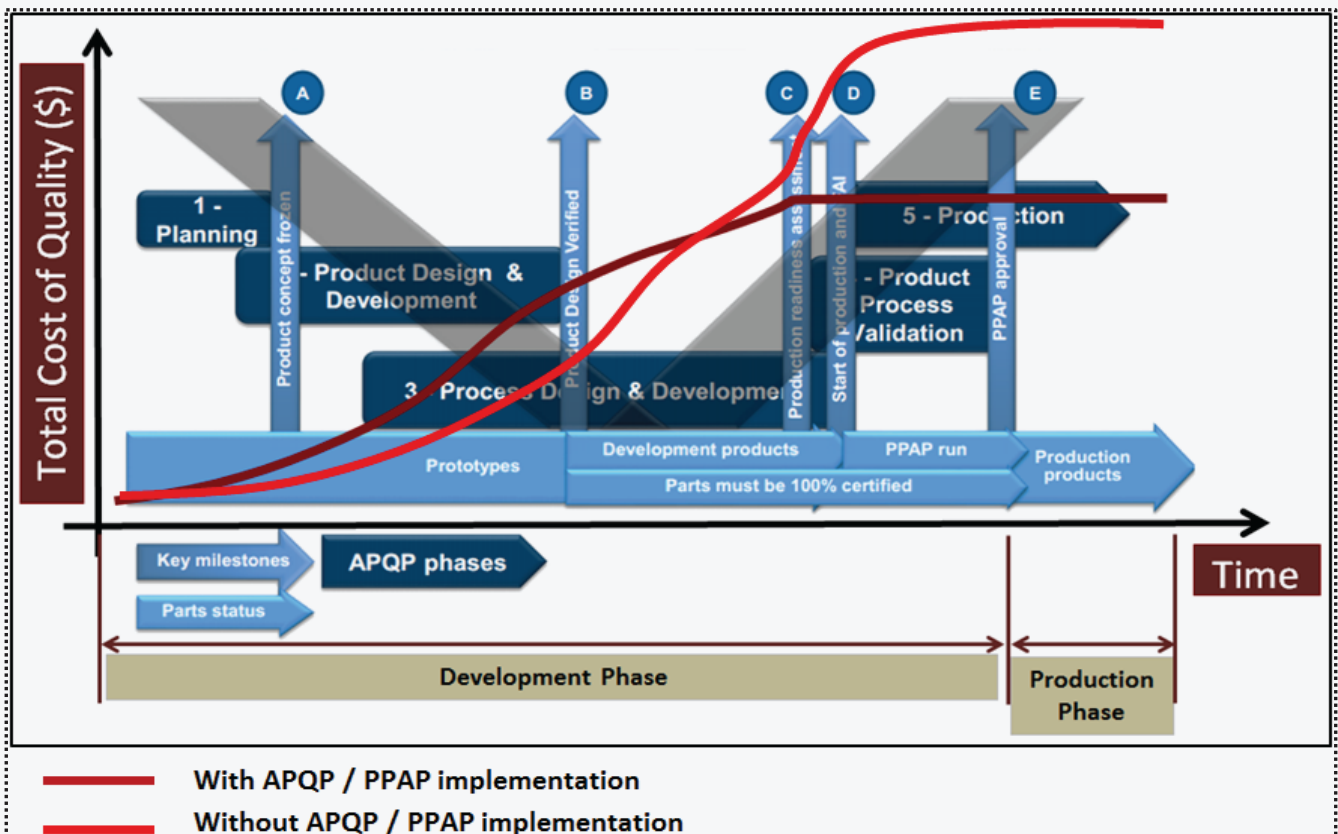


Figure 2: APQP / PPAP Lifecycle Development / Production Phase Entry, Cost Impact



## When is PPAP Approval / Re-approval Triggered?

The circumstances under which PPAP should be generated and submitted for approval is during New Product Introduction (NPI) or any changes to the approved process (approved PPAP). This is illustrated in figure 3.

The level of submission of PPAP is decided by the OEMs / Customers based on the reason for the submission of PPAP.

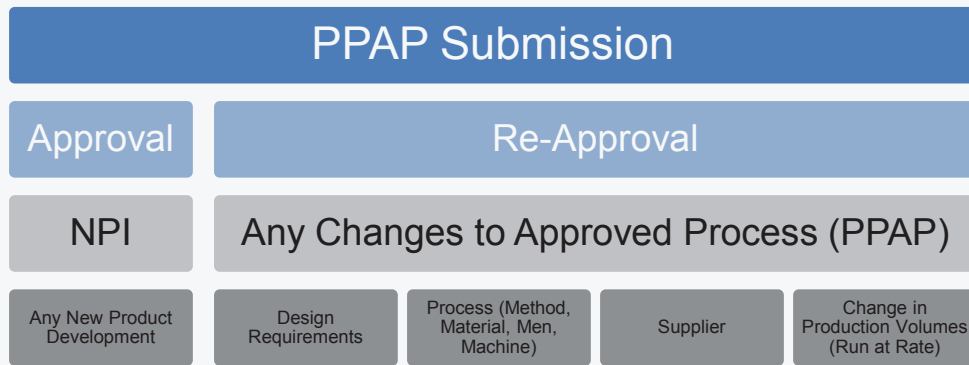


Figure 3: PPAP Submission Scenario

## Benefits of PPAP Submission & Sign Off

Implementation of PPAP helps both suppliers (manufacturers of parts) and customers (OEMs). Process functions that are clearly planned, validated, documented and communicated or in short that have been subjected to PPAP result in:

### Improved Quality ensures:

- Reduced variation in manufacturing process
- Statistically controlled processes
- Consistent approach in assuring quality and providing evidence
- Process changes are better controlled
- Quality Process Monitoring & Controlling

### Paced Delivery:

- Improves on time delivery with complete avoidance / minimization of rework, repair or rejection
- Controls quality before delivery to customer
- Helps tracking of part and product status

### Saved Cost:

- PPAP along with APQP contributes to lowering the COPQ, which will be substantial

### Confident Customer:

- Enhanced customer confidence in supplier's capabilities
- Early identification & resolving bottlenecks



Figure 4: APQP & PPAP Benefits

# PPAP in Aerospace

## Why to Implement in Aerospace?

PPAP has been a proven methodology in the Automotive industry for the last two decades.

Whilst this concept is applied on all manufacturing components in Automotive industry successfully for the past two decades, the question is - will the same hold good in Aerospace, Marine, Nuclear or Medical? When we engaged with the Aerospace OEMs for the past decade we realise that PPAP implementation is the need of the hour. We understand the benefits that Aerospace industry can get from implementing PPAP and at the same time we also understand the challenges

in such an implementation. Whenever and wherever there is need for quality and consistent delivery against a significant demand over a period of time, it calls for PPAP.

Over the last two decades the Aerospace industry has grown rapidly and in the next two decades it is expected to grow at a rate of 4-5% CAGR. IAQG in April 2014 released the Aerospace APQP Manual through their portal under [Supply Chain Management Handbook \(SCMH\)](#) Section 7.2.3. The other sections that talk about APQP are Sections 7.2.1 & 7.2.2.

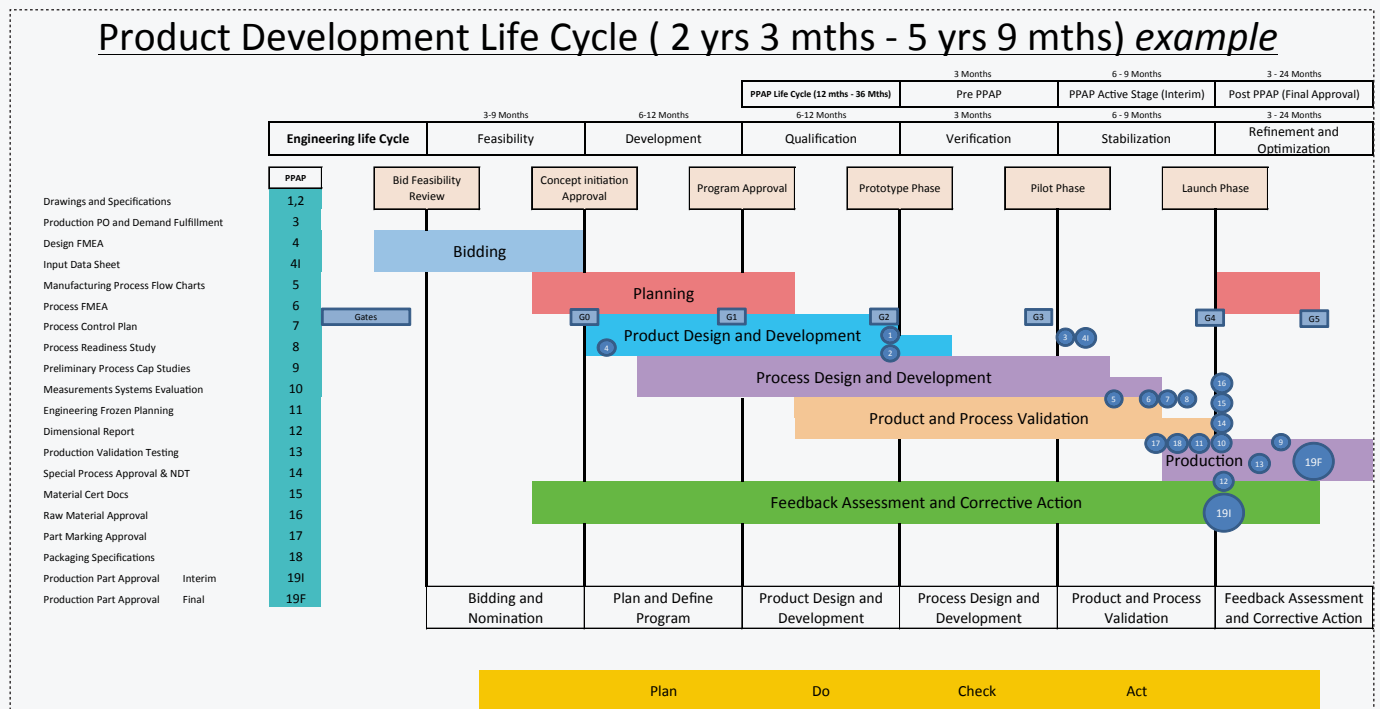


Figure 5: Product Development Life Cycle

A typical new product development lifecycle and the way PPAP is interlinked is depicted.

## Why PPAP while First Article Inspection Reviews (FAIR) happen today?

FAI is widely the standard applied across all parts of Aerospace industry. (Refer to 9102 - International Aerospace Standard, 9103 - Variation Managements of Key Characteristics)

The purpose of the First Article Inspection is to provide objective evidence, based on an assessment of the first production article, that all engineering, design and specification requirements are correctly understood, accounted for, recorded, verified and complied with. The purpose of this standard is to provide a consistent documentation requirement for Aerospace components FAI.

### PPAP v/s FAI Importance

1. Drives a consistent documentation requirement for aerospace components
2. PPAP affirms process readiness for mass production
3. Emphasizes on risk identification and mitigation prior to flag-off of mass production

SI. No.	Document List (SCMH Section 7.2 APQP, Revision Letter: A, Revision Date: 01-APR-2014, Page 81 of 88)	FAI Requirement*	OEM Quality Systems <sup>§</sup>	Aerospace PPAP Requirement
1	Purchase Order	✓	✓	✓
2	Authorized Engineering Change Documents	✓	✓	✓
3	Customer Engineering Approval	✓	✓	✓
4	Design Failure Mode and Effect Analysis (Ref. 2.01)	✗	✗	✓
5	Process Flow diagram (Ref. 1.07 & 3.01)	✗	✓	✓
6	Process Failure Mode and Effect Analysis (Ref. 3.05)	✗	✓	✓
7	Control Plan (Ref. 3.07 & 4.05)	✗	✓	✓
8	Measurement System Analysis Studies (Ref. 3.08 & 4.02)	✗	✗	✓
9	First Article Inspection	✓	✓	✓
9a	o Design Records (Output of Phase 2)	✓	✓	✓
9b	o Dimensional Results	✓	✓	✓
9c	o Records of Material/Performance Tests	✓	✓	✓
9d	o Qualified Laboratory Documentation	✓	✓	✓
10	Preliminary Process Capability Study	✗	✓	✓
11	Appearance Approval Report	✓	✓	✓
12	Sample Production Parts	✓	✓	✓
13	Master Sample	✓	✓	✓
14	Checking Aids	✓	✓	✓
15	Customer Specific Requirements	✓	✓	✓
16	Part Submission Warrant (PSW)	✗	✗	✓

<sup>§</sup> Few Aero OEM's had updated their process to be better than the FAI requirement, even before Aero PPAP requirement called for

\* 7.2.7 : APQP Phase 4 Checklist -December 2013 (xlsx) - Checklist 4.08

Figure 6: PPAP v/s FAI Requirement

First Article Inspection is a complete, independent, and documented physical and functional inspection process to verify that prescribed production processes have produced an acceptable item as specified by engineering drawings, engineering specifications, and / or other applicable design documents

However, FAI alone will not be sufficient to ensure:

- Production Readiness
- Initial Process Capability
- Major process risks identified and resolved prior to rate production



## Challenges in Applying PPAP Elements in the Aerospace Industry

The dawn of PPAP happened in the Automotive industry where, volumes are high and life cycle of parts is shorter, contrary to Aerospace.

The challenges in implementing PPAP in Aerospace industry are categorised as:

### Process / Framework:

- Lot size during product launch is typically less than 30 making the Statistical Process Control study challenging
- Non- availability / incomplete DFMEA due to lack of integration of PPAP elements in NPD process

### Capability:

- Lack of knowledge in methodology and importance of various elements of PPAP as it is relatively new to the Aerospace industry

### Cost:

- Inadequate infrastructure
- Cost associated with PPAP documentation not in contractual agreement
- Shortage of resources to implement the standard

## Addressing the Challenges

### Process / Framework:

- The requirement of minimum batch quantity to assess the process capability and approve a PPAP is trimmed down in Aerospace. For some of the products, full PPAP approval could take like 1-2 years until which time an interim PPAP approval is provided. This could be for the reason of getting a minimum quantity of 25 parts to assess process capability and stability
- Design / Process Failure Mode Effect Analysis (D/PFMEA) are two of the most powerful tools / attributes of APQP / PPAP process. Recently the Aerospace industry has identified these as vital tools for the future success of its business sectors and as the only way to ensure full compliance to their customer expectations. Their preferred use is in tandem having both a Design FMEA (DFMEA) and Process FMEA (PFMEA) within the APQP / PPAP process. The DFMEA is an important input to PFMEA; defining the Critical to Quality (CTQ) features / characteristics of the design. Having said that, we can still generate a PFMEA even though a DFMEA is not available, provided as an input we have, a Critical Characteristics and / or Significant Characteristics Matrix, a definition of the product and a Process Flow

Diagram. The Critical Characteristics and / or Significant Characteristics Matrix is generated at the design phase, often as an additional document for classified or proprietary design the OEM does not share the (DFMEA) with their supply base. Additionally, it is important to have all available quality history of part / product (this includes history from similar design and similar / same significant process steps defined in the Process Flow). In summary, whilst, DFMEA's is developed to circumvent the failure of product, PFMEA's are produced to curtail the probability of producing the product wrong

### Capability:

- One way to address the challenge of capability gap and which is a potential solution - is using a mixed capability team. Outlined below is a recommended structure – PPAP knowledge, which includes from basic proficiency to expert level. By breaking the tasks and aligning certain elements of tasks below, the need for number of experts and people to implement PPAP are reduced.



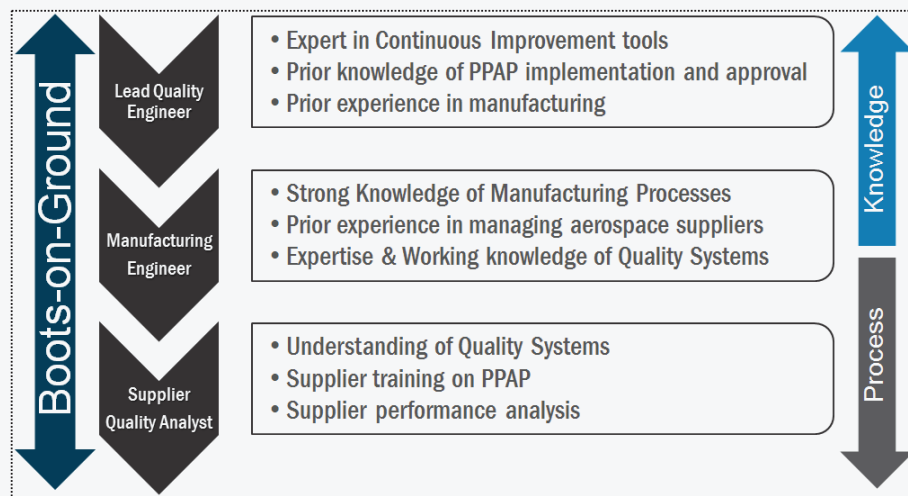


Figure 7: Structured Team with Mixed Capability

- In addition, OEMs can accelerate PPAP implementation by engaging with Engineering Service Organisations (ESO) like QuEST who are good in establishing and managing mixed capability teams. OEMs can also engage ESOs to train their suppliers on the PPAP requirements
- Alternatively, resources from automotive domains can be trained through structured training programs. ESOs can also support this in a large scale by providing services to execute the task as such

#### Cost:

- Effort & Cost associated with the amount of paper work can be reduced by integrating PPAP submission with current FAI submission and using industry tools to manage the rest of the information collection and compilation. In order for these tools to be effective, a good capable and seasoned team is equally important
- By engaging with global Engineering Services Organisation (ESO) firms who can bring mixed capability teams and delivery centres across the globe, the total operating costs can be limited. Working with ESO partner who has a global footprint can also help reduce travel costs associated with visiting suppliers

## Conclusion

The Aerospace vertical is characterized by rapid technological advancements in engineering and a diversified product outlook. Adapting end-to-end engineering solutions such as APQP & PPAP to manage and to improve QCD (Quality, Cost & Delivery) is no more an expectation but a very basic need.

By adopting PPAP in Aerospace, companies do not need to invest on extra resources and technology as required for individual projects of different capacities executed across the globe. Companies can also concentrate on the broader scale of their business interests.

QuEST is in a very good position in terms of pedigree in Aerospace and Aero-engines industry, demonstrated ability to ramp up and build competent teams, with strong governance and communication methods to maximize productivity and long term value addition and it continues to invest in building and developing teams for long term relationship with customers.

QuEST integrated PPAP Solution is flexible and scaleable. It addresses the challenges faced by Aerospace OEMs whilst implementing PPAP. QuEST is serving automotive customers as well as aerospace customers on PPAP. With this QuEST is poised to serve Aerospace OEMs / Customers / TIER-1s to implement PPAP effectively.



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## Author Profile



### Sheshadri Nagaraja Nittoor

Sheshadri Nagaraja Nittoor is based out of Bangalore, India in the role of Technical Solution Leader (TSL) – Supply Chain Services (SCS) and is responsible for Developing SCS Strategy primarily for Auto customers along with Aero-engines customers with a special focus in the Asia Pacific region.

Sheshadri comes with an experience of just over 14 years; he has been with QuEST for the past 8.5 years during which he was with the QuEST-Aero Centre as Project Manager - Manufacturing Engineering Services for 3 SCU's, he was also part of the Business Excellence Team as Black Belt for 2 years.

Prior to joining QuEST, he worked in RAPSRI Engineering, Tyco Electronics and for the automotive giant General Motors through a service provider. Sheshadri has manufacturing knowledge coupled with quality and project management knowledge. He is also a certified Six-Sigma Green Belt.

Sheshadri holds a Bachelor's degree in Industrial & Production Engineering.

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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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