

# Strengthening SMEs through Rapid Prototyping to Meet Future Challenges Why & How?

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## Abstract

In the current scenario of the global economic crisis, market uncertainty, layoffs, shrinkage in market size are some common issues which the business is facing and at the same time looking for some way outs. This situation demands the reconfiguration of existing theories, models or frameworks so that innovative solutions can be developed to ease the situation. Technology like Rapid Prototyping have the potential to meet certain future challenges, but there is a dire need to blend the technology and strategy together to end up with a viable solution, unfortunately there is no one and simple solution, but joint efforts by different stakeholders is the need of time.

A recent trend is the globalization of the production operations in which the manufacturing is done basically in the developing countries largely through SMEs but the question is that are these small to medium entrepreneurs ready to take the challenge of the fast changing requirements and is it possible to meet these challenges without building the capacity of the these small companies? This paper take a closer look of the SMEs by giving an in depth analysis of the inherent problems and challenges such companies are facing and how the technology like RP can assist them to come out of this situation. The paper also highlights the role of the stakeholders including both government and non government organisations including universities and provides valuable recommendations for the capacity building of these small to medium companies, which will not only boost the local economies but will also facilitate the international production & operations management in a better and most effective way.

**Keywords:** Rapid Prototyping, Rapid Manufacturing, SMEs, Global Value Chain

## Introduction

Manufacturing is a critical and strong component of the economy. The global economic crisis supplemented by the high cost of energy has posed considerable threats to the companies especially small to medium entrepreneurs SMEs. The environment in which these organizations are operating demands, customized, low volume products at reasonable quality and price, so the quick response and flexibility have become important determinant of success in global market.

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Manufacturing companies in both developing and developed countries are affected by this changing mechanism of increased competition and new market chemistry. Canadian Manufacturers are at a critical crossroads. The evolution of new technology and increase in competitive pressure will impose a great challenge for them (CME 2004). Current global financial crisis has created a new set of challenges with adding pressure on local firms to compete in the markets. Throughout 2009, the manufacturing sector in Australia has faced a challenging economic environment with an overall decline in activity (IEA 2009).UK manufacturers are clearly affected by the current economic slowdown (Berr 2008) .

A recent trend is the globalisation which has been defined as “not merely the geographical extension of economic activity across national boundaries but also and more importantly the functional integration of such international dispersed activities”(Dicken 1998), in which companies have decentralized their operations in different parts of the world to form global value chains. Two important features of which are production globalisation, which demands growth in industrial capabilities in developing countries and vertical disintegration (Gerreffi<sup>a</sup> 2005). This new scenario has increased the importance of the SMEs in developing countries due to the increased reliance of the international partners, but the important point at this stage is that are these SMEs ready to take this global challenge. This paper systematically highlights such issues, by analysing their current capabilities and hurdles to become an effective player in global value chains, role of the technology like Rapid Prototyping (RP) and how it can assist these companies to play effective role in global value chain. It also provides recommendations for all the stakeholders for an effective and sustainable solution.

### **Role of SMEs in Economy**

The strategic importance of small and medium enterprises in the development of the economy is widely recognised in both developing and developed countries (Abdullah<sup>a</sup> 2000). SMEs play an important role in the development of national economy of any country. UK economy is 99 % SMEs, so out of the 4.8 million UK businesses less than 1 % are large corporations i-e over 250 employees (Rowe 2008). The share of employment accounted for 70% of total employment and the product share for over 46% in South Korea (Lee 2000). In Malaysia SMEs accounted for about 48% of manufacturing establishment (Abdullah<sup>b</sup> 2000). There are about 118,648 SMEs in Thailand representing around 98% of total firms in manufacturing sector (Suthiphand 2000). China is fast becoming the largest economies in the world and SMEs are key element in China’s economy accounting for 99% of total number of firms and 69.7% of overall employment (Tang 2007).

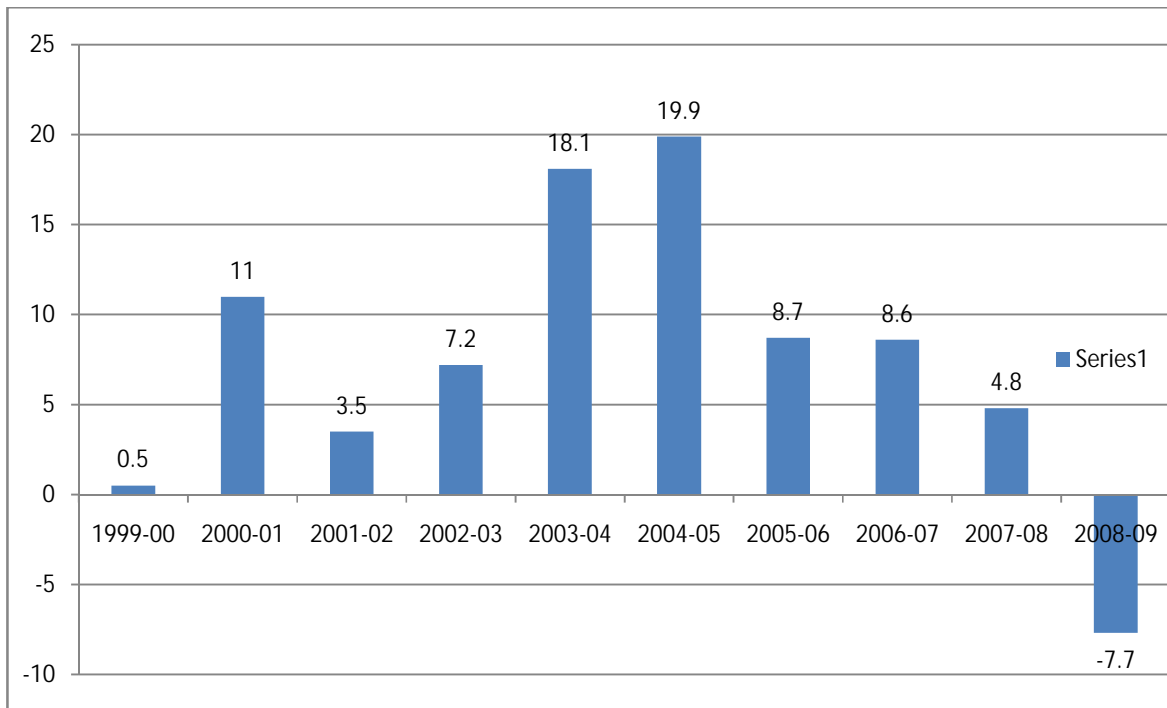
The above statistics clearly shows the role of SMEs in the economy of the country and their contribution in labour absorption, poverty alleviation and revenue generation. The critical importance of this sector warrants much more attention by all the stakeholders which includes govt agencies, academia and multinational companies because of their vested interest. The SMEs around the globe are facing similar sort of issues but their magnitude is different which largely depends on the culture and the way the governments tackle the issue and this is one of the critical point where developing countries differentiate from developed nations. Developing countries have attracted the large companies manufacturing operations, as these countries are labour intensive and ends up with very low cost of finished products. Despite of these opportunities these SMEs are facing certain challenges which must be pointed out clearly and should be addressed jointly not only to facilitate the international production operations but also to assist these companies to come out from this economic turmoil to meet future challenges. Small and medium sector of Pakistan in general and automotive sector in particular is selected. This will provide an overview of their importance

and contribution in the economy and the technical challenges they are facing and will also highlight that how the technology like RP can make a difference.

**Small and Medium Sector of Pakistan**

SMEs today are widely considered as panacea of many economic problems. They are considered as great source of reducing unemployment and poverty in the economy. In Pakistan the manufacturing is the largest sector of the economy and have 18.4% contribution to the GDP (Rehman 2009) .Pakistanis manufacturing sector recorded the weakest growth in decade during 2007-08 fiscal year. Overall manufacturing witnessed a growth of 5.4% during the first nine months of the current fiscal year against the target of 10.9% (Kazmi 2008) and overall manufacturing sector posted a negative growth of 3.3% during the fiscal year 2008-2009 against the target of 6.1% and 4.8% last year. However production in large scale manufacturing during Jul-Mar 2008-09 posted a decline of 7.7% against the revised growth target of -5% (Rehman 2009). There are many factors responsible for this slow growth which includes but not limited to political environment, energy crisis, govt policies etc but the technical challenges are the subject of discussion only.

**Fig 1. Large Scale Manufacturing Growth (%) 1999-00 till 2008-09 (July-March)**



Source: Pakistan Economic Survey 2008-2009

**Automotive Sector**

There are around 400 units which are categorized as organised units, they are registered vendor to assemblers and are bound to supply to them but due to the low demand from the assemblers they are forced to sell in the replacement market. There are also 1200 units in unorganized sector. In reality 90% of the automotive part industry consists of SMEs. Some statistics about this sector are shown in fig.2 which shows their critical role in national economy (Asif 2006).

**Fig 2. Industry Statistics**

Number of Units	Approximately 1600 Units(400 in organized sector, 1200 small scale unorganized one)
Employment Generated	About 500,000 (Organized sector provides employment to 120,000 people whereas unorganized sector employs almost 380,000)
Revenue to GOP	Rs 8 Billion (By organized sector only)
Total Investment	Rs 72 Billion
Contribution to GDP	Rs 25 Billion
Foreign Exchange Saving	Rs 279 Million
Import Substitutions	Rs 699 Million

Sources: Cluster Diagnostic Study SMEDA

### **SMEs Infrastructure Related Issues**

It is imperative to consider the unfolding dimensions of the SME infrastructure before moving into any technology related issues, the main reason is that any solution suggested may lose its effectiveness without considering the environment completely in which they are going to be implemented as small companies differ from that of large companies in many respects and any solution designed for large companies may not fit to the small companies. There are number of reasons for that 1. Education level at SMEs is very low 2. Most managerial positions are acquired based on experience and lack professional qualifications 3. R&D culture is absent due to financial constraints (Ahmad 2008). Most of such issues are common in many countries. In Malaysia management abilities, R&D and technological capability in particular is a constraint on innovation and high value added activities in this sector (Peter 2000). SMEs in Korea are economically weak units facing lack of technical competitiveness, money skilled labour force, management and market awareness (Abdullah<sup>b</sup> 2000). Management problems in SMEs are largely because many of their entrepreneurs lack high level of education and professional training and they perform poorly in many areas of production and quality control (Abdullah<sup>a</sup> 2000) .

### **Technical Issues & Challenges in SMEs**

The most critical challenge in manufacturing is the design and development of the products. Auto part vendors and manufacturers do not make drawings of the parts. These drawings are provided by the foreign partners. This sector converts these drawings into products and is reliant on traditional product development methods of casting, forging, machining etc (Asif 2006). This ends up with much longer lead times, poor quality and limited range of products. Flexibility is almost absent because of the limited capabilities of the process used. SMEs need special attention on product and development. Many large companies still import their components, rather than purchased from local SMEs supplies. The main reason is the high price and low quality of the locally produced components (Abdullah<sup>a</sup> 2000). In auto cluster only 10% of companies are capable to export only because their products comply with

international standards and import of the parts which cannot be produced locally due to the lack of technology is projected to increase dramatically and technology is considered as big hurdle in the growth of this sector (Asif 2006). This issue is also highlighted in a UN document “Developing countries need to place the development of productive capacities at the heart of national policies. The firms continue to face a number of obstacles that inhibits growth and reduce their relationship with global value chains (GVCs) one of them is to increase the competitiveness of SMEs (UNCTAD 2006).

### **SMEs & Global Value Chain**

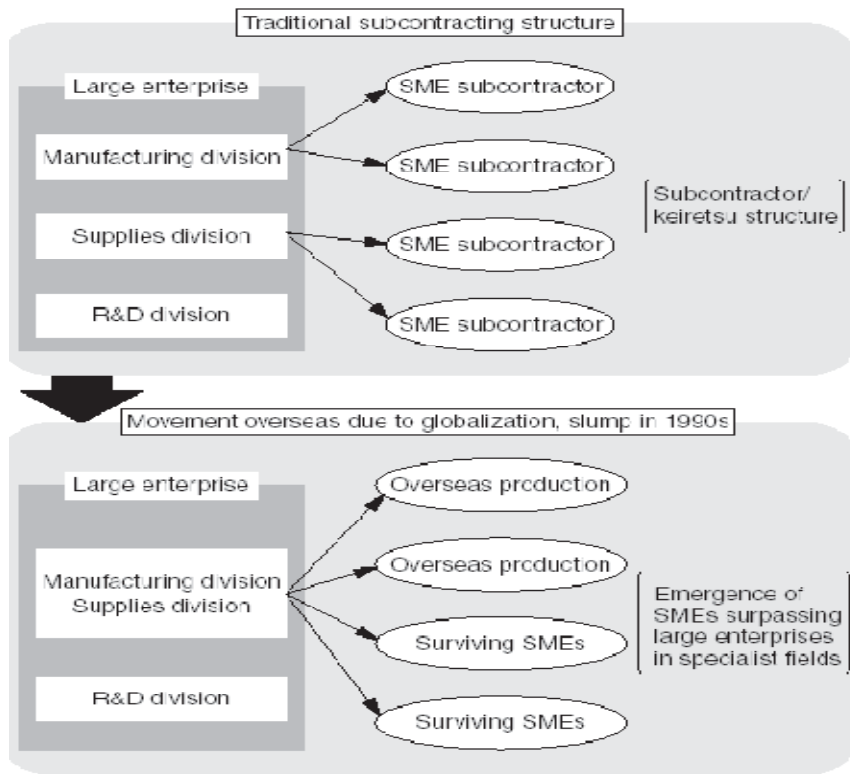
The dependency of the nations, through the flow of goods, service and financial market has made globalisation a catchword in the late 20<sup>th</sup> century (Gereffi<sup>b</sup> 2001). In this new era of globalisation the fragmentation of production operations have been increased significantly. In this new scenario if large companies and multinationals are at fore front, the role of SMEs in this new production context has also been emerged as critical and significant but very rare information is still available on the changing relation between multinational corporations (MNCs) and SMEs and its role in global value chain(OECD May 2007).

Global value chains cover a complete list of activities ranging from conception to production to final delivery to the customers and these activities are performed by firms located in different geographical locations of the world (UNCTAD 2006) . The Organization of Economic Corporation and Development (OECD) which consist largely on developed nations also highlighted the issue faced by SMEs and their role in global value chain. The challenges include 1.Awareness and understanding of the value chain dynamics, competitive strength identification, inability to upgrade, protect in house technology, to innovate and strict product quality compliance (OECD 2008).

Global value chain poses a great threat and opportunities to the SMEs at the same time and has certain common threads of issues and challenges in both developing and developed nations. The role of Governments, political environment and cultural differences are the certain points where developing economies differ from that of developed economies and demands different set of solutions to address the issue effectively. The role of SMEs in developing countries has changed, where they have become important partners of multinational companies (MNCs) Fig 3. Value chain analysis is an innovative tool that developing countries should consider. It is important to consider that it is the international buyer who determines quality, value and delivery speed. Buyer requirements coupled with market conditions, standards and regulations are few factors which determine the competitive ability of any firm in any country (ITC 2003).

With the increased complexity of the products, the product life cycles and time to market are shortening and to ensure long term success, the manufacturers are required to concentrate on both markets and technology (IEA 2009). In this rapidly changing scenario, the capacity building of the SMEs can play a vital role particularly during the product development cycle, as this process can be regarded as a gateway to the international markets if it meets the market attributes but in case of SMEs it is ending with long lead time, high cost and poor quality where the production of complex products is almost impossible in large number of companies. The reliance on old technology and production processes is one of the main reason which is leading towards limited, standardized sort of markets due to their inherent capabilities. Future changing scenario where more production is required from them by large enterprises demands the awareness and adoption of latest technology and processes and only this can ensure their effective role in global value chains.

Fig 3. Changing Role of SMEs



Source: White Paper on Small and Medium Enterprises in Japan 2005

### Role of Rapid Prototyping in Capacity Building of SMEs

Rapid prototyping is additive manufacturing, which builds a part layer by layer, in contrast to previous methods which use subtractive methods, by using material like wax, metal, several type of plastics, paper etc. The inherent capability of this technology has made it an ideal candidate for producing parts, with any complexity and through range of materials available. The developed parts can be used for wide range of applications like functional testing; form-fit analysis or even the parts produced can be used as end product, based on the material and equipment used. Another great advantage of the technology is direct tooling application and all these benefits have great effect on the design-manufacture cycle with a significant impact on the lead time and the cost of the product which leads towards the increased capacity of the company. The rapid and unpredictable change in business environment has inflamed the prevailing high risk nature of business operations and this technology must be addressed within the context of market turbulence (Kidd 1997). With increasing importance of globalisation, the companies have realized an increased pressure on every sector of manufacturing and the recent revolution of RP technologies has enabled companies to produce the design in much shorter time (Onuh 2001). The few benefits of entering the market with innovative products are increased sales life, pricing advantage and customer loyalty (Folkestad 2002). Technology is also lending in a variety of applications like medical, jewellery, micro electrical systems and providing easy solutions for large number of manufacturing operations.

Companies across the world are finding these technologies to be extremely beneficial and they are adopted at an increasing rate. From large multinationals to small companies the

benefits of RP are striking and the companies which are using the technology are reporting significant reduction in design-prototype cycle, leading towards improved product quality (Wohlens 1995). Success stories of RP technology are rapidly making space in literature. Boeing has made extensive use of the rapid prototyping machines to produce parts, tooling and manufacturing aids for the F 18 and other military aircraft. “We have just touched the tip of the digital manufacturing iceberg” says Jeff DeGrange, an engineering manager with Boeing’s Phantom Works. Direct digital manufacturing has also become standard practice in the hearing aid industry. “Literally millions of hearing aid shells have been produced on our ster lithography systems,” says Abe Reichental, CEO of 3D systems. (Ogando 2007).

RP is not for large firms only, it also offers tremendous potential for SMEs to pursue and create new opportunities (Kidd 1997) . Despite of a common thread between the problems of these companies like limited design and manufacturing capabilities and the benefits offered by the technology, still a small proportion of industry is in use of this technology and this is particularly true for small to medium size companies, as up to author’s knowledge only one RP system is available for the automotive cluster mentioned before and this problem persist in companies around the globe. “The general consensus is that less than 20% of the design and product development community use Rapid Prototyping. In the manufacturing engineering discipline the level of use is far less. If the technology is so powerful why few companies use it (Grimm 2004). There are many reasons for this low diffusion but the one which largely contributes towards the problem is the lack of awareness that why a company should use this technology and how to successfully adopt this technology. This sector is totally unaware about the strategic benefits offered by this technology due to the absence of complete adoption mechanism. Survey of 262 UK companies showed that 85% of the companies don’t use RP and the lack of awareness is the key factor holding back the RP market. The majority of the group who feels RP is irrelevant have never searched its application (Grenada 2002).

The increasing demand of outsourcing, where large MNCs are shifting manufacturing to developing countries, the importance of SMEs have increased manifold but they can assist these large companies when they are ready to become the part of global value chain and this is only possible when they equip them with the latest technology like RP to overcome the critical problems in product development, which at this stage is a barrier to be an effective global value chain partner.

## **Recommendations**

### ***Consortium Development***

Capacity building of the SMEs is critical for all the stakeholders involved. For government it contributes towards economic growth, poverty alleviation, increased jobs and better market share. For MNCs it assists in squeezing the supply chain, in which most of the parts can be produced locally where the operations of such companies exist or for outsourcing. It can provide a great avenue of research for academics by providing them real life problems but the way all these stakeholders are tackling the issues must be understood before recommending any solution. Currently govt, MNCs and academics are handling the SMEs independently ending up with weak links as shown in Fig.4a. The main reasons are

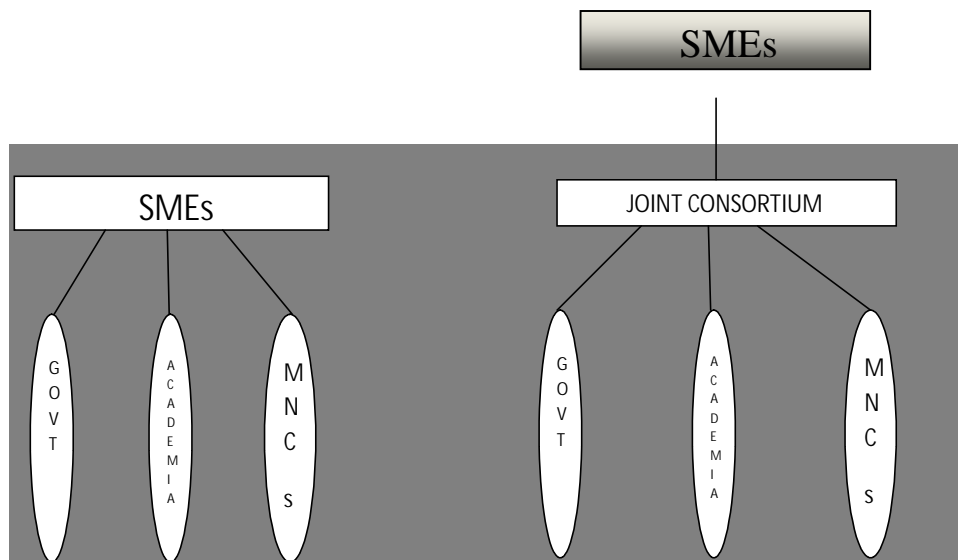
- People sitting in Govt departments dealing with SMEs are either non technical or unfamiliar with the latest technology, which is changing with a very rapid pace. It is difficult for them to understand the impact the technology can have on the

current business operations or what strategic benefits can be captured from the technology as this is subjected to a continuous and extensive research. The end result is a mismatch between the solutions offered and the real problems.

- Poor relations of academia with SMEs due to the inability to excess on latest technology is ending with a poor relations, where these companies loose trust on academics due to the failure in addressing the technological challenges faced by these companies. This also hampers the R&D activities of the academic institutions.
- MNCs on the other hand have links directly to the companies which are relatively stable but they still rely on the import of parts which require high quality , this activity results in lengthening the supply chain .It also minimize the opportunity for SMEs to understand and access the global value chain effectively.

This situation warrants a joint consortium of govt, academia and MNCs where the issues are addressed jointly as it requires knowledge and competencies in many areas Fig 4b and all the desired skills required to address the issue are not present in any one stakeholder. Academics role is very critical as they are the one who can provide a trained manpower and customised solutions for these companies. Academics also need assistance from govt and MNCs for infrastructure development and for the knowledge of latest technology and market trends.

Fig4. Coordination mechanism with SMEs



4a. Current Mechanism

4b. Proposed Mechanism

Development of technology centres jointly, is also proposed as a starting point, which will not only assist in the R&D activities but will also facilitate the development and up gradation of the courses as per changing requirements of market trends. It was observed that such centres established by government independently failed to play the role for which it was designed. Researcher's community also need to devise solutions which are exclusive to SMEs by keeping in view of their inherent structures and problems and these should be comprehensive, detailed and easy to adopt. This will assist them in the exploitation of the strategic benefits offered by the technology to become an effective global value chain partner.



## Conclusion

Many issues related to SMEs around the globe were highlighted and it is found that companies are facing challenges in both developing and developed economies where the problems are fuelled by political instability and energy crisis in developing nations. This situation is hampering the SMEs to understand and play critical role in global value chain. Product design and development is a very first critical stage which determines the success of the company and its role in global value chain. This stage is linked now with short lead times, high customisation and low volume and these are the current and future challenges, these companies are facing. Strengthening SMEs in this new era of manufacturing through latest technology like RP is an important ingredient of success. This demands the combined and unidirectional efforts by all the stakeholders involved for the sake of sustainable and long term solutions. More responsibility lies on the academics and researcher community to provide solutions which assist this sector to play an important and critical role by exploiting opportunities in global value chains.

## References

- Abdullah<sup>a</sup>. M. A. (2000). Small and Medium Enterprises (SMEs): Some Pertinent Issues. Small and Medium Enterprises in Asian Pacific Countries. M. A. Abdullah. NY, Nova Science Publisher, INC. **1**.
- Abdullah<sup>b</sup>. M. A. (2000). Myths and Realities of SMEs in Malaysia. Small and Medium Enterprises in Asian Pacific Countries. M. A. Abdullah. NY, Nova Science Publisher. **1**.
- Ahmad, A., Maruf Hasan, Von Voorthuysen Erik Jan (2008). Time Compression Technology: Why Limited Uptake in SME's? 2nd International Conference on Additive Technologies. Ptuj, Slovenia.
- Asif, M. (2006). "Cluster Diagnostic Study Auto Parts Cluster Lahore." Retrieved 20 May, 2008, from <http://www.smeda.org.pk>.
- Berr. (2008). "Manufacturing New Challenges: New Opportunities." Retrieved 16 Aug, 2009, from [www.berr.gov.uk/files/file47660.pdf](http://www.berr.gov.uk/files/file47660.pdf)
- CME. (2004). "Manufacturing Challenges in Canada." Retrieved 15 Aug, 2009, from [www.cme-mec.ca/mfg2020/Challengespdf.pdf](http://www.cme-mec.ca/mfg2020/Challengespdf.pdf)
- Dicken, P. (1998). Global Shift: Transforming the World Economy New York, N.Y, Guildford Press.
- Folkestad, J. E., Russell L. Johnson (2002). "Integrated Rapid Prototyping and Rapid Tooling (IRPRT)." Integrated Manufacturing Systems **13**(2): 97-103.
- Gereffi<sup>b</sup>. G. J. H., Timothy Sturgeon (2001). "Introduction: Globalisation Value Chains and Development." IDS Bulletin **32**(3).
- Gerreffi<sup>a</sup>. G., John Humphrey, Timothy Sturgeon (2005). "The governance of global value chains." Review of International Political Economy **12**:1(78): 104.
- Grenada, E. (2002). "User Views on Rapid Prototyping." Retrieved 10 October 2008, from <http://home.att.net/~castleisland/>.
- Grimm, T. (2004). User's Guide to Rapid Prototyping, Society of Manufacturing Engineers.
- IEA. (2009). "Engineering the Future of Australian Manufacturing." Retrieved 15 Aug, 2009, from [www.engineersaustralia.org.au](http://www.engineersaustralia.org.au).

- ITC. (2003). "Value Chain Analysis: A Strategy to Increase Export Earnings." Retrieved 10 September, 2009 from <http://www.tradeforum.org/news/fullstory.php/aid/529>.
- Kazmi, R. (2008). Pakistan Economic Survey 2007-08, Ministry of Finance Govt of Pakistan.
- Kidd, P., T (1997). Rapid Prototyping For Competitive Advantage UK, Cheshire Henbury.
- Lee, Y. J. (2000). Role and Experience of SMEs in South Korea Small and Medium Enterprises in Asian Pacific Countries. M. A. Abdullah. NY, Nova Science Publisher INC. 1.
- OECD (2008). Enhancing the Role of SMEs in Global Value Chains
- OECD (May 2007). Enhancing the Role of SMEs in Global Value Chains. Tokyo.
- Ogando, J. (2007). Rapid Manufacturing's role in the factory of the future. Design News.
- Onuh, S., O, K.K.B.Hon (2001). "Integration of Rapid Prototyping Technology into FMS for Agile Manufacturing." Integrated Manufacturing Systems **12**(3): 179-186.
- Peter, W., David Smallbone, Satirejit Kaur Johl (2000). The Implications of the Economic Crisis on (SMEs): A Micro Perspective. Small and Medium Enterprises in Asian Pacific Countries. NY, Nova Science Publisher.
- Rehman, H. U. (2009). Pakistan Economic Survey 2008-2009. Ministry of Finance ,Govt of Pakistan.
- Rowe, J. (2008). "SME Value and Contribution to UK Economy." Retrieved 18 Aug, 2009, from [www.buzzle.com/.../sme-value-and-contribution-to-the-uk-economy.html](http://www.buzzle.com/.../sme-value-and-contribution-to-the-uk-economy.html)
- Suthiphand , C., Nathavit Chantrasawang (2000). Experience of SMEs in the Financial Crisis in Thailand. Small and Medium Enterprises in Asian Pacific Countries. NY, Nova Science Publishers INC: P86.
- Tang, Y., Paul Wang, Yuli Zhang (2007). "Marketing and Business Performance of Construction SMEs in China." Journal of Business & Industrial Marketing **22**(2): 118-125.
- UNCTAD (2006). Global Value Chains for Building National Productive Capacities. Geneva.
- Wohlers, T. (1995). "Future potential of Rapid Prototyping and manufacturing around the world." Rapid Prototyping Journal **1**(1): 4-10.