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Advanced Manufacturing Technology (AMT): A Literature Review

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ABSTRACT

This paper presents a literature review of Advanced Manufacturing Technology (AMT) based on a source bank of about 730 AMT publications, software and institutions. After introducing AMT briefly, the study focuses on AMT resources, and history of AMT. Since AMT is a universe of technologies, production methods and methodology about computerized production the three legs of the trivet which construct the basis of AMT are introduced. 10 AMT books are recommended for the use of the researchers. This research is done by using the framework of Chan&Wu(2002). I hope this study will help the practitioners and especially the researchers of AMT.

Key Words: Product Development, Technology Acquisition, Advanced Manufacturing Technology (AMT)

1. INTRODUCTION

AMT is a combination of methodology, production method and technology which aims to ease the way that people produce. With the recent developments and changes both in the market and the claim enterprises are obliged to keep up with these two concepts. Even though it is not uttered beforehand the rationale of AMT starts with the use of first machine. Later on with the use of computers in DNCs the concept is being used till then. In order to provide a reference page for every researcher of the topics included in the text the authors scanned more than 3000 sources of AMT. The ones which seemed to be most relevant to the title are included in the study. Lastly 10 usefull publications of AMT are suggested.

Although they are only mentioned with citations in the study, most of these sources are available from the authors. The articles, books and online resources are classified by sub-titles of AMT trivet.

2. HISTORICAL ORIGINS OF AMT

The history of AMT goes back to 6000 years. The process begins with the use of potter's wheel and bow drill. This is the beginning of use of technology in manufacturing. The roots of BPA which is an element which constructs BPM originated from this use. Later on, in 1808 Mauldslay's block machine flashed on the development of CMS. Then with the establishment of a discrete department in NCR Corp. HRMS was introduced. Inspired by the views of Frederick Taylor's management theories and Carl Bath's machinery applications BPM was being used in manufacture. With the changes in the market and the demand after The Second World War(1945) IRS and NC was used in the production process. During 1950s a lot of improvement was observed such as AS/RS, ONC, DNC, Toyota's JIT, CAD in arrordance with PDM and PIM, TQM and AGVs. MRP was put forward in 1960 and in 1961 the first robot was used and this led the improvement of Robotics. In 1970s GT, DCS, PLC and also CAM was enounced. 1980s witnessed many development in AMT with the use of g-codes in DNCs CNC and MDE, as an output of CAD/CAM CAPE, CAPP and CAQ as a result of use of TQM and also Lean manufacturing were advanced in this period. In 1990s the use of computer integrated manufacturing systems became more common and this flashed up the development of ERP, SCADA, BPI, RAD, MOM, CONWIP as an alternative to Kanban and lastly IBP. In the 21st Century BPM(modeling), COTS, DSM, HMI, MPM, OBASHI, SOA, S&OP, OEE and lastly HIM were put forward for the use of manufacturers and researchers of AMT.

3. AMT RESOURCES

3.1. Books

The AMT litareture is rich. It improves itself day by day. The literature provides many books such as; Goetsch (1989), Allegri (1989), Philips (1992), Parker&Wall (1998), Chmiel (1998), Navalingam (2000), Busby (1992), Qin&Juster (2003), Kulianic (2005), Timings (2000), Dean (1987) and Gibson&Smilor (1992)

provide information about AMT. Also Bessant (1991), Vickery & Campbell (1991), Wall et al. (1987) and Turniansky & Hare (1998) manpower, Miller (1986), Gerwin & Kolodny (1992), Mullins (2007), Harrison (1990), Voss (1986), Karwowski & Salvendy (1994) and Dorf & Kusiak (1994) management, Compton (1988), Butler (1991) and Matta & Semeraro (2005) design, Pike & Neale (2006), Baik (2004), Abdel-Kader & Dugdale (1996) and Broadbent & Cullen (2003) investment decision, Barnes & Getzler (1999) case study, Johnson (1988) ergonomics, Timings (2003) e-manufacture, Carlsson (1995) sourcing of AMT, Chakravarty (2001) and Blache (1988) acquisition and implementation of AMT, Nelson (1993) compares Canada and USA.

3.2. Articles

The AMT literature provides wide range of articles for the researchers and applicators. For example; Small (1998), Pandza (2005), Panizzolo (1998), Singh et al. (2007), Sambasivarao & Deshmukh (1995), Co et al. (1998), Beaumont et al. (2002), Sohal & Singh (1992), Youssef & Zairi (1996), Harrison (1986), Small & Yasin (1997, 2003) Challis (1986), Voss (1986) and Sohal (1999, 2006) adoption of AMT, Chan et al. (2001), Putterill et al. (1996), Sohal (1994) Burcher & Lee (2000) and Small (2006) investment decisions, Castrillon & Cantorna (2005) training, Monge et al. (2006), Gupta & Whitehouse (2001), Gupta et al. (1998), Diaz et al. (2005), Small (1999), Bayou & Reinstein (1995) and Salaheldin (2007) performance, Zairi (1991), Zhang et al. (2006) and Cook & Cook (1994) competing, Jonsson (2000) empirical taxonomy of AMT, Marri (2007) Pakistan. Sun et al. (2001) China, Dawson (1996) Australia, Sohal et al. (2001) South Africa, Mora-Monge et al. (2008) North America, Thakur & Jain and Dangayach & Deshmukh (2005) India, Sohal (1999) comparison of American and British implementations and lastly, Shaw et al. (1997) IT software.

3.3. Software

Advanced Manufacturing <http://www.advancedmanufacturing.com/index.php/SOFTWARE/> Industrial Press http://new.industrialpress.com/products/category_list/CD

3.4. Institutions

There are schools, organizations and companies which aim to train and inform people who are interested in the area. For example;

Ivy Tech, <http://www.ivytech.edu/>,

Sandia National Labs. , <http://www.sandia.gov/Main.html>,

Doleta, <http://www.doleta.gov/>,

Innovation Technology Centre, <http://www.itcyorkshire.com/default.asp>,

University of Nottingham, <http://www.nottingham.ac.uk/>,

CIT, <http://www.citindia.com/index.htm>,

LAVC Job Training, <http://www.lavc.edu/jobtraining/amti/index.htm>,

ECC, <http://www.everettcc.edu/>,

AMT Online, <http://www.amtonline.org/>,

Manufacturing Career Guide, <http://www.khake.com/index.html>,

MGCCC, <http://www.mgccc.edu/>, IT urls, <http://www.iturls.com/English/default.asp>,

State University, <http://www.stateuniversity.com/>,

VMIC, <http://www.jmu.edu/vmic/index.htm>,

UMASSD, <http://www.atmc.umassd.edu/welcome.cfm>

WTCS, <http://www.wtcsystem.edu/index.htm>.

4. THE AMT TRIVET

In this part of the research the researchers divided the AMT TLAs into three groups, i. e: Methodology, Production method and technology in order to provide the reader clues for covering the topic. Figure 1 illustrates the distinctions and the legs of AMT trivet



Figure 1. AMT TLA universe

4.1. Methodology

4.1.1. Business Activity Monitoring (BAM)

Business Activity Monitoring (BAM) is a kind of software that aids in monitoring of business activities, as those activities are implemented in computer systems. Put forward by Gartner, Inc. analysts it represents the the aggregation, analysis, and presentation of real time information about activities inside organizations and involving customers and partners. Its main purpose is to obtain real time data and analysis of the organization. Thus it utilises its main benefit that is; coping with the problems immediately by making necessary regulations, A dashboard is used to show the key performance indicators. Also event correlation is done by the use of the data which is displayed in the dashboard. Greenwald et. al.(2008) , Wayne(2006) and Jeston&Nelis(2006) provide methodological information, Adams(2002) mentions the benefits of usage of BAM, Wei et. al. (2007) mentions the role of BAM in SPC. Havey (2005) expresses the relationship between BAM and Process Mining.

4.1.2. Business Driven Development (BDD)

Business Driven Development (BDD) is a methodology which satisfies the need of IT solutions in business requirements. This is achieved by adopting a model-driven approach that starts with the business strategy, requirements and goals and then transforms them into an IT solution. Mitra (2005) provides general information about BDD, Kroll&Royce (2005) presents key principles in BDD and Koehler (2008) emphasized

the role of visual modeling and transformation in BDD. Kuster et al. (2008) demonstrated BDD as a tool for merging processes. Walhi et al. (2008) pointed BDD for rational compliance.

4.1.3. Business Process Management (BPM)

Business Process Management (BPM) is a field of management which focuses on collocating parts of organizations due to the needs and the wishes of the customer. This is a combining approach which unites business effectiveness and efficiency with innovation and integration with technology. Lee&Dale (1998), Smith&Fingar (2002) and Khan (2004) provide general information. Jeston&Nelis (2006) provides a framework and more than 50 case studies. Burlton (2001) dedicates ways of prospering the process. Harrison-Broninski, (2005) discusses human interaction in BPI. Spanyol (2003) points out BPM as a team sport. Jennings, Faratin N. R. et al. (1996) focused on agent based BPM. Elzinga et al. (1995) presents empirical information, Leymann & Roller (1994) mentions BPM with FlowMark.

4.1.4. Business Process Modeling (BPM-2)

Business Process Modeling (BPM) plays an important role on Business Process Management (BPM) and it is the study of by representing the existing processes of an enterprise in order to execute the present state and do betterment for future. It is done by digging out the whole dynamics of the process such as vendors, suppliers, inputs, outputs... etc. The term BPM first coined by S. Williams in 60s but it acquired reputation in 90s. Havey (2005) provides wide information about BPM. Scheer (2000) mentioned the relationship between BPM and ARIS. Lin et al. (2000) constructed a generic framework for BPM. Dennis et al. (1994) compares BPM with old technology with BPM in new technology. They (Dennis et al., 1999) also investigate BPM with group support systems. Moreover Gruhn (1995) explains BPM with workflow management. Nüttgens et al. (1998) discusses BPM with EPC and UML transformation and integration. Luo & Tung (1999) establishes a framework for selecting BPM methods.

4.1.5. Business Process Improvement (BPI)

Business Process Improvement (BPI) first put forward by H. James Harrington (1991) as a systematic approach which helps an organization to optimize its sub-processes in order to obtain betterment. In 1990s Michael Hammer & James Champy improved the popularity by addressing in their book "Reengineering the Corporation: A Manifesto for Business Revolution" (1993). The aim of BPI is to make radical changes rather than small adaptations. Andersen (2007) besides general information about BPI it also presents a framework. Weerakkody & Hinton (1999) investigates the data systems and technologies in BPI framework. Weerakkody & Hinton (1998) and Lientz & Rea (1998) mentions how to plan and implement BPI.

4.1.6. Constant Work in Process (CONWIP)

Constant Work in Process (CONWIP) system is a factor in pull production system. Basically it is a single-staged alternative to Kanban. Schniederjans & John (1999), Black&Hunter (2003), Kusiak (2000), Bell (2005), Lödding (2004), Aksin & Goldberg (2002) and Halevi (2001,2006) provide information about CONWIP and also Hopp & Spearman (1991) studied failures, Spearman et al. (1990) describes CONWIP, Al-Tahat & Rawabdeh (2008) stochastic analysis, Ip et al. (2002,2007) FMS control and assembly production line, Ghamari (2008) comparison of Kanban and CONWIP, Duenyas & Hopp (1993) estimation of throughput of a CONWIP system, Ryan (2000) inventory levels, Gaury (2000) acquisition of CONWIP, Dar-el (1999) CONWIP in multiple bottlenecked lines and Yıldız & Tunalı (2008) response surface methodology.

4.1.7. Domain Specific Modeling (DSM)

Domain Specific Modeling (DSM) is a method which is used by IT users to design and develop the current process and consists of orders which are written in a special language i.e; Domain Specific Language (DSL). Kelly & Tolvanen (2008), Baumaster et al. (2005), Fishwick (2007), Rossi (2008), Ralyte et al. (2007) provide information about DSM and also Choi et al. (2003) studied rapid energy estimation.

4.1.8. Enterprise Content Management (ECM)

Enterprise Content Management (ECM) is a system which is used to ensure effective information flow via compound technologies. McNay (2002), Glazer & Jenkins (2005), Forquer et al. (2005), Noack (2007), Hilier (2007), Huff (2006), White (2005) and Allen (2008) maintains extensive information about ECM.

4.1.9. Human Interaction Management (HIM)

As far as human is used in manufacturing processes the need to deal with human will be stuck in mind. So the sum of the studies to integrate human factor effectively in manufacturing processes is called Human Interaction Management (HIM). This method is being used as a collateral activity in BMP. Harrison-Broninski (2005) and Fischer (2007), <http://www.rolemodelliers.com> and <http://www.human-interaction-management.info/> provide information about HIM.

4.1.10. Human Machine Interface (HMI)

Human Machine Interface (HMI) is a screen on which the state of every variable is monitored in an automation system. Liptak (2005), Lewins & Becker (1997), Chen (2002), Bühler & Knops (1999) and Rehtanz (2003) provide information about HMI and Gertz (1994) studied virtual laboratories and Ross & Burnett (2001) vehicle navigation systems.

4.1.11. Human Resource Management System (HRMS)

Human Resource Management System (HRMS) is based on the effective use of every individual and group for betterment in process. Poole (1999), Pieper (1990), Stahl (2006) provide information on HRMS and Sohal & Marriott (1993) studied HRMS in Australia, Jain (1991) and Sparrow & Budhwar (1996) India, Habir & Lasarati (1999) Indonesia, Yang (1994) Japan, Rowley (1998) Asia Pacific and Brewster (1994) Europe.

4.1.12. Integrated Business Planning (IBP)

Integrated Business Planning (IBP) is a process in which every function of the enterprise is included in order to obtain better results from the whole process more commonly by establishing estimations on the next year. That's why it is done in November and December generally.

Wang et al. (2007), Friday (2003) and Harborne (1999) give information about IBP and Targett et al. (1999) studied disaster recovery process, Ptak & Schragenheim (2000) introduced S&OP.

4.1.13. Model Driven Engineering (MDE)

Model Driven Engineering (MDE) is a way of developing software which is inspired by models and their creation processes. Melby (2007), Burmester (2006), Engels (2007), Alanen (2003), Stahlet al. (2006) and Gerard et al. (2005) provide information about MDE and Yang (1995) studied policy based MDE, Nguyen et al. (2006) web information system development, France & Rumpe (2007) tame complexity, Fernandes (2006) integration of DFD into UML, Ceri et al. (2007) active context awareness and White et al. (2008) Autonomic Computing.

4.1.14. Manufacturing Operations Management (MOM)

Manufacturing Operations Management (MOM) is a method of processing the aim of which is to optimize the process itself. Gifford (2007), Galloway (1996), Schroder (1989) and Thierauf & Hoctor (2006) provide information about MOM and Westbrook (1994) studied priority management.

4.1.15. OBASHI

OBASHI is an acronym which is used for explaining a methodology which helps the manager of the plant to visualize the workflow in the manufacturing process and consists of six layers i.e: Ownership, Business, Application, System, Hardware and Infrastructure. <http://www.stroma.eu/SOBASHI.asp>, <http://en.wikipedia.org/wiki/OBASHI>, provide information about OBASHI methodology.

4.1.16. Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is a sub-process of performance measurement of lean manufacturing systems. Hansen (2001), Productivity development team (1999), Hutchins (1998), Wireman (2004), Moore (2004), Nicholas & Soni (2006) and Mobley (2002) provide information about OEE and Ljungberg (1998) studied TPM activities, Dal et al. (2000) operational improvement, Bamber et al. (2003) cross-functional team, Gibbons (2006) Lean Six Sigma and Braglia et al. (2009) and Muchiri & Pintelon (2008) performance.

4.1.17. Project Management (PM)

Project Management (PM) is the use of every utilizable function in order to reach the planned objectives with the predicted budget and high performance. Kernzer (2005), Meredith et al. (2005), Lewis (2007), Heerkens (2001), Duncan (1996) and Lock (2007) provide information about project management and also Walker (1999) studied construction, Bryde (2003) performance, Eve (2007) development, Hillson (2003) capability, Bryde (1997) Total Quality Management (TQM).

4.1.18. Rapid Application Development (RAD)

Rapid Application Development (RAD) is another method of developing software in which recurring prototyping is done to obtain better products with faster developing stages. Martin (1991), McFarlane (2003), McMahan (2000), Sommerville (2007), Perry (2006), Hughes & Hughes (2000), Harbour (2002), Carmichael (1998), Zaninotto & Potencier (2007) and Tayntor (2007) provide information about RAD and also Howard (1997) studied system development, Tudhope (2001) commercial prototyping and Mnaouer et al. (2004) web services.

4.1.19. Sales and Operations Plan (S&OP)

Sales and Operations Plan (S&OP) is a method which tries to compromise the predicted level of production with the foreseen sales. Palmatier & Crum (2002), Langenwalter (2000), Wallace (2004), Sheldon (2006), Dougherty (2007), Gray (2007), Hanfield (2006), Hamilton (2002) provide information about S&OP and also Grimson & Pyke (2007) introduces a framework, Lapidé (2004) discusses enabling technology and Mello (2007) forecasting.

4.1.19. SOA

SOA is a way of software architecture consists of well-defined and loosely coupled components in order to support the harmonious work of business functions. Barry (2003), Erl (2004, 2005, 2007), Hurwitz et al. (2007), Marks & Bell (2006), Krafzig et al. (2004), Hasan (2004) and Lawler & Howell-Barber (2007) provide information on SOA and also Granebring & Revay (2007) studied decision support, Malatras et al. (2008) services integration, Kim & Lim (2007) telecom, Maurizio et al. (2007) EAI & SOA and Haller et al. (2005) WSMX.

4.1.20. TQM

TQM is a term for the sum of the techniques which take the applier to a proper product or service standart if fulfilled properly. Besterfield (2002), Hakes (1991), Oakland (2003), Gummer & McCallion (1995), Williams (1994), Kani & Asher (1996), Melum & Sinioris (1992) and Carr & Littman (1993) provide wide information about TQM and also Brown (1994) studied work study, Leonard & McAdam (2002) implementation, Lewis (1991) and Svensson (2005) leadership, Smith (1990) quality, Kumar (2008) performance, Gunasekaran & McGaughey (2003) supply chain, Seddon & Jackson (1990) culture and Chapman & Al-Kwaldeh (2002) labour productivity.

4.2. Production Method

4.2.1. Lean Manufacturing

Lean Manufacturing is a production method which is originated from Toyota Production Flow. It is basically using less by means of resources and obtaining more by means of product. Feld (2000), Carreira (2005), Hobbs (2003), Bozzone (2002), Conner (2001), Black & Hunter (2003) and Dennis & Shook (2002) provide information about lean manufacturing and Barker (1994) studied design, Sullivan (2002) equipment replacement, Lee-Mortimer (2006) planning, Worley & Doolen (2006) communication and management support, Comm & Mathaisel (2005) and Taj (2008) China implementation, Wu (2003) supplier, Bicheno et al. (1997) dimensions, James-Moore & Gibbons (1997) awareness of the concept.

4.2.2. Group Technology (GT)

Group Technology (GT) is a way of production which aims to combine the cells for more effective use of machinery. Nolen (1989), Wild (2002), Suresh & Kay (1998), Snead (1989), Ham et al. (1985), Kamrani & Logendran (1998), Suri (1998), Ayres (1991), Koenig (1990) and Shah & Mäntylä (1995) provide information on GT. Also Burbidge (1991) studied production flow analysis, Selim et al. (1998) cell formation, Lee (1987) management, Santos & Araújo (2003) computational system, Dale (1984) planning, Lee (1984) productivity,

Cheng (1995) design, Chevalier (1984) CAD/CAM integration, Al-Salti & Statham (1994) application and Kamel (1994) machine assignment.

4.2.3. Material Requirements Planning (MRP)

Material Requirements Planning (MRP) is the act of defining the required quantity of materials via using software. Primarily Orlicky (1975) and Hitomi (1996), Krajewski & Ritzman (1993), Kalakota & Robinson (2000), Chase et al. (2000), Monks (1995), Childe (1997), Lysons et al. (2005), Shim & Siegel (1999) and Anderson (1981) provide information on MRP. Also Wacker (1985) studied reducing uncertainty, Pandey et al. (2000) planning, Aghazageh (2003) profitability, Krueger et al. (1992) training, Koh et al. (2000), measuring uncertainties, Shah (1991) optimum order cycles, Petroni (2002) SMEs, Burns et al. (1991) success factors, Bareket (1991) lead times and Kumar & Meade (2002) literature review.

4.2.4. Manufacturing Resource Planning (MRP II)

Manufacturing Resource Planning (MRP II) is an extended version of MRP with the estimation of financial and operational effects. Sheikh (2002), Wight (1984,1995), Drexl & Kimms (1998), Wallace (1990), Rufe(2001), Timings (2000), Toomey (1996), Martin (2007) and Brown (2005) provide information about MRPII. Also Luscombe (1994) studied customer- focused MRPII, Ip et al. (2000) maintenance, Robertson (1996) adoption of MRPII, Aldridge & Betts(1995) flexibility and Barker (1994) scheduling.

4.2.5. E Enterprise Resource Planning (ERP)

Enterprise Resource Planning (ERP) is an extended version of MRPII with the integration of enterprise-wide operations into planning process. O'Leary (2000, 2002), Harwood (2003), Wallace & Kremzar (2001), Ptak & Schragenheim (2003), Shields (2001), Hossain et al. (2002), Sumner et al. (2007), Callaway (1999) and Ferran & Salim (2008) provide information about ERP and Payne (2002) studied benefits of ERP, Willis & Willis-Brown (2002) and Elbertsen et al. (2006) process, Ho (2004) adaptation, Xu et al. (2002) data quality, Huang & Palvia (2001) application in developed and developing countries, Umble (2003), Rao (2000) and Mashari et al. (2003) implementation and Poston & Grabski (2001) financial issues.

4.2.6. Manufacturing Process Management (MPM)

Manufacturing Process Management (MPM) represents the sum of work being done between design and marketing phases. Zülch (2004), Prabhu (2003) and Stark (2004) provide information and Antony (2001) studied quality, Yokotani (1999), Curcio (2007) and Fortin & Huet (2007) develop MPM systems, Chong (1997) claims to represent best practice cases.

4.2.7. Just In Time (JIT)

Just In Time (JIT) is a production method which aims to provide right sum of material, in the right time and in the right place. Waters (1999), Greasley (1999), Shim (2000), Rufe (2001), Dennis & Shook (2007), Propenko (1987), Hirano (1988), Viale (1996) and Petroff (1993) provide information on JIT. Golhar & Stamm (1991) introduced a literature review, Voss & Robinson (1987) studied in UK, Giunipero (2005) purchasing, Kazazi (1994) effectiveness and Green & Inman (2007) introduces JIT II.

4.2.8. Flexible Manufacturing System (FMS)

Opposite to the traditional production methods Flexible Manufacturing System (FMS) gives the opportunity to produce different types of products in the same line with the necessary arrangements to the workflow. Tempelmeier & Kuhn (1993), Miltenburg, (2005) Raouf & Ahmad (1985) and Talavage & Hannam (1988) provide information about FMS and Shang & Sueyoshi (1995) and Stam & Kuula (1991) studied selection of FMS, Jeong & Kim (1998) scheduling mechanism, Co (1990) process problems, Stylianides (1995) programming, Goyal et al. (1995) and Lee & Cheng (1996) scheduling, Lau & Mak (2004) design, Macbeth (1985) management, Lim (1987) flexibility in UK and Stockton & Bateman (1995) and Ranky (1981) performance.

4.3. Technology

4.3.1. Numerical control (NC)

Numerical control is a kind of machinery which is being operated by commands which are encoded beforehand via numeric cards. Later on this system is developed by putting Open Numeric Controls (ONC).Reintjes

(1991), Childs (1982), Patton (1972), Wilson (1972), Massey (2003), Leone (1967), Vhalos (1968) and Hatvany (1973) provides information on NC. Also Baek et al. (2006) studied chip volume prediction, Hansson (1974) industrial robot, Poh (1984) application in Singapore, Dunning et al. (1993) stitching machines, Tarnig & Shyur (1995) modelling and Drysdale (1989) simulation.

4.3.2. Direct Numerical Control (DNC)

Direct Numerical Control (DNC) is the improved type of ONC by computing the machinery with computer commands. Talavage & Hannam (1988), Liu et al. (2005), Piercy (1984), Jawitz (1997), Preece (1995), Groover (2007) provide information about DNC.

4.3.3. Computer Numerical Control (CNC)

Computer Numerical Control (CNC) is the use of machinery which are conducted by computers by using g-codes. Seames (2002), Lynch (1992, 1994), Krar et al. (2000), Luggen (1996), Sava et al. (1990), Nanfara et al. (2001), Mattson (2002), Valentino & Goldberg (2002), Amic (1996), Curran & Stenerson (2001), Lin (1994), Queasada (2005) and Evans et al. (1992) provide information about CNC. Also Onwubolu et al. (2002) studied drilling machine, Sun (2002), data envelopment analysis, Yeung (2003) intelligent process planning, Zhou et al (2005) failure model, Auer (1974) robotics, Wang (1999) failure database, Adams (1990) aerospace, Rubenowitz et al. (1990) management, Fireman (1991) lead time.

4.3.4. Computer-Integrated Manufacturing (CIM)

Computer-Integrated Manufacturing (CIM) is the way of production in all processes of which new managerial philosophies are combined with computer operations. The origins of the system goes back to 1980s. There are many subsystems included in CIM such as; CAD/CAM, CAPP, ERP, CNC,DNC etc. Groover (2007), Rehg et al. (2004), Ayres (1991), Adelsberger et al. (1995), Ranky (1986), Rembold et al. (1993), Boaden & Dale (1986), Weatherall (1988) and Melnyk & Narasimhan (1991) provide information about the methodology of CIM. Also Shaw (1987) studied networks, Sanvido & Medeiros (1990) construction, Beeckman (1989) open system architecture, Chui (1999) rapid prototyping, Kathawala (1992) macro effects of CIM, Forrester (1995) CIMple system, Caputo et al. (1998), Marri (2003) CIM in SMEs, Milling (1997) Germany, Sohal (2000) Australia, Hardaker & Ahmed (1995) perspectives from Europe and Japan.

4.3.5. Distributed Control System (DCS)

Distributed Control System (DCS) is a way of controlling the plant by seperating the system into parts and controlling the parts both individually and holistically by the use of a network. Borer (1991),Gini (2002), Johnson & Jennings (2006), Clarke et al. (2004), Zelkowitz (1999), Groover (2007), Lukas (1986), Winick (1995) and Antunes (2008) provide information about DCS. Also Luntz & Messner (1997) studied flexible materials handling, Sýs et al. (1993) fermentation experiments, Lian et al. (2002) and Lewis (1997) design, Tomura et al. (2001) simulation models, Baasel (1976) plant design, Mahalik (2003) fieldbus technology, Loukianov (2004) robotics.

4.3.6. Programmable Logic Controller (PLC)

Programmable Logic Controller (PLC) is a computer which operates the whole factory lay-out. Bolton (2006), Rohner (1996), Swainson (1992), Carrow (1998), Phipps (1998), Baukal et al.(2001), Rexford & Giuliani (2003), Huntington (2000) and Lea et al. (2008) provide information on PLC and also Plaza & Medrano (2007) studied implementation, Prendergast & Barrett (2006) education, Hajarnavis & Young (2008) automotive, and Kaminski & Rink (1984) distribution and marketing.

4.3.7. COTS

COTS is a term which is used for products (generally computer software and hardware) which are ready to be marketed. Kazman & Port (2004), Meyers & Oberndorf (2001), Beydada (2005) and Tipton & Krause (2006) provide information about COTS. Also Bergbreiter & Pister (2003) studied robotics, Farr & Verma (2002) training, Jiang et al. (2006) aerospace, Capretz (2008) software, Brownsword (2000) process and Egyed & Balzer (2006) integration of COTS.

4.3.8. Cellular Manufacturing System (CMS)

Cellular Manufacturing System (CMS) is a way of plant lay-out which aims to achieve peak efficiency rates with minimum residual. A well designed cellular plant can keep up with the change in the market than the

fixed manufacturing systems. The entire process becomes easier to control and more stable and as a result it flourishes the productivity. Irani (1999), Suresh & Kay (1998), Brandon (2003), Hyer & Wemmerlöw (2002), Fraser (2007) and Shambu et al. (1996) provide information about CMS. Also Samaddar & Rai (1992) studied data resource management, Mubarak (2003) focused cellular manufacturing, Kannan, & Ghosh (1996) CMS using virtual cells, Jamal (1993) neutral Network and CMS, Kumar & Hadjinicola (1993) champion irrigation products, Onwubolu (1998) redesigning jobshops, Wemmerl & Hyer (1989) CMS in US industry, Vakharia & Wemmerlov (1990), Singh (1993), Choobineh (1988) design of CMS, , Heragu (1994) GT and CMS, Ghosh (1990) equipment investment decision analysis in CMS, Balakrishnan & Cheng (2005) dynamic CMS, Ang (2000) handling exceptional elements in CMS, Shambu et al. (1996) performance evaluation of CMS.

4.3.9. Computer Aided Design (CAD)

After the use of first graphic system in mid 1950 by the US Army, Dr. Patrick J. Hanratty who is also known as "the father of CAD/CAM" developed PRONTO, the first commercial numerical-control programming system in this category in 1957. In 1960, Ivan Sutherland used TX-2 computer and this is considered the first step to CAD industry. During the phase of development in 1970s General Motors used the first DAC (Design Automated by Computer) and today CAD is being used in every field of the area which covers design varying from aerospace to diapers.

Computer Aided Design (CAD) is to use computer systems in order to design the good which is being produced or to be produced soon. This good can vary from a very small micro-chip to large apartment buildings. With the usage of CAD designers and engineers also architects, etc. can make their designs on the computer. By doing so they can make necessary changes faster and more accurately. After finishing the design they can install the whole system together and check whether it will work or not. Ingham(1990), Stark(1986), Krouse(1982), Encarnação & Schlechtendahl(1983), Hunt & Johnson (2000), Kloos & Pardo(2004), and Besant (1983) give wide range of information on CAD. Zhu & Chen(2000) studied CAD of communication networks. Shah(1993) researched design of electronic circuits and CAD, Kloos & Pardo(2004) CAD in education, Lowther & Silvester(1986) in magnetics, Zandi(1985) in drafting, Janardan et al.(2003) in Geometric and Algorithmic Aspects of CAD, Onstott(2006) studied enhancing CAD drawings with photoshop. Dimitriou & Antoniadis(2008) worked on CAD in spur and helical gears, Okamoto et al.(2003) healthcare products, Nahm & Ishikawa (2006) a new system for set-based parametric design, Choi et al.(2006) a web based measurement system, Ou-Yang & Liu (1999) application, Leibrecht (2005) ecological assesment, Masood & Lau (1997) machining, Beaumont et al.(2007) elementary function identity, ElKott & Veldhuis (2007) CAD based sampling, Álvares et al. (2008) a CAD/CAM/CAPP system, - Zhang et al(2003) an interface between CAD and rapid prototyping systems.

4.3.10. Computer Aided Manufacturing (CAM)

Computer Aided Manufacturing (CAM) is the use of software in manufacturing processes. The first commercial use of CAM was in 1970s by Renault for car body design. With the usage of CNC tools CAM is being used to materialize the outputs of CAD. Chang et al. (1997), Cornelius (2000), Krouse (1982), Pressman & Williams (1977), Leondes (2001) and Hordeski (1985) give broad information about CAM. Mitter & Luiken (1992) focuses on women employment in CAM. Bone (2001) investigates the opportunities in CAD and CAM. Lerner (1981) runs CAM applications. Edwards (1989) researches the impact of CAM on work.

4.3.11. Computer-Aided Quality Assurance (CAQ)

Computer-Aided Quality Assurance (CAQ) is the use of computer integrated systems for quality check. It enables the enterprise to act concurrently in quality assurance. When compared with non-computer aided quality assurance systems CAQ systems are economic because it is free from error, tirement and illnesses. CAQ process includes; attribute charts, vendor rates, inspection of goods, equipment management and documentation. Wigand et al. (2003), Mittag & Rinne (1993) and Werner (2008) provide wide information about CAQ. Wagner & Schneider (1992) studied CAQ in oral heath care. Innala & Torvinen (2000) discusses the most common types of CAQ systems. Mbang & Hasis (2004) studies CAQ in car body engineering. Kollar et al. (1999) studied CAQ in horticulture and food industries.

4.3.12. Computer Aided Production Engineering (CAPE)

Computer Aided Production Engineering (CAPE) is accepted as a novel type of computer aided systems which is stipulated to enrich the productivity of manufacturing systems. The implications of CAPE starts in 1990s.

With a glance in literature one can see that research and theoretical thinking is still being done by conferences and symposiums. McGeough et al. (2001), Puigjaner & Heyen (2006) and Robson & McLaren (1991) provide information about CAPE.

4.3.13. Computer Aided Process Planning (CAPP)

Computer Aided Process Planning (CAPP) is the automation of the methods, standards, and planning function of manufacturing engineering (Koenig 1990). Basically CAPP is the use of automation in planning the production process. It is done by combining the whole processes which are required for effective workflow such as Group Technology (GT), graphical description of elements, producer's database and various algorithms. Koenig (1990), Walker (1996), Edosomwan (1991), Wang & Li (1991), Rufe (2001), Alting & Zhang (1989) and Leondes (2000) provide information about CAPP. Cho et al. (1994) presents a formal approach to integrate CAPP to shopfloor control. Lutters et al. (2000) studies CAPP for sheet metal based on information management. Steudel (1984) discusses the future of CAPP.

4.3.14. Automated Storage and Retrieval Systems (AS/RS)

Automated Storage and Retrieval Systems (AS/RS) is a term which arose in 1950s in USA. This is basically as can be derived from its name has automated parts which can easily do classification, sorting, put-away, storage, order-picking, staging and loading of goods. Especially in libraries and warehouses this system is being used effectively for many years. With a glance in literature one can see that Gervasi (2005), Tompkins & Smith (1998) and MacConeill (2007) provide wide information about the system. Also Eynan & Rosenblatt (1994) studied establishing zones in single-command class-based rectangular AS/RS. Halsam et. al. (2002) investigated the usage of AS/RS in library.

4.3.15. Information Retrieval System (IRS)

Information Retrieval System (IRS) is a method used to utilize any kind of information effectively in production and management systems. Kowalski & Maybury (2000), Baeza-Yates (1999), Grossman & Frieder (2004), Crestani (1998), Korfhage (1997), Manning (2008), Zhang (2008), Chowdhury (2004) provide general information about IR. Hersh (2003) examines health and biomedical, Ellis (1999) system design and Libutti et al. (1995) education.

4.3.16. Automatic Guided Vehicle (AGV)

The Automated Guided Vehicle or Automatic Guided Vehicle (AGV) is a mobile device used in industrial applications to move materials around a manufacturing facility or a warehouse. The first AGV was installed by the Cravens Company at Mercury Motor Express in Columbia, SC in 1954. Koenig (1990) provides a definition of AGV, Castleberry (1991) gives features of AGV. Hammond (1986) presents system components and he also discusses why to use AGVs in his second chapter. Mulcahy (1994) offers various AGV control methods. Rooks (2001) exemplifies a fully automated package. Cheng (1987) presents a simulation study to investigate the effects of different AGV dispatching rules on performance of a FMS. Hollingum (1998) introduces an inductive system for Smartcart AGVs. Lee (1993) studies AGV in CMS. Buyurgan et al. (2007) studies real-time routing for AGVs.

4.3.17. Supervisory Control And Data Acquisition (SCADA)

Supervisory Control And Data Acquisition (SCADA) is a system which is used for monitoring and computing the production process. Clarke et al. (2004), Boyer (1999), Shaw (2006), Mohitpour (2004), McDonald (2003), Northcote-Green & Wilson (2006), Lewis (2006), Jajodia (2008), Strauss (2003) and Capehart (2007) provide information about SCADA and also Greeves (1994) studied radio telemetry, Ip et al. (2000) maintenance, Patel & Sanyal (2008) securing SCADA, Qiu & Gooi (2000) and Medida et al. (1998) internet, Daneels & Salter (1999) description and Cern LHC experiment,

4.3.18. Robotics

Robotics is the use of fully automated robots in production processes. Craig (2004), Lovine (2004), Domaine (2005), Gura & King (2007), Sukhatme et al. (2007) and Selig (2005) provide wide information on Robotics. Also Engelberger (1979) and Wilson (1997) studied robotics in UK, Monkman (1994) in Finland, Pelerin (1991) the future of robotics, Ranky (2004) automotive, Kim & Kleiner (1990) investment decisions on Robotics, Virk et al. (2004) mobile robotics, Kusuda (2005) Japanese robotics, Çavusoglu et al. (2003) robotics for telesurgery, Wallin (1993) food industry, Robinson (1996), Taylor (1996) education, Shim &

Kumar (2005) market segments, Shirinzadeh (1996) robotics in South East Asia, Bernhardt et al. (1992) robotics in CIM.

4.4 Suggested AMT Publications

Researchers and also appliers of AMT can make use of these 10 books in their studies.

- ✓ Gerwin, D. & Kolodny, H., 1992, *Management of Advanced Manufacturing Technology: Strategy, Organization, and Innovation*, Wiley
- ✓ Dorf, R.C. & Kusiak, A., 1994, *Handbook of Design, Manufacturing, and Automation*, Wiley-IEEE
- ✓ Matta, A. & Semeraro, Q., 2005, *Design of Advanced Manufacturing Systems: Models for Capacity Planning in Advanced Manufacturing Systems*, Springer
- ✓ Karwowski, W. & Salvendy, G., 1994, *Organization and Management of Advanced Manufacturing: A Human Factors Perspective*, Wiley-IEEE
- ✓ Timings, R.L., 2003, *E-manufacture: Application of Advanced Technology to Manufacturing Processes*, Pearson/Prentice Hall
- ✓ Wall, T.D. et al., 1987, *The Human Side of Advanced Manufacturing Technology*, Wiley
- ✓ Abdel-Kader, M.G. & Dugdale, D., 1996, *Investment Decisions in Advanced Manufacturing Technology*, Bristol Business School, University of the West of England
- ✓ Allegri, T.H., 1989, *Advanced Manufacturing Technology*, Tab Professional and Reference Books
- ✓ Bessant, J.R., 1991, *Managing Advanced Manufacturing Technology: The Challenge of the Fifth Wave*, NCC Blackwell
- ✓ Groover, M. P., 2007, *Automation, Production Systems, and Computer-integrated manufacturing*, Pearson Education Inc. New Jersey

5. CONCLUSION

The need to produce in a better way is becoming more and more important in our day. The more an enterprise manufactures, more with less expense with less errors and less effort the more it gets close to the advantage of competing not only in the domestic but also in the international arena. This study aimed to provide a literature review about AMT for the researchers and practitioners of AMT. Therefore we began with the resources of AMT. Then we proceeded with the history of AMT. Later on we included information about the sub-titles of AMT and also their sub-titles. Lastly we suggested 10 AMT publications those of which we used more frequently from the others while doing the research. It is hoped that anybody who is about to study any of the titles included in this study can make use of this paper.

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