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A Review of Developments in Web Based Manufacturing

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Abstract:- Deeming the befall changes in market needs, virtual production management will produce immense complementary appraisal for manufacturers. Customer needs for ultimate products are very unforeseeable due to rapid changing environmental conditions and technologies. A significant change in the environment of industrial firms is the propagation of internet technologies in production processes. As scheduling of shop floor operations is a topical and partial decision in enterprises, the distributed local scheduling problems should be unified at the enterprise level. Since decisions at the shop floor are very valuable, the subsequent generation of production management will be performed as a decentralized system. Collaborative agents for production planning and scheduling and web based manufacturing systems have been developed in the past decennary. Web based systems are developed for collaborating activities in different life cycle phases of product development such as design, process planning, production, distribution, service, marketing etc. These distributed product development lifecycle activities are associated into a globally integrated environment using internet as well as web technologies. In order to survive in a rival market, manufacturers should make their parts or products with lower costs and shorter delivery time as well as higher grade specification. Manufacturing Execution System provides real time information about the shop floor to management in order to take appropriate decisions.

Keywords:- Web Based Manufacturing, Collaboration, Product Life Cycle, Collaborative Agents, Scheduling, Manufacturing Execution System.

I. INTRODUCTION

Web based systems have been developed in the past decennary for sustaining collaborative activities in different life cycle phases of product development. It comprises of marketing, design, process planning, production, distribution, service, etc., and associating these distributed product development life-cycle activities into a globally integrated environment using internet as well as web technologies [26, 27, 50].

In the past, having a better design or manufacturing process was often the key to a company's welfare. Now days, quality practices and quality products are assumed; the determining factor is shifting toward other aspects of manufacturing agility, lean manufacturing practices, information management, and effective use of the supply chain. The book ''A Stitch in Time'' chronicles how the American apparel industry managed to exploit information technology in order to survive against low cost competition [11].

II. LITERATURE SURVEY

Data model is used for collaboration among different product development partners at different locations developed Cyber View system [28]. Cyber View system was developed to model the geometry of a same product using web browsers for different designers at different locations. Next Cyber Eye system was introduced. This Cyber Eye system incorporates the technologies of HTML, ASP, JAVA, COM and ODBC in the development of a platform for collaborative product design. The concept of People and information Finder (PIF) was introduced by [29] to gather information about projects using web browsers and people in order to maintain communication among team members of the project.

A Representational State Transfer (REST) based web service and Web 2.0 technologies driven into platform for collaboration product development (WCPD) [30].The WCPD aims to consolidate the once fragmental world of customized product development into more efficient platform of collaboration 2.0, enabling products to be sourced and built more easily, quickly, inexpensive and at higher quality levels. Users create their own profile to network with peers, build their reputation, promote their company, find collaborators & buy and sell products. The WCPD serves as an effective platform for firms to integrate their core competencies and to develop customized products collaboratively in rapid responding to customer requirements. The sharability, reusability and interoperability of the WCPD are realized by adopting Java/J2EE solutions, AJAX, X3D and REST based web service technologies.

Collaborative Manufacturing Management (CMM) is the rostrum and supporting environment. It proposes efficacious solution and ideas for implementations. Such as sharing of resources, collaborative working and even in realizing the integration of whole life cycle of products [51].

Product development software systems, such as CAD, CAM, database management, intelligent knowledge based, etc as shown in **Fig.1** are integrated through web technologies, into these web based collaboration systems [31]. Multi-criteria decision making problem is made for identifying possible manufacturing processes, materials, their combinations, ranking etc using the fuzzy decision support scheme. The concept of concurrent collaborative manufacturing is used successfully in Micro Electro Mechanical Systems (MEMS).

In recognizing the running sessions of the interlinked WebPages of tutorials and reference pages to explain the fabrication processes and material choices and interactive knowledge base that can be updated and maintained via internet.

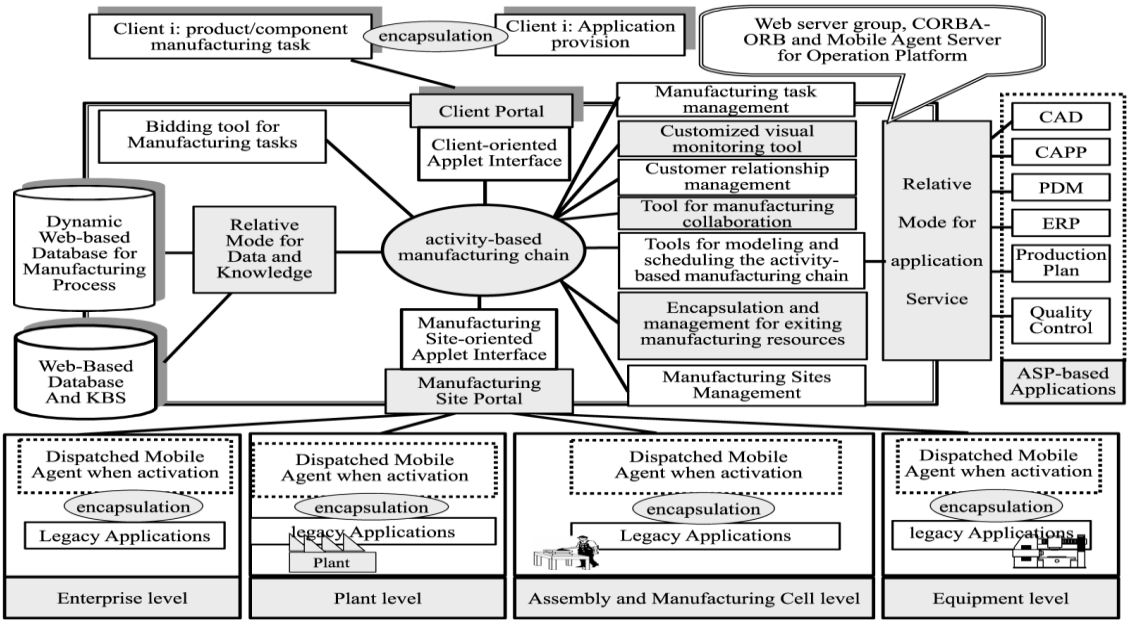

Fig.1: Web Based Manufacturing System [62].

The world of wilful national and international normative standards has also been evolving in the presence of the growth of the Internet and the widespread use of computers in personal and business life. Earlier these standards were in the form of protocols. With the help of protocols such as Carrier Sense Multiple Access (CSMA/CD), even the access to the network is managed by the use of a control token and the CSMA/CD protocol. Some protocols are used for moving information around, such as the ASCII standard [59] for encoding letters and symbols used by teletype machines, or even the pervasive TCP/IP networking protocol standard that drives the Internet itself[5,54].

These standard characteristics concentrate on the way in which information is to be encoded (the syntax) and only marginally describe the nature of the information being standardized (the content).Manufacturing Automation Protocols (MAP) was developed for General Motors factory communication, Manufacturing Message Service (MMS) was developed to enable a computer to control distributed devices and MMS aims at interaction of manufacturing resources.

Specifications of the International Organization for Standardization (ISO) standards are typically highly structured texts intended for a human reader. Increasingly, the kinds of information structures being standardized today are much more complex than they were a decade ago. Syntactic specifications have begun to be defined in a computer readable form such as the Express language7 or XML.8 ISO 10303,informally known as the Standard for the Exchange of Product Model Data, is a specification that describes how computer based design information is to be shipped from one computer aided design (CAD) system to another [5, 8, 11, 54].

This kind of standard distinguishes between the information model that describes the information content and the encoding mechanism that specifies the syntax. In doing this, the need for rigorous definitions of terms has become even more apparent, since the intended producers and consumers of the information are computer programs. Thus, it is becoming clear that information standards in the future will need two additional components: unambiguous definitions of terms, and a rigorous, computer readable means of stating these definitions.

Teams of researchers are tackling these new requirements in the form of definition languages such as the Resource Description Framework (RDF) proposed by the World Wide Web Consortium (W3C) and the DARPA Agent Mark-up Language DAML [55] + the Object Interchange Layer (OIL) [60], sometimes referred to as DAMLOIL.

In ‘‘weaving the Web, Tim Berners-Lee speaks of a dream for the Web’’: ‘‘in the first part, the Web becomes a much more powerful means for collaboration between people. In the second part, collaborations extend to computers [8]. A ‘Semantic Web ‘emerged to make this possible, so that the day to day mechanisms of trade and our daily lives will be handled by machines talking to machines, leaving humans to provide the inspiration and intuition. And on the other side, others are working on standardizing the definitions themselves, such as the Standard Upper Ontology work [47]. Concept of semantic web services, similarity matchmaking fuzzy set material selection was proposed, which accentuates on the process of reusing existing WSDL specified services for building web based applications [16]. Since Universal Description, Discovery and Integration (UDDI) is insufficient so semantic web technology concept was introduced to relieve the publication, discovery etc.

The communication methods such as Synchronous and Asynchronous were developed [32], where in Synchronous communication allows more than one designer to access the same product database simultaneously. If any change is made by a designer in the product database, that change is then propagated to the system used by other designers instantaneously. Well on the other hand, Asynchronous communication allows different designers to conduct different design activities independently i.e. the change made in one location by a designer will not be updated in other location. An asynchronous collaborative system has been presented in [33], called Immersive Discussion Tool (IDT), which emphasizes on the elaboration and transformations of a problem space and underlines the role that unstructured verbal communication and graphic communication can play in design processes.

A prototypical system called cPAD has been developed in [34,35] that enables designers to visualize product assembly models and perform real time geometric modifications, based on polygonized representations of assembly models. The Detailed Virtual Design System (DVDS) for shape modelling in a multi modal, multi sensory Virtual Environment (VE) has been presented in [52], enabling collaborative design and design among multiple designers both in the same site and in remote site virtual environments. An Internet based virtual reality collaborative environment called Virtual-based Collaborative Environment (VRCE) developed with the use of Vnet, Java and VRML [36], demonstrates the feasibility of collaborative design for small to medium size companies that focus on a narrow range of low cost products.

A web enabled Product Data Management (PDM) system which facilitates various collaborative design activities providing also 3D visualization capabilities was developed [37]. Another tool for dynamic data sharing in collaborative design has been developed in [38], ensuring that experts may use it as a common space to define and share design entities. A web based collaborative product design platform for dispersed network manufacturing has been proposed in [39]. This platform enables authorized users in geographically different locations to have access to the company’s product data, such as product drawing files stored at designated servers and to carry out product design work simultaneously and collaboratively on any operating systems. Most collaborative tools are more related to a Product Development Lifecycle Management as shown in **Fig.2**.

Fig.2: Product Development Life Cycle.

Now days the industrial environment is challenged with the need to provide timely and effective decisions regarding its operations based on workshop data and other business information. The greater challenge is to select proper, appropriate technologies that meet the required needs, increase the productivity, and successfully integrate with the existing technologies and personnel. The development of advanced technologies led to emergence of collaborative manufacturing management, based on collaborative manufacturing network and the concept of cellular manufacturing system (CMS) [51].

In Korea, more than 900 manufacturing companies are using web based collaboration systems developed by the government led project, referred to as i-manufacturing. The system supports some similar functions of Product Data Management (PDM) as well as Project Management System (PMS). A web based collaboration system provides many useful functions for collaborative works. This system, however, does not support new linking services between buyers and suppliers. Therefore, in order to find new collaborative partners, a new framework was developed; this framework creates new connections between buyers and suppliers facilitating their collaboration, referred to as Excellent Manufacturer Scouting System (EMSS). EMSS acts as a bridge between overseas buyers and suppliers [25]. EMSS connects buyers to suppliers by two phases: discovery and scouting. Using ontology concept enables EMSS to discover suppliers who buyers want. During the discovery phase, EMSS chooses several suppliers based on the buyer's preference. In other words, EMSS extracts candidate companies for buyers.

Then EMSS recommends potential suppliers to the buyer according to the rank given by using the assessment method proposed in the scouting phase.

Most information on the Web is simply text for people to read. That's great for people, and even for B2C (business-to-consumer) electronic commerce activities such as browsing catalogs of goods. But the real revolution that's underway is in B2B (business-to-business) commerce [11]. Furthermore, the true impact will take place when computers transact business with other computers. They will be communicating about carefully defined things, and they will not tolerate ambiguity as to what the terms of a contract are. However, before this can take place, there are a few pieces of technology missing.

MES (Manufacturing Execution Systems) solutions provide real time information about what is happening in the shop floor, for managers (under a strategic approach), and for direct operation workers (under a purely operative approach) as shown in **Fig.3 [61]**. It is also an information bridge between Planning Systems used in Strategic Production Management (such as Enterprise Resource Planning - ERP) and Manufacturing Floor Control Supervisory Control and Data Acquisition (SCADA). It links the Manufacturing Information Systems layers (Strategic Planning and Direct Execution) through the adequate online managing and control of updated information related with the basic enterprise resources: people, inventory and equipment [9].

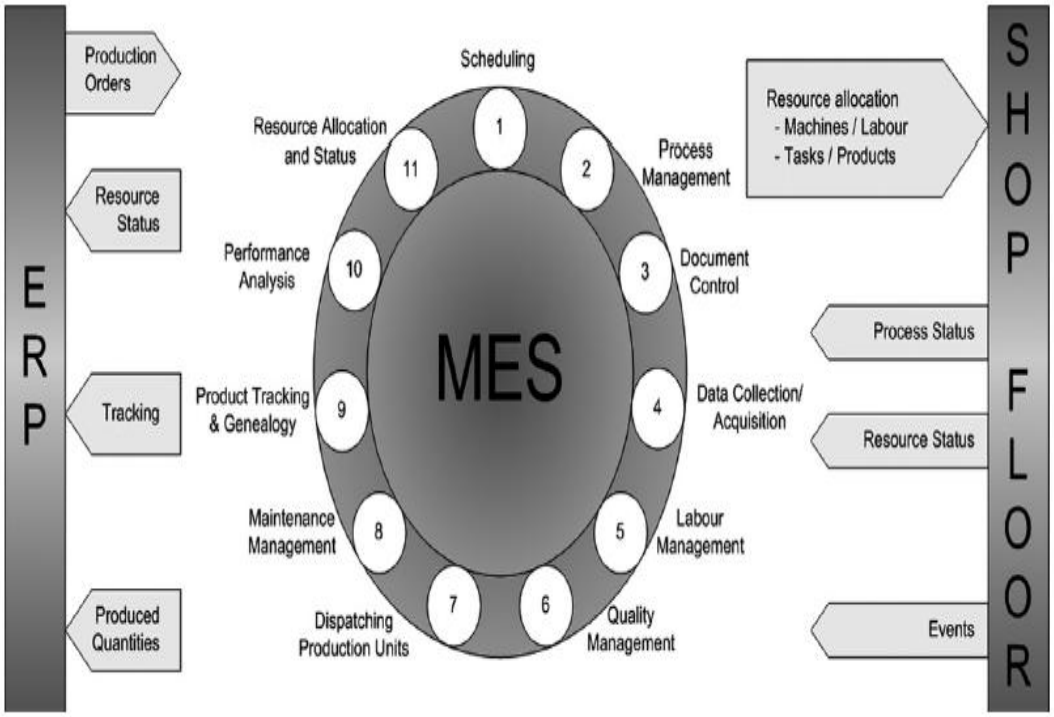

Fig.3: Manufacturing Execution System [61].

III. QUALITIES OF WEB BASED MANUFACTURING

Several qualities of Web based Manufacturing (WBM) are discussed as follows:

- WBM using the application of internet technologies accomplish new qualities of the production system such as easy reconfigurability
- WBM indicates no electronic production; instead it focuses on the physical production of goods.
- WBM points both on operational and strategic goals.
- WBM concentrates on internal production processes.
- WBM will not concentrate on dislocated processes between companies.
- WBM considers both technological tasks and functions e.g. business administration tasks and functions.
- WBM enables an interconnection between decentralized production units or the production networks and virtual organization using the application of Internet Technologies.

IV. OVERALL ISSUES

- Conflict resolution and reasoning strategies.
- Identifying suitable architecture for CNC systems.
- Manipulation of Information.
- Lack of interoperability between systems, with several standards competing for managing data [56].
- Life cycle issues are not well understood i.e. modelling and planning do not effectively take all life cycle aspects in to consideration; such as end of life disposal, operation, maintenance issues are given limited concentration in project planning equation.
- Greater degree of man machine computer interface.
- Handling of intra department and inter departmental information.
- The business foundation for addressing increased security concerns does not exist.
- Establishing a decision making system for import/export of data in heterogeneous environment.
- The ability to assess uncertainties, impact of failures is not mature due to limited availability of tools.
- Collaboration among product development partners [53].
- Limited set of parameters are optimized in design and program plans in a limited domain.
- Using of proper and appropriate common data model for collaboration.

A. Challenging Research Issues:

1) Interoperability in Manufacturing Systems

Integration of information and manufacturing systems is one of the great achievements of Enterprise Modelling.

However, new factors, such as the fast evolution of Information and Communication Technologies (ICT) or the need to set up alliances among different types of enterprises quickly in order to benefit from market opportunities, are causing new types of problems, like interoperability, to appear in the Enterprise Modelling context. A detailed definition of a UML Profile for model transformation between Extended Actigram into UML Activity Diagram is proposed, in order to deal with interoperability problems. Which arise in collaborative enterprises at the Enterprise Modelling level when they try to follow a model driven approach [4].

The final objective of performing this profile is to achieve a Model Driven Interoperability solution that can start out from enterprise models and guide enterprises to obtain Enterprise Software Applications. One of the main advantages of the approach based on UML Profiles is that it provides enterprises with a common solution to model and use their own business domain in a model- driven way, which takes interoperability into account. Moreover, in this paper we provide some other approaches that could be followed if the model transformation tools do not provide facilities for applying UML Profiles.

A widely recognized model for information systems interoperability is, Levels of Information Systems Interoperability (LISI) [40]. LISI focuses on the increasing levels of sophistication of systems interoperability (Isolated systems, connected interoperability in a peer-to-peer environment, Functional interoperability in a distributed environment, Domain based interoperability in an integrated environment; Enterprise based interoperability) in a universal environment. LISI focuses on technical interoperability and the complexity of interoperations between systems.

2) Framework Interoperability:

Framework interoperability is also an important and critical issue in system integration. Usually Data interoperability focuses on common data models or formats. While Frameworks interoperability depends on communication language and protocols. Data interoperability is suitable for centralized integration approach, while Framework interoperability is suitable in highly distributed, loosely coupled integration approach, using different data models or formats [56] .Combination of Data interoperability and Framework interoperability is used when two different sensor networks need to work together.

V. SYSTEMS INTEGRATION APPROACH

B. Web Based Systems

The World Wide Web [53] was originally developed to share and access the information distributed at different locations .The information is shared and gathered using the web tool (web browsers). The web technologies are incorporated in manufacturing field to associate various product development activities such as planning, designing, production, customer service etc. A web based system uses a centralized information integration approach through a shared web server. With the concept of integration and collaboration, the productivity can be increased by means of increasing product quality and reducing the product lead time. Information access is not only the main criteria i.e. web servers should not act as repositories of information; even the system should concentrate to engage users in active dialogs.

C. Distributed Object

The object oriented programming emphasizes programming efficiency and centralized integration approach. It is widely used in implementation of integrated systems specially and in the development and deployment of Distributed Objects standards such as: COBRA by the object management group (OMG), COM/DCOM by Microsoft and Java RMI. The advantages of using distributed object manufacturing are:

- Huge pool of manufacturing resources available online.
- Monitoring of production.
- Making layered manufacturing available to small designers.
- Locating a manufacturing resource that will best meet the user needs.
- Easily extending manufacturing resources.
- Removing the complexity of using layered manufacturing hardware with the aid of the processing server.

D. Software Agents

The software agent technology was applied to systems integration and collaboration before the web became available [7]. The agent technology was best used in industrial applications [6]. Agents are best suited for applications that are modular, decentralized, changeable, ill structured and complex. The importance and real gain obtained from an agent based approach however comes from a better description of the real world by focusing on objects rather than functions.

Integrated multi agent and p2p software architecture for supporting collaborative design processes was proposed in [48]. Based on this integrated platform, both human experts and software agents are capable of emitting and perceiving awareness events that correspond to planned activities. The concept of mobile collaboration support infrastructure by integrating the semantic web was implemented in order to provide a framework for shared definitions of terms, relationships, resources etc [49].

Table 1: Comparison of the basic requirements for interactions in Agents and Web services technologies.

	Software Agent Technology	Web Services Technology
1.	An agent needs to publish its services and resources to other agents as well as discovering services or resources of other agents [47]. This is achievable through registration in the Directory Facilitator (DF).	A Web service publishes its services or resources in order to be discovered and used by other Web services or clients. This is achievable through registration in the UDDI registry
2.	Agents need to be able to access (existing) information sources [47].	Web services, as long as the XML based SOAP messages transportation is possible, can access the existing information sources.
3.	Agents need to communicate with each other. They should also be able to use existing infrastructure (TCP/IP networking, HTTP, etc) [47].	Web services communicate with each other through SOAP messages standard. The transportation protocol of Web services is HTTP (regardless of platforms)
4.	The communication should be robust in the sense that recovery from exception conditions should be possible [47].	An Asynchronous communication is robust. In the synchronous case, a Web service needs some information from another one; it suspends the execution until receiving information. However, a Web service is multi threats and offers services to a large number of users at the same time.

E. Web Services and a Semantic web

The basic Web servers are passive, i.e., they only reply to requests from users, rather than actively or proactively send data or information to users or other servers. They neither cooperate nor coordinate. The Web service technology officially proposed by W3C in 2002 is meant to address these shortcomings. In fact, it is very similar to the concept of Active and Proactive Web Servers proposed in [18]. By their definitions, a Web service is ‘‘a software system designed to support interoperable machine-to-machine interaction over a network” and a Semantic Web is ‘‘an evolving extension of the Web in which Web content can be expressed not only in natural language, but also in a format that can be read and used by software agents” [50].Semantic web technology was introduced to facilitate the publication ,discovery and execution of web services at semantic level [2,20] .An Holistic approach for introducing organizational and technical measures to an information federation was implemented in [19] . A fundamental challenge to product life cycle management in collaborative value networks is to utilize the vast amount of product information available in order to improve business analytics decision support and processes. This becomes even more challenging if these sources are distributed across multiple organizations.

Fuzzy match making approach for semantic web services to support a more automated and veracious service discovery process in collaborative manufacturing environments was introduced in [16]. The practical ontology driven framework towards constructing semantic heterogeneous was developed in order to fulfil the gap of data and semantic heterogeneity between the heterogeneous systems [17].

A process driven approach by integrating software agents and Web services technologies was proposed in [14]. It is very similar to the Cooperative Work flow concept as presented in [13]. A semantic web based approach to enable interoperability between two existing CAD and GIS platforms was developed [15], a Similar approach was also reported in [12]. Web services based framework for managing information from heterogeneous, distributed, and autonomous sources was implemented in [10].

F. Unification of RFID & Wireless sensor networks.

Radio Frequency Identification (RFID) is a wireless technology that enables one to automatically identify and track assets in almost any organization. It offers wireless communication between RFID tags and readers with non line-of-sight readability. This reduces or eliminates the need for manual data entry and introduces the potential for automated processes to increase productivity, safety and efficiency. RFID is just one kind of wireless sensor network (WSN) technology [21]. A Comprehensive framework model was proposed to identify and promote dynamic RFID adoption and diffusion

The cubic model is designed based on three different perspectives: stage, scale, and scope dimension of technology diffusion. . In each dimensions of cubic model, different RFID success factors were suggested by Delphi method. Based on cubic model, we provide appropriate RFID success factors for Indonesia case by AHP method.

Many researches [22, 23, 42, 43] showed that RFID & WSN could help to improve the efficiency and effectiveness of Just In Time (JIT) management. A service Oriented Architecture (SOA) was developed as it is one of the solution for effective collection and sharing of information in supply chain management. An integrated information sharing environment through the development of an information framework and application of SOA, RFID, WSN technologies was built in [24]. The frame work can communicate and manage information generated in the heterogeneous environment of Construction supply chain management (CSCM). The combination of SOA, RFID, and WSN could improve the effectiveness and efficiency of CSCM

VI. ROLE OF EXPERT SYSTEM: IN MANUFACTURING

Expert system is an interactive computer based decision tool that employs both facts and heuristics to answer hard decision problems founded on the knowledge obtain from an expert system [44]. Expert system method has been applied to numerous problems of arrangement, design and diagnostics. The problems have to be tackled in an incorporated way with knowledge from dissimilar domains and sources. In the case of inventory web based manufacturing, Expert system can be used for forecasting.

G. Development of Expert System:

Artificial Neural Network (ANN) and Genetic Algorithms offered a lot of helpful methods for developing the competence of problem solving **[44]**. Expert system and development in related topics made it potential to tackle numerous practical problems .Expert system employing heuristic methods are helpful in characterizing dissimilar types of knowledge .They are insufficient to tackle engineering design problems in an incorporated way .Engineering design usually follows a generate and test attitude in which answer(s) are produced and then estimated beside suitability criteria. Production and assessment of one explanation at a time may not be successful approach in many situations. The amount of potential solutions that can be generated is unbalanced. Knowledge base expert system is the primary understanding of the study on the field of Artificial

Intelligence (AI) as a type of software skill. For developers of application software mainly in medical and engineering branches, it was a beneficial as it addressed the decision making procedure with the use of symbols rather than numbers. Tasks belonging to the categorization and analysis category were the primary ones to advantage the appearance of knowledge base expertise. In the area of Computer Aided Engineering (CAE) many investigators showed an active interest in additional improvement of this technology by exploring its dissimilar aspects and applicability to different fields.

VII. COLLABORATION TECHNOLOGIES

H. Web Based Collaboration

As mentioned above in Section (Systems Integration Approach 5.1), the Web was originally designed for information sharing and collaboration. It is natural to develop and use Web based tools to facilitate collaboration in manufacturing.

I. Agent Based Collaboration

Software agents are usually used to facilitate collaboration or interoperation among software systems, but they can also be applied to facilitate communication and collaboration among software system users [26], organizations [1], and hardware systems.

J. Collaborative Virtual Environment

With the integration of virtual reality, software agents, and Internet/Web-based technologies, collaborative virtual environments are being widely applied in almost all e-business and engineering domains for collaboration among distributed teams. A framework for collaborating in a virtual environment including a database (based on IFCs) containing various models and relationships, a virtual world environment for collaboration, and an agent-based society for handling communication between the users. The issue of decision making support for small and medium size enterprises operating within a virtual project driven enterprise environment was addressed in [46]. The problem considered here can be defined in terms of finding a feasible schedule that satisfies the constraints imposed by the work order duration, the price, and the time constrained resource availability. The problem belongs to the class of multi mode case problems of project scheduling, where finding a feasible solution is NP-hard. A heuristic method for process planning and scheduling is proposed. The method is based on a critical path approach and the branch and bound search scheme. It has been implemented in a web enabled interactive software package, and is illustrated using the example of a virtual construction enterprise.

VIII. SUMMARY

This paper provides a comprehensive review of recent trends on web based manufacturing systems. The overall introduction of web based manufacturing system is presented here. Web based manufacturing systems are developed and used for supporting different product development life cycle activities, such as to manage configurations, describe geometry, collaborative planning, control of production, identify reasons of faults by connecting devices with the web etc. Later in upcoming sections, web based manufacturing qualities, overall issues, Research issues, System Integration approach, Collaboration technologies are well discussed. Thus in the present era as companies spread their operations across the geographically distant locations to widen their reach and take advantage of local factors, Web based manufacturing proves to be the ideal solution in meeting the corporate objectives.

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