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1. Immense Opportunities in Manufacturing  
2. Mega Trends Impacting the Manufacturing World – A TCS Point of View  
3. Changing Business Models as the Mega Trends Gain Ground  
4. Aligning Business Models with Consumers’ Business Drivers  
5. Staying Relevant in the ‘New World of Manufacturing’ – A Call to Action  
6. Conclusion
Traditional modes of manufacturing have given way to ‘virtual factories’ and 3D manufacturing. The industry has come a long way and will continue to evolve. This paper throws light on what’s next in this metamorphosis of the manufacturing industry, and the role business and information technology are playing in this evolution.

The technological landscape is constantly evolving, and each change that it undergoes creates the need for reorientation across industries. Business processes are altered in order to accommodate the technological change, organizational policies are reworked, and people are expected to think and act differently – simply put, the ‘way of doing things’ changes. Change management is also an everyday challenge.

Observation of business behavior of leading industry players, on-field experiences, and insights from analysts and industry experts - are all indicative of a subtle shift in the way the manufacturing industry operates.

This shift is attributed to various reasons - evolution in factors of production, competitive forces that drive firms to bring about points of differentiation, and consumption patterns that are influenced by socio-economic drivers. The subtle change in manufacturing operations has in turn resulted in new business models and focal points for industry investment.

This white paper highlights some obvious and some subtle changes that have been observed and analyzes whether these are temporary responses to business stimuli, or are more permanent in nature.

The availability of new technological capabilities - information technology as well as business technology - provides an impetus to the winds of change. We believe that technology, when applied with a strategic intent along with top management’s support, can well become a point of differentiation for an organization.
Immense Opportunities in Manufacturing

Startling facts

International Data Corporation (IDC) predicts that by FY16, the business opportunity in the manufacturing domain will be valued at $68 billion in IT Services and at $30 billion in the BPO business, adding up to nearly $100 billion – a remarkable figure.

A research study we conducted on a sample of 192 manufacturing companies from the Fortune 500/Industry Week 1000 business list indicates the following:

- The automotive industry currently brings in about $2.25 trillion in revenue and is growing at a rate of 4.3%
- The aerospace and defense industry garners about $500 billion in revenue and is expanding at a rate of 2.8%
- The continuous process and chemical industry approximately earns $800 billion in revenue and is growing at a rate of 4.4%
- The industrial machinery segment currently brings in $1 trillion in revenue but is only growing at a sluggish rate of 1.7%

What insights can we gain from these facts? That though the opportunity in manufacturing is enormous, it grows moderately in alignment with the high state of maturity and is impacted by the unpredictable demands of end customers.

Our analysis shows that, on an average, the industry spend on IT is 2% of sales. This is much lower in comparison to similar spends in other industries such as banking and insurance, retail and consumer products. Moreover, over two thirds of this spend is on ‘business as usual’ (often referred to as ‘keep the lights on’ or ‘run the business’ budgets). This can be attributed to the industry’s relative maturity over a long period of time, as well as the stratification of the expense across multiple budgets such as the Chief Engineer’s budget and the Manufacturing (Plant) budget apart from the Chief Information Officer’s budget.

But the future may not necessarily be a captive of the past. The nature and context of the opportunities are rapidly changing, making it necessary for us to assess whether the content, structure, and model of the current IT services industry can be utilized to exploit this opportunity. This white paper looks to delve deeper into this metamorphosis of the manufacturing industry, and the role business and information technology are playing in this evolution. As an example, the Chief Marketing Officer’s budget in manufacturing enterprises is already emerging as a strong contender for discretionary budgets.

Data from industry sources and estimates secured from our internal analysis yield these astonishing figures:

The advent of new forces driven by the convergence of new technologies is enabling firms to create newer waves of competitive differentiation, and creating what we refer to as the ‘Seven Mega Trends’ of the manufacturing industry.

Mega Trends Impacting the Manufacturing World – A TCS Point of View

The manufacturing industry is currently witnessing high-impact changes in the business ecosystem, which are driven by the ever-evolving complexity in buyer behavior, technological advancements and competitive pressures. Based on close interaction with the world’s leading manufacturers, and careful observation of business patterns on the ground, we have outlined the manufacturing industry’s tectonic shifts and aligned them with the emerging future technology landscape. Industry analysts have increasingly started referring to next generation technologies such as cloud, big data, mobility, and social-driven IT, in various forums. However, technology on its own is not sufficient. It is the changes in the underlying business model brought about by these new technologies that are reinventing manufacturing. Let us examine a set of key mega trends.

The newfound focus on end customers is driving the realignment of business systems inside manufacturing organizations. Given the rapid pace and intensity of market demands, legacy processes and systems fail to help organizations perceive and respond quickly to market changes. As a result, the industry is witnessing an increase in global transformation programs with leading manufacturers reaching out both formally and informally to the end consumers – thereby driving a ‘consumerization’ of manufacturing. In essence, the industry is gradually drifting from the traditional Business-to-Business (B2B) model towards the Business-to-Business-to-Consumer (B2B2C) model. Evidence of this can be traced in the efforts to:

- Hasten market response in a bid to build differentiated products and services for countering competition. To this end, manufacturers are devising mechanisms to bridge the gap and get closer to the consumer.

- Focus on consumer reach and customer experience, which in turn leads to customer retention, loyalty and advocacy. These elements are increasingly becoming critical factors contributing to marketing and budgeting decisions.

- Establish customer-centric business systems that drive multi-channel convergence. Examples of these channels include interactive websites, digital marketing channels, Point-of-Sale (POS) systems, e-commerce, incentive-linked rewards and loyalty management, service contracts for customer lock-in, etc., which command a significant portion of the discretionary IT budgets.

Mega Trend 2: Virtualization and digitization for all - Global collaboration from product design to customer service

The emerging digital journey of the manufacturing industry leverages the power of high performance computing (HPC), Big Data and predictive analytics, mobility, social media, and interactive marketing. Companies are increasingly opting for virtual collaboration platforms to work with the globally dispersed supplier base, and using simulation, visualization, and virtualization to understand the product behavior and performance under virtual conditions. This not only reduces the time required for testing, but also enables organizations to test many more scenarios. It allows for seamless collaboration across a geographically dispersed supplier base. Overall, the favorable impact on the time-to-market for the product is very high. Organizations should, therefore, leverage cloud technologies to enable this collaborative and interactive process of design and development, for it contributes immensely to the virtualization process.

Mega Trend 3: Supply chain network economy for better management of B2C aspirations

Supply chain network economy - a network of interrelated supply chains - is emerging as an important concept, because an efficient and close-knit network of partners in the B2B ecosystem is vital for organizations seeking to fulfill their Business-To-Consumer (B2C) aspirations. Thus, a next generation supply chain that is scalable and
provides visibility from the vendor to the consumer, is absolutely essential. This will play a key role in collaboration across the entire process, spanning the range from demand planning to co-innovation and product development. Historically, the demand signals in the traditional push supply chain were typically out of sync with the market realities when they reached the manufacturer. Today, the visibility of the supply chain has extended all the way from distributor to supplier, allowing for agile planning as well as lower inventory carrying costs. So, while continuous process industries are looking at engaging the distribution channel, aircraft companies are integrating suppliers.

There is an impact on production planning aspects – a shift from ‘Made to Stock’ (MTS) to ‘Engineer and Assemble to Order’ is visible. Today, the large focus is on giving customers options, allowing them to configure product specifications, assess cost implications, and in some cases even visualize the end product. This is not only being witnessed in the discrete manufacturing industry, but is also gaining popularity in the continuous process industry.

Mega Trend 4: Complexity reduction and modularization of business

Having built or acquired a complex set of products, processes, and companies, manufacturing firms are looking for ways to simplify internal business operations while staying in touch with customers. By enriching the established concepts of standardization and harmonization, and by attempting to simplify them, manufacturing firms can bring down the cost of doing business and respond to market shifts faster. To make it easy for customers to interact with the organization, it is imperative to have a customer-facing perspective which integrates all interface points under a common front-end. The manufacturing industry has gained a lot from the evolution of the retail industry over the last decade in this regard. Focus on modular production facilities that enable faster ‘lift and shift’ operations is coming into play, allowing firms to move their centers of production closer to the point of demand. At the heart of it, lies the inherent componentization and modularization of business. This modularization is being driven by the critical need to surpass the industry’s time-to-market expectations and to stay ahead of the competition. The ability to mix and match product components further provides the opportunity to create a diversified portfolio which meets the demands of the end customer.

Mega Trend 5: Product design, material science, and sustainability

Today, trends across industries point to an increasing use of materials that are high on performance, low on cost, and even lower on carbon footprint. Sustainable manufacturing not only requires environmentally sustainable end products, but also calls for fundamental shifts in the underlying design, in order to favorably impact the supply-side footprint. Application of next generation material science technologies on these breakthrough materials enables organizations to create significantly differentiated products. Manufacturing firms that stay ahead of the curve would be able to create significant long term competitive advantage, going beyond the current dimensions of competitive comparisons.

Mega Trend 6: Next Gen technology - Hybrid crossover solutions

We believe that transformation opportunities are numerous when companies cross traditional business boundaries. Hybrid solutions that help such crossovers are mandatory, and this calls for next gen solutions. This is
evident in the infotainment industry, where embedded electronics, telematics, mobility, telecom services, and conventional engineering systems are converging to create compelling value propositions. In addition, mobility, connected marketing, social media, listening services and Big Data-related business insights are accelerating a change in business model to B2B2C. Volumes of published research are available on this topic, leaving no need for elaboration. However, the fact that these technologies are being deployed to solve manufacturing-specific problems today is indicative of an entirely new emerging business process. A few innovative changes that truly point to the advent of the ‘future of manufacturing’ are the application of mobility to address shop floor productivity and the ‘takt’ rate, utilization of ‘listening platforms’ that digitize a customer’s voice to analyze the implications on product design, etc.

Mega Trend 7: Evolution of the manufacturing model

The demographic evolution of the market, already in evidence for the last decade or so, is driving a fundamental shift in the manufacturing philosophy. Large centralized manufacturing units have now given way to a network of smaller modular factories, which are closer to centers of demand. This places tremendous pressure on logistics and supply chain optimization, as enterprises look to achieving the benefits of lean processes in a widely dispersed setup. Visualization and tracking technology play an important role in this process enablement.

Many of these facts have also been discussed in the IDC Manufacturing Insights report, ‘Rethinking the Factory of the Future’, February 2012, which seeks to understand from the manufacturers where the sources of differentiation will come from in the next five years. The research indicates that price leadership, customer fulfillment, service leadership, and complexity reduction, are going to be the primary focus areas going forward. The research also highlights the inherent shift of consumption towards custom-built products, modularization, and the emergence of factory networks.

Changing Business Models as the Mega Trends Gain Ground

To substantiate the mega trends introduced earlier, we analyzed the four major segments of the manufacturing industry - aerospace, automotive, chemicals and process, and industrial machinery. We discovered visible shifts in business models across the board, as a means to counter challenges by leveraging the emerging technology convergence. As part of our research, we traced the shift in the ‘center of gravity’ – the control center of all action - for each sub-industry within manufacturing, and arrived at Figure 1.

We observed that aerospace suppliers, who were traditionally focused on product engineering, are now making a subtle shift towards aligning their business models with that of the airplane manufacturers, thus bringing in harmony to the supply chain and an increased level of customer-centricity. Airplane manufacturers are also becoming more collaborative with suppliers as well as the airline companies, in order to make products that meet market demands better. Some more trends are illustrated in Figure 2.

**Figure 2: The Changing Business Models in Manufacturing**

**Figure 1: Segmentation on Business Centricity for Superior Insights**

(Source: TCS internal research)

<table>
<thead>
<tr>
<th>Engineering Oriented</th>
<th>Operations Oriented</th>
<th>Collaboration Oriented</th>
<th>Customer Oriented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focal Point</td>
<td>Engineering</td>
<td>Supply Chain</td>
<td>Customer Experience</td>
</tr>
<tr>
<td>Typical Drivers</td>
<td>Product Focused</td>
<td>Cost Focused</td>
<td>Agility Focused</td>
</tr>
<tr>
<td>New Product Innovation and Lifecycle Processes</td>
<td>Manufacturing Excellence</td>
<td>LEAN Operations</td>
<td>Customer Loyalty</td>
</tr>
<tr>
<td>Cost to Market</td>
<td>Compliance</td>
<td>Scalability</td>
<td>Voice of Customer</td>
</tr>
</tbody>
</table>

*Figure 2: The Changing Business Models in Manufacturing*

1. The aerospace industry is embracing the tiered supply chain structure of the automotive industry – moving away from the traditional vertically integrated model to a collaboration model.

2. The Tier 1 suppliers – going by the voice of the customer – are moving forward to become system integrators for car companies, providing integrated solutions that the customers want. The connected car is a good example.

3. The chemical industry is looking at models for direct interaction with customers for need identification & demand planning, leveraging the integration of Point of Sale systems with call centers and mobile apps.

4. The auto industry – relatively the most 'customer facing' of the four – is the one evolving the fastest. Auto bigwigs have embraced the newest possible technologies to create differentiation and in turn, value for end customers.
Aligning Business Models with Consumers’ Business Drivers

The demand drivers of the customer’s customer – in effect, the consumer – today determine how manufacturing firms define their business models. The ‘traditional manufacturers’, in the emerging ‘new world of manufacturing’, need to align their business models to be responsive to their consumers. The next generation technologies and their convergence provide a significant opportunity to rapidly embrace new models.

To better understand how business models are evolving, we studied some manufacturing companies as well as the customers that buy from them. Instead of looking at the four major segments (automotive, aerospace, chemicals and process, industrial machinery), we drilled down a level to analyze some prominent sub-segments in each, and identified their key business drivers or success factors. Additionally, we studied the customers of these sub-segments and their drivers. This in-depth analysis gave us clues to the ‘real’ pull factors that help manufacturing companies in creating newer sources of differentiation. Figure 3 illustrates some of our findings:

The ‘traditional manufacturers’, in the emerging ‘new world of manufacturing’, need to align their business models to be responsive to their consumers. The next generation technologies and their convergence provide a significant opportunity to rapidly embrace new models.
<table>
<thead>
<tr>
<th>Industry</th>
<th>Industry Sub Segment</th>
<th>Drivers</th>
<th>Their Customers</th>
<th>Their Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Suppliers (Tier –1)</td>
<td>Cost Management Engineering (Design to Build)</td>
<td>Airplane Mfg</td>
<td>Cost, Quality, Delivery &amp; Reliability, Collaborative Pdt Dev capabilities</td>
</tr>
<tr>
<td>Auto</td>
<td>OEM</td>
<td>Engineering for Product Differentiation Operations &amp; Supply Chain Cost</td>
<td>NSCs, Distributors, Dealers</td>
<td>Product Reliability, Portfolio, Channel Management, Market Alignment</td>
</tr>
<tr>
<td></td>
<td>Tier 1</td>
<td>LEAN Management</td>
<td>OEM</td>
<td>LEAN Supply Chain, Collaborative Product Development</td>
</tr>
<tr>
<td></td>
<td>NSC / Retail</td>
<td>Working Capital Management</td>
<td>All of us</td>
<td>Complete Ownership Experience, Total Cost of Ownership, Brand Value</td>
</tr>
<tr>
<td>Process</td>
<td>Chemical</td>
<td>Operations Excellence &amp; Cost</td>
<td>Pharma, Industrial, Retail</td>
<td>Reliability, Variety, Innovation for Value Added Products</td>
</tr>
<tr>
<td></td>
<td>Glass</td>
<td>Operations Excellence &amp; Cost</td>
<td>Industrial, Retail</td>
<td>Supply Chain, Product Variety for varying applications</td>
</tr>
<tr>
<td></td>
<td>Cement</td>
<td>Energy, Logistics, Raw Material (Mining)</td>
<td>Contractors / Industrial Buyers, Distributors &amp; Retail</td>
<td>Product Reliability / Durability/ Strength, Cost, Supply Chain, Channel Incentives</td>
</tr>
<tr>
<td></td>
<td>Paper</td>
<td>Raw Material, Energy</td>
<td>Paper Companies</td>
<td>Product Variety, Supply Chain, Quality, Sustainability</td>
</tr>
<tr>
<td></td>
<td>Paints</td>
<td>Operations &amp; Cost</td>
<td>Industrial, Retail Channel</td>
<td>Product Variety – Finish - Durability, Supply Chain, Point of Sale Impact</td>
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<tr>
<td></td>
<td>Specialty Materials</td>
<td>Product Definition, Reliability</td>
<td>Pharma, Industrial</td>
<td>Product Characteristics, Reliability, Compliance &amp; Sustainability of Source</td>
</tr>
<tr>
<td>IMC</td>
<td>Capital Goods</td>
<td>Operations Excellence &amp; Cost</td>
<td>Manufacturing, CPG</td>
<td>Supply Chain Performance, Product Reliability &amp; Performance</td>
</tr>
<tr>
<td></td>
<td>White Goods</td>
<td>New Product Launch, Product Range</td>
<td>Retail</td>
<td>Product Variety – Features - Performance, Supply Chain Performance</td>
</tr>
<tr>
<td></td>
<td>Distributors</td>
<td>Supply Chain Agility</td>
<td>End Companies</td>
<td>Customer Experience – especially Service</td>
</tr>
</tbody>
</table>

Figure 3: Drivers for Different Types of Manufacturing Firms (Source: TCS internal research)
Thus, having a clear understanding of the customer’s behavioral patterns and nature of business is vital for manufacturers wanting to adopt the mega trends stated in this paper. The advent of information technology also plays a significant role in this adoption process. Drivers mentioned in Figure 3, such as collaborative product development, complete ownership experience, service transformation, product variety, portfolio management, and product reliability, can be addressed in an agile and differentiated manner by leveraging the next gen technology streams and the hybrid platforms created by their convergence.

Staying Relevant in the ‘New World of Manufacturing’ – A Call to Action

An organization will need the support of an IT partner offering a full range of services to master the ‘digitized’ business environment that is the new face of the manufacturing industry, and become a leader. Service integrators will need to play an industry-defining role by transforming into a ‘master of the manufacturing business game’ to stay relevant in the emerging industry context.

Leading integrated service providers no longer deal with just discrete technologies or one monolithic manufacturing industry. They deal with the convergence of the technologies and the mega trends that impact at least the four large segments that we researched, and potentially over two dozen industry sub-segments as Figure 3 highlights. If we were to look at oil and gas and petrochemicals as a continuum of the process manufacturing industry, and look at pharmaceutical manufacturing or medical device manufacturing in a similar manner, then the combinations are even more in number. With this wealth of knowledge, integrated service providers will be able to bring the much needed capability, capacity and experience that can significantly accelerate an organization’s plan of technology adoption.

Create a line of sight for your firm – Leverage the business transformation capabilities of full service integrators

The industry today seeks to leverage the business transformation capabilities of full service integrators for:

- Facilitating market entry, establishing manufacturing facilities rapidly, and establishing market networks and business systems – the scope goes well beyond simply deploying IT systems
- Providing design and deployment capabilities on a ‘services model’ like a pay-per-use model, measured in terms of either resource consumption or transactions. Examples of usage would include HPC, social media platforms, conventional systems such as service management and dealer management or even traditional core systems such as production planning, scheduling, logistics, and business intelligence
- Playing the role of a true system integrator by bringing together multiple service providers under one umbrella and taking accountability for the full system, for example, being a provider of infotainment systems that can also provide the telecom services billing plans, mobile app stores, telematics and embedded electronics, in addition to the conventional IT system itself
Operating their plants and business systems, along with accountability for service delivery – linking revenues to actual performance using ‘takt’ rates and cycle times

Participating in strategic cost reduction initiatives on a risk share and gain share basis

In view of the changing expectations, the service providers of the future will also be measuring themselves differently – the new measures would include aspects like:

- IPRs registered and their monetization
- Co-innovation with the industry and pipeline of new ideas
- Portfolio risk balance as revenue streams become more outcome linked
- New services portfolio and the contribution of next generation technologies towards business revenues
- Global footprint to service the ‘glocal’ customer

Conclusion

We believe the next gen manufacturer would look very different from the kind we see today. You can expect to see a much more customer-focused and agile set of organizations, as they leverage the new innovations in business and information technology. Traditional businesses will not change, but the convergence of innovative technologies to change business process and models will bring in greater agility. The new business model based on the mega trends will be the key differentiator between competing firms. Therefore, firms must prepare themselves today to remain relevant tomorrow. Firms that will adapt faster, embrace the digital wave better, and clearly identify the defining elements of the end consumer’s new center of gravity, will remain at the forefront of the industry.
About the Manufacturing Solutions Unit

Global manufacturers are trying to reduce operational expenditure, invest in process improvement, utilize existing capacity optimally and increase efficiencies, while maintaining product quality and meeting safety and regulatory norms.

TCS’ Manufacturing Solutions provide you the bandwidth to innovate on business models, leveraging contemporary technology solutions.

We believe in leveraging learning from across the segments in driving business solutions. Be it in applying the concepts of lean new product introduction from discrete industries to a chemical manufacturer, or leveraging the aerospace industry experience in service management for the automotive sector, our dedicated Manufacturing Centers of Excellence (CoEs) under these focus vertical industries are continuously looking at breakthrough solutions. Clients can benefit from our rich experience in both the discrete (automotive, industrial machinery and equipment, aerospace) and process industries (chemicals, cement, glass and paper).

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