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Procedia Technology 16 (2014) 1135 – 1145

Procedia Technology

CENTERIS 2014 - Conference on ENTERprise Information Systems / ProjMAN 2014 - International Conference on Project MANagement / HCIST 2014 - International Conference on Health and Social Care Information Systems and Technologies

New JIT, New Management Technology Principle: Surpassing JIT

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Abstract

The aim of this paper is to reassess the way management technology was carried out in the manufacturing industry and establish "New JIT, New Management Technology Principle". New JIT consists of the Total Development System (TDS), the Total Production System (TPS) and the Total Marketing System (TMS), which are the three core elements required for establishing new management technology principles for sales, R&D, design, engineering, and production, among others. To realize manufacturing that places top priority on customers with a good QCD in a rapidly changing technical environment, the author proposes a high linkage model, employing a structured "integrated triple management technologies system - Advanced TDS, TPS & TMS" for expanding "uniform quality worldwide and production at optimum locations".

Keywords: JIT; New JIT; Science SQC; Advanced TDS, TPS & TMS; Toyota

1. Introduction

A future successful global marketer must develop an excellent management technology system that impresses users and continuously provides excellent, quality products in a timely manner through corporate management. To realize manufacturing that places top priority on customers with a good QCD (Quality, Cost and Delivery) and in a rapidly changing technical environment, it is essential to create a new core principle capable of changing the work process quality of all divisions for reforming the super-short-term development production [1,2].

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Peer-review under responsibility of the Organizing Committee of CENTERIS 2014.
doi:10.1016/j.protcy.2014.10.128

The Japanese administrative management technology that contributed the most to the world in the latter half of the 20th century is typified by the Japan Production System represented by the Toyota Production System. This system was kept at a high level by a manufacturing quality management system generally called "JIT" (Just in Time) [3]. However, a close look at recent corporate management activities reveals various situations where an advanced manufacturer, which is leading the industry, is having difficulty due to unexpected quality related problems. Against this background, improvement of the Japanese administrative management technology is sorely needed at this time [4-7]. To be successful in the future a global marketer must develop an excellent quality management system that can impress consumers and continuously provide excellent quality products in a timely manner through corporate management for manufacturing in the 21st century.

In the remarkable technologically innovative competition seen today, in order to realize manufacturing that ensures customer first QCD, it is indispensable to first create a core technology capable of reforming the business process used for the technological development of divisions related to engineering designing. Equally important, even for production related divisions, is to develop new production technologies and establish new process management which, when combined, enable global production [8]. Given this context and by predicting the form of next generation manufacturing, the author hereby proposes "New JIT, New Management Technology Principle" which contains hardware system - three core elements "Total Development System (TDS), Total Production System (TPS), Total Marketing System (TMS)", and software system – "TQM-S, TQM by utilizing "Science SQC, New Quality Control Principle" called "Science TQM, New Quality Management Principle" for transforming management technology into management strategy [1,9-14].

New JIT is the basis of "Manufacturing Fundamentals 21C" accomplished by innovating the conventional JIT system. To realize manufacturing that places top priority on customers with a good QCD in a rapidly changing technical environment, the author requires the urgent establishment of a "new global management technology" for the next generation. The author, therefore, proposes a high linkage model, employing a structured "integrated triple management technologies system – " High Linkage Model, Advanced TDS, Advanced TPS and Advanced TMS" for expanding "uniform quality worldwide and production at optimum locations" [15]. The focus of this paper is thus the theory and application of strategic management technology through the application of New JIT. The effectiveness of New JIT is then demonstrated at Toyota and others [2,15-18].

2. Management tasks of manufacturing companies shifting to global production

2.1. Progress of production control in the manufacturing industry

Advanced companies in the world, including Japan are shifting to global production to realize "uniform quality worldwide and production at optimum locations" for survival in fierce competition. Today when consumers have quick access to the latest information in the worldwide market thanks to the development of IT (Information

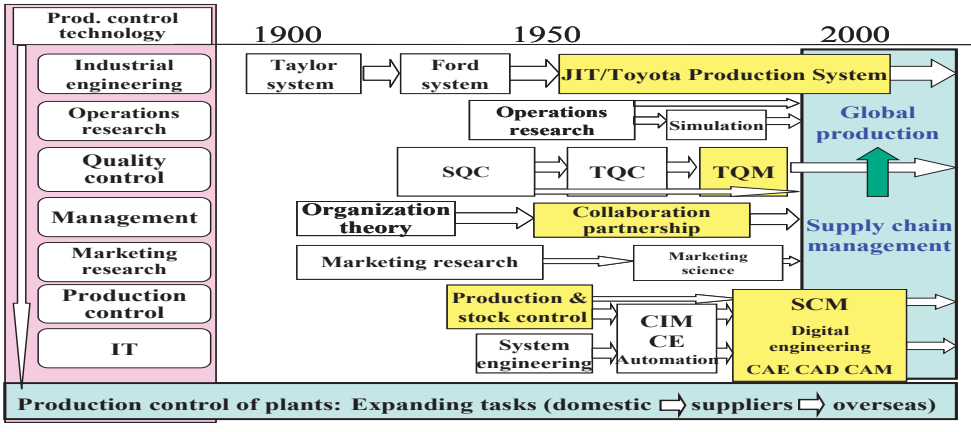

Fig. 1. Progress of management technology in the manufacturing industry

Technology), strategic organizational management of the production control department has become increasingly important. Simultaneous attainment of QCD requirements is the most important mission for developing highly reliable new products ahead of competitors [14]. This requires the urgent establishment of an innovative production control system for the next generation (called next-generation production control system).

Fig.1 summarizes the *progress of production control in the manufacturing industry* [10,11,13]. In the figure, the flow from IE (industrial engineering) to recent IT is shown as major technologies contributed to production engineering in the vertical direction. In the transverse direction, major elementary technologies, control methods and scientific methodologies that contribute to production control are listed in time series for mapping. For the production control department, the key to success in global production is modelling strategic SCM (supply chain management) for domestic and overseas suppliers with a systematization of its management methods. In the implementation stage, deep-plowing studies of the Toyota Production System, TQM, partnering, and digital engineering will be needed in the future [15].

2.2. Basics of JIT–The Toyota Production System

What is known as the JIT, a Japanese production system typified by the Toyota Production System, is a manufacturing system that was developed by the Toyota [3,19]. The "Basic Philosophy of the Toyota Production System" is built upon the ideas of the company founder, Sakichi Toyoda, and his business mottos, (1) "Be ahead of the times through endless creativity, inquisitiveness, and the pursuit of perfection", (2) "A product should never be sold unless it has been carefully manufactured and has been tested thoroughly and satisfactorily". These are the basic concepts of JIT which aims to realize "quality and productivity" simultaneously by effectively applying TQC and TQM to the automobile manufacturing process. In the JIT implementation stage, it is important to constantly respond to the customers' needs, promote flawless production activities, and conduct timely QCD research, as well as put it into practice [1,14].

In Fig.2 these management technologies have been placed on the vertical and horizontal axes. As shown in the figure, the combination of these technologies reduces large irregularities in manufacturing to the state of "tiny ripples" where the average values are consistently improved in the process. This strategy is an approach used by reasonable corporate management in which the so-called "leaning process" is consistently carried out. As indicated by the vertical and horizontal axes in the figure, when the hardware technology of the Toyota Production System and the software technology of TQM (TQC) are implemented, the statistical quality control (SQC) is to be effectively incorporated to scientifically promote QCD research and achieve constant upgrading of the manufacturing quality. Another point that can be understood from the figure is that TQM and SQC are the foundations of maintaining and improving the manufacturing quality, and both have also historically served as a basis for the advancement of JIT [9,10].

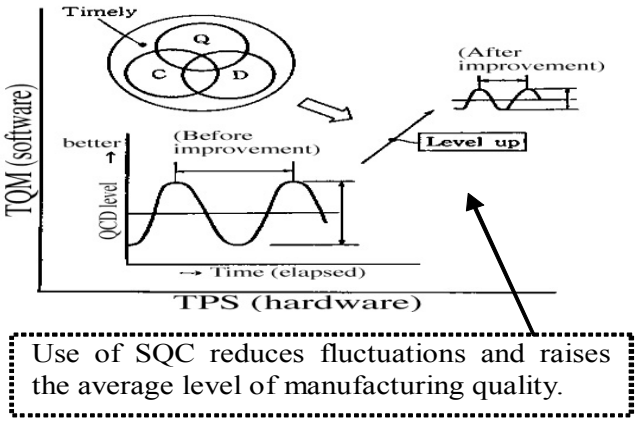

Fig. 2. Relation between Toyota Production System and Total Quality Management

3. Developing New JIT, New Management Technology Principle

3.1. Innovation of Manufacturing Fundamentals Surpassing JIT

Manufacturing of world is currently facing two major transformations. First is the shortened life cycle of products due to the diversification and sophistication of customers' needs. Therefore, the manufacturers need to realize the shortest lead time possible in cooperation with their suppliers from the product development stage, through to manufacturing, and finally to sales, so that they are able to respond to this change. Second, it has been deemed essential to "create a new administrative management technology" necessary for the deployment of "global production – worldwide uniform quality and simultaneous production (production at optimal locations)" and to manage such production in a systematic and organized manner [10].

Based on the knowledge obtained above, the author deems it necessary to "establish an advanced model of a new management technology toward "Innovation of manufacturing fundamentals surpassing JIT" to all the business processes of each department from upstream to downstream. In order to succeed at global production, worldwide uniform quality and simultaneous launch (production at optimal locations) is an urgent task. In order to offer customers high value-added products and prevail in the worldwide quality competition, it is necessary to establish an advanced production system that can intellectualize the production engineering and production management system. The author [2] believes that what determines the success of global production strategies is the advancement of technologies and skills that are capable of fully utilizing the above mentioned advanced production system in order to realize reliable manufacturing at the production sites.

3.2. New JIT for Renovating Management Technology

3.2.1. The Concept of New JIT for Renovating Management Technology

The creation of attractive products requires the implementation of "Customer Science" [1,20,21] to scientifically grasp customers' tastes. To achieve this, the entire organization must be managed by each of the marketing, engineering and production divisions. All of these are organically combined by control divisions (Engineering Control, Production Control, Purchasing Control and Information Systems), the general administration division, and those in charge of motivating human resources and organizing the divisions as a whole. Therefore, a new organizational and systematic principle for the next-generation, new management technology principle, New JIT, for accelerating the optimization of work process cycles of all the divisions is necessary.

The author [1,2,22] has developed New JIT, as shown in Fig.3 which contains hardware and software systems as the next generation technical principles for transforming management technology into management strategy. The first item, the hardware system, consists of the Total Development System (TDS), Total Production System (TPS), and Total Marketing System (TMS), which are the three core elements required for establishing new management technology principles for business planning, sales, R&D, design, engineering, and production, among others.

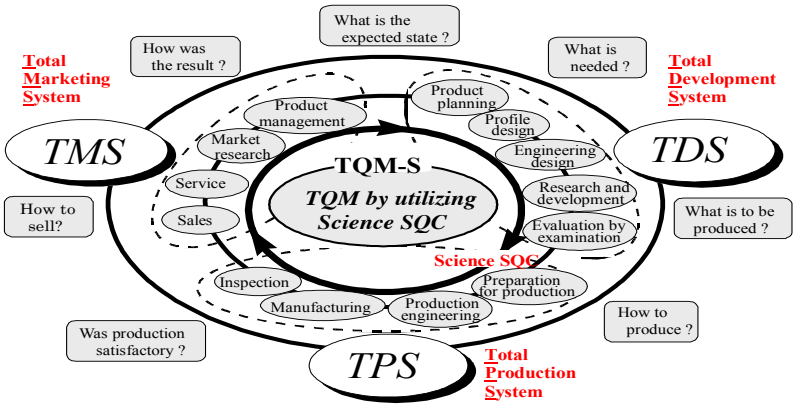

Fig. 3. New JIT, New Management Technology Principle

For the second item, software, the author (Amasaka, 2000c,d,e) has developed TQM-S (Total Quality Management utilizing "Science SQC, New Quality Control Principle" called "Science TQM, New Quality Management Principle") as the system for improving work process quality of the thirteen divisions shown in Fig. 3.

The author believes that this linkage contributes to further growth and development of the three core elements of New JIT, and general solutions have to be approached by clarifying the gaps that exist in theory, testing, calculation and actual application.

3.2.2. Three Subsystems of New JIT

(1) TDS: The First Principle

The expectations and role of the second principle, TDS, as shown in Fig.4, is the systemization of a design management method which is capable of clarifying the following [1]: (a) Collection and analysis of updated internal and external information that emphasizes the importance of design philosophy, (b) Development design process, (c) Design method that incorporates enhanced design technology for obtaining general solutions, and (d) Design guidelines for designer development (theory, action, decision-making).

The application of TDS to improve the process quality of design work in order to realize these criteria is called "Design SQC" [23]. To create the latest technology in response to technological evolution, it is important to implement Design SQC so that it may contribute to the development of proprietary technology, its continuation, and its further advancement. The important thing is to establish general technological solutions, rather than particular solutions, by building up partial solutions. The true objective of establishing TDS is to create technologies through optimum design brought about by information sharing.

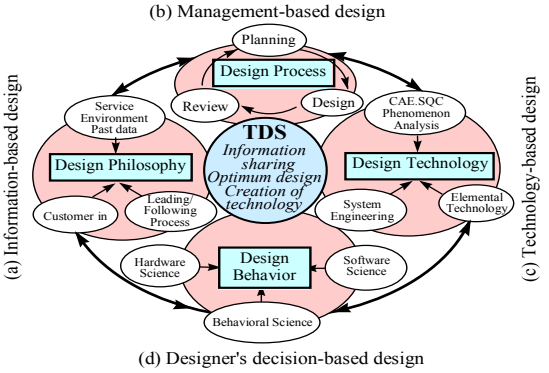

Fig. 4. Schematic Drawing of TDS

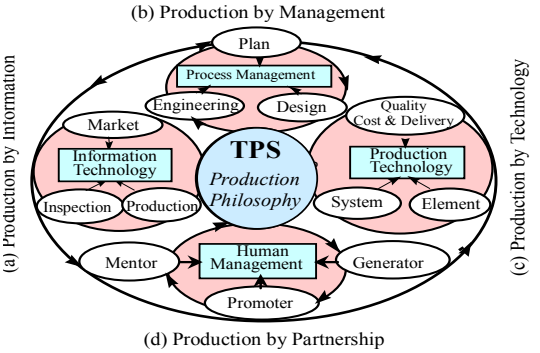

Fig. 5. Schematic Drawing of TPS

(2) TPS: The Second Principle

The expectations and new role of the third principle, TPS, as shown in Fig.5, comprise the following [1]: (a) Customer-oriented production control systems that place the first priority on internal and external quality information, (b) Creation and management of a rational production process organization, (c) QCD activities using advanced production technology, and (d) Creation of active workshops capable of implementing partnerships.

The application of TPS to strengthen the overall production organization to achieve these objectives is called "Production SQC". One of the objectives of TPS implemented through the application of Production SQC is to solve bottleneck technical problems at the production engineering (preparation) and production stages. The second objective is to establish a rational, scientific process control method for achieving a highly reliable production system [24,25].

(3) TMS: The Third Principle

The expectations and role of the first principle, TMS, as shown in Fig.6, include the following [1]: (a) Market creation through the gathering and use of customer information, (b) Improvement of product value by understanding

the elements essential to raising merchandise value, (c) Establishment of hardware and software marketing systems to form ties with customers, and (d) Realization of the necessary elements for adopting a corporate attitude (behavioral norm) of enhancing customer value and developing Customer Satisfaction (CS), Customer Delight (CD), Customer Retention (CR), and networks using IT.

The practical application of TMS the effectiveness [26] of which was demonstrated by the author in establishing TMS in the sales division as well as contributing to business through product planning departments, is termed "Marketing SQC". In order to scientifically conduct market surveys not confined only to readily apparent sales, recognize the importance of Marketing SQC, which contributes to future development, and carry out customer-oriented global marketing, the implementation of Customer Science is becoming more and more important, not least in terms of properly linking TMS, TDS, and TPS.

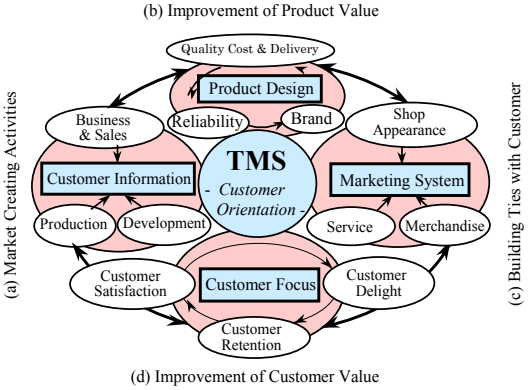

Fig. 6. Schematic Drawing of TMS

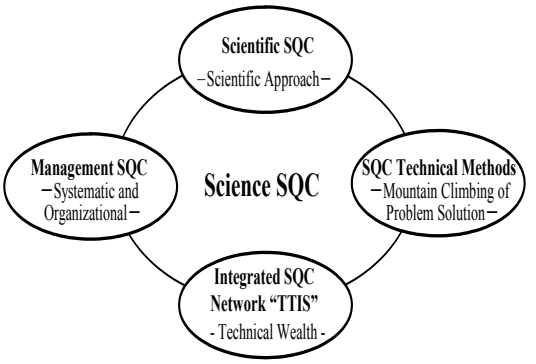

Fig. 7. Science SQC, New Quality Control Principle

3.2.3. New JIT driven by Science SQC

Supplying products that satisfy consumers (customers) is the ultimate goal of companies that desire continuous growth. Customers generally evaluate existing products as good or poor, but they do not generally have concrete images of products they will desire in the future. For new product development in the future, it is important to precisely understand the vague desires of customers. Developing Customer Science [1,20] makes it possible to concretize customer desires "Wants". To realize this, the further expansion of the New JIT, Science SQC by utilizing the four core principles as shown in Fig.7 is a new principle for a next generation quality management technique for the manufacturing business, aiming at providing a universal "general solution" and thus creating a technology for problem solving [2,12,27]. The first of the four principles, "Scientific SQC" is a scientific quality control approach, and the second principle, "SQC Technical Methods" is a methodology for problem solving. The third principle, "Total SQC Technical Intelligence System, TTIS", is integrated SQC network by using technical wealth that deal with proprietary technologies or business processes into owned assets.

3.3. Advanced TDS, TPS & TMS, Key to Global Manufacturing Strategy of New JIT

3.3.1. High Linkage Model "Advanced TDS, TPS &TMS" for the Advanced Management Strategy

A future successful global marketer must develop an advanced management system that impresses users and continuously provides excellent products of high quality in a timely manner through corporate management. Since providing what customers desire before they notice their wants will become a more essential part of any successful manufacturing business, the author has constructed a Customer Science [1,21] that utilizes New JIT. In this section, the author [15] proposes a high linkage model that is composed of a "triple management technology system". This system combines Advanced TDS, Advanced TPS, *and* Advanced TMS as shown in Fig.8.

(1) Advanced TDS, Total Development Design Model

Currently, to continuously offer attractive, customer-oriented products, it is important to establish a "*new*

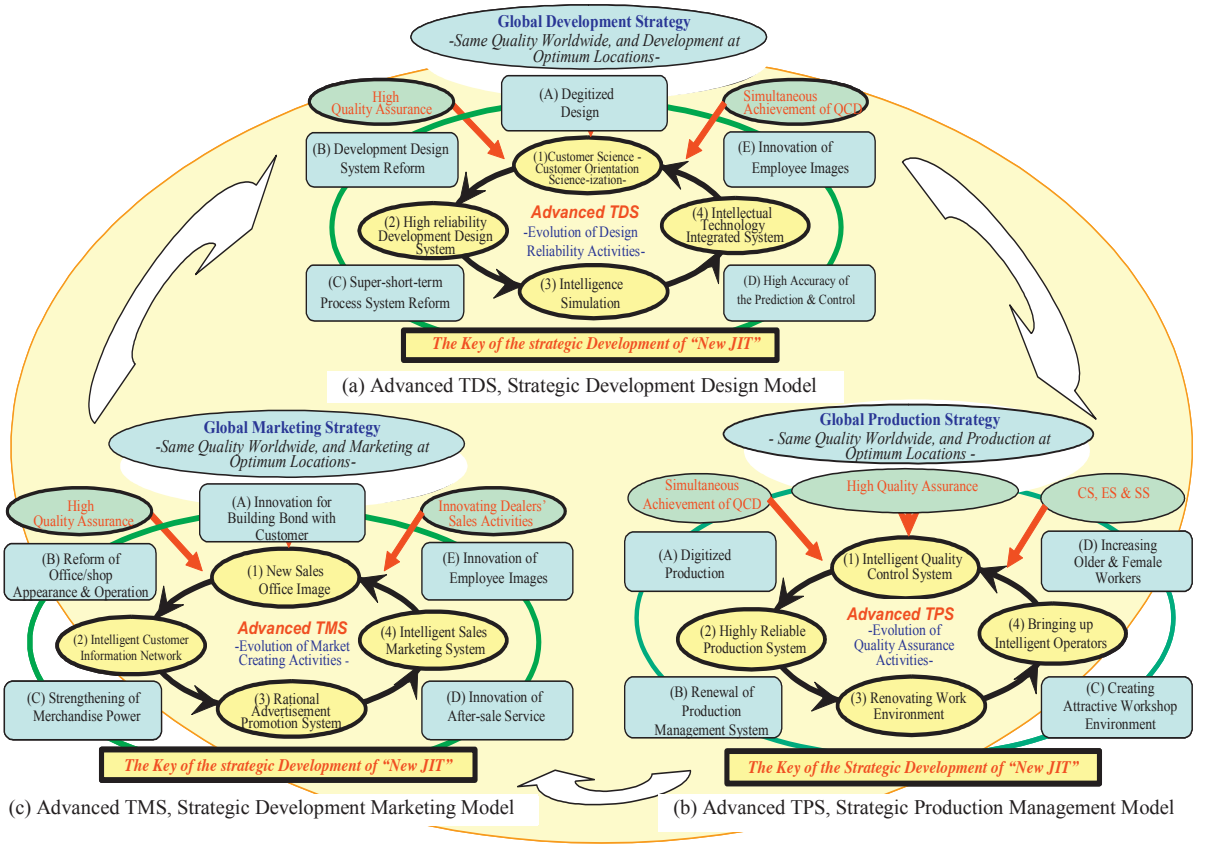

Fig. 8. High Linkage Model "Advanced TDS, TPS & TMS" for Strategic New JIT

development design model" that predicts customer needs. In order to do so, it is crucial to reform the business process for development design [15,16,29]. Manufacturing is a battle against irregularities, and it is imperative to renovate the business process in the development design system and to create a technology so that serious market quality problems can be prevented in advance by means of accurate prediction/control.

For example, as a solution to technical problems, approaches taken by design engineers, who tend to unreasonably rely on their own past experience, must be clearly corrected. In the business process from development design to production, the development cost is high and time period is prolonged due to the "scale-up effect" between the stages of experiments (tests and prototypes) and mass production. In order to tackle this problem, it is urgently necessary to reform the conventional development design process.

Focusing on the successful case mentioned above, the authors [16] deem it a requisite for leading manufacturing corporations to balance high quality development design with lower cost and shorter development time by incorporating the latest simulation (CAE, Computer Aided Engineering) and Science SQC. Against this background, it is vital not to stick to the conventional product development method, but to expedite the next generation development design business process in response to a movement toward digitizing design methods. Having said the above, the authors [15,16] propose "Advanced TDS, Strategic Development Design Model" as described in Fig.8.(a), and further updates TDS.

For realization, (1) customers' orientation (subjective implicit information) must be scientifically interpreted by means of Customer Science [1,20], namely, converting the implicit information to explicit information by objectifying the subjective information using Science SQC so as to (2) create High reliable development design system, thereby (3) eliminating prototypes with accurate prediction and control by means of *Intelligence Simulation.*

To this end, it is important to (4) introduce the "Intellectual Technology Integrated System*"* which enables a sharing of knowledge and the latest technical information possessed by all related divisions.

(2) Advanced TPS, Total Production Model

As digital engineering transforms manufacturing in workshops, a reduction in the engineering capability of members is often a result. This weakens the scientific production control that ensures that quality is incorporated in processes. Therefore, despite conventional success from the viewpoint of global production, it is an urgent task to strategically Advanced TPS" [15,17] in order to enable. The author, considering the necessity of including and organically integrating these four elements in the strategic application of Advanced TPS towards global production, has clarified the *"*Strategic Production Management Model*"* as described in Fig.8.(b). This model is an advanced production management principle designed to be applied as a global production technology and management model. The mission of Advanced TPS in the global deployment of New JIT is to realize CS, ES (Employee Satisfaction), and SS (Social Satisfaction) through production with high quality assurance.

In implementing New JIT for uniform quality worldwide and production at optimal locations (concurrent production), the fundamental requirements are (i) the renewal of production management systems to accommodate digitized production (see (A) and (B) in Fig. 8.(b) and (C) the creation of attractive workshop environments tailored to (D) the increasing number of older and female workers (see (C) and (D) in Fig.8.(b). In more definite terms, what is needed is to (1) strengthen process capability maintenance and improvement by establishing an intelligent quality control system, (2) establish a highly reliable production system for high quality assurance, (3) reform the work environment in order to enhancement intelligent productivity, and (4) develop intelligent operators (skill level improvement) and establish an intelligent production operating system. Accomplishing these objectives will achieve higher - cycled next-generation business processes, enabling earlier implementation of uniform quality worldwide and production at optimum locations.

(3) Advanced TMS, Strategic Development Marketing Model

When the author views recent changes in the marketing environment, what is needed now is to develop "Innovative business and sales activities" that are unconventional and correctly grasp the characteristics and changes of customers' tastes. "Contact with customers" has never called for more careful attention and practice and to offer an appealing, customer-oriented marketing strategy, it is important to evolve current market creation activities [21]. Therefore, the author proposes "Advanced TMS, Strategic Development Marketing System" as described in Fig. 8.(c), that further updates TMS. Advanced TMS [15,30] is aimed at the implementation of a successful "Global Marketing Strategy" by developing "*Same Quality Worldwide, and Marketing at Optimum Locations*".

As shown in the figure, Advanced TMS aims to achieve "a high cycle rate for market creation activities" and is composed of four core elements (1)-(4): Core element (1), a "new vehicle sales office image" to achieve a high cycle rate for market creation activities by, (A) innovative bond building with the customer and (B) shop appearance and operation, is particularly important, These constitute the basis for the innovation of (C) business talk, (D) after sale service, and (E) images of the employee image. At a certain stage of execution, for example, it is more important to construct and develop (2) an "Intelligent customer information network", (3) a "Rational advertisement promotion system" and (4) an "Intelligent Sales Marketing System" that systematically improves "Customer information software application know-how" about users who patronize vehicles of various makes. This information network turns customer management and service into a science by utilizing "TMS" according to customers' involvement with their vehicles in daily life.

4. Application – Verifying the Validity of Advanced TDS, TPS & TMS for New JIT Strategy

In this section, the author introduces some typical research examples of how Advanced TDS, TPS & TMS improved the management technology for global manufacturing strategy of New JIT at Toyota and others.

4.1. The Effectiveness of Advanced TDS

Some characteristic research cases that contributed to the establishment of Advanced TDS, the core technology of

development designing are: (i) the business process method for "Automobile exterior color design development model", "Automobile form and color design approach model" to support the development designer's conceptual process [31,32], and (ii) the creating a "New software development model" to assess the success of information sharing [33].

Moreover, through the cooperation of the development designing, production, sales, service, and purchasing procurement departments with the suppliers, (iii) the application of advanced and accurate CAE for the "Highly reliable development model" [29] that shortened the period needed for highly reliable designing and development, (iv) the failure mechanism of such worldwide technical issues as "Optimal CAE design approach model" for preventing "Oil leak in the drive-train oil seal" [34], and (iv) the "Automotive product design & CAE" for bottleneck solution of "loosening bolts" [35], were also clarified.

As for these researches, by utilizing the acquired technical results for improving the prediction accuracy of the CAE numerical simulation [16,29], a substantial quality improvement was successfully achieved.

4.2. The Effectiveness of Advanced TPS

Some characteristic research cases which contributed to the establishment of Advanced TPS, the core technology for production engineering and manufacturing are: (i) the implementation of the global production compatible, "New Japan global production model, NJ-GPM", a system designed to achieve worldwide uniform quality and production at optimal locations [17], and (ii) the "New global partnering production model" to increase global quality by generating a synergetic effect [36]. Another example is (iii) the next generation "Human digital pipeline system" enabling a total linkage from designing to manufacturing through a digital pipeline for production preparation [37].

Furthermore, in order to realize the key to success in "global production" - "uniform quality and simultaneous plant start-up worldwide", the authors introduce (iv) the "How to build a linkage between high quality assurance production system and production support automated system" [38], (v) the "Body auto fitting model" using NJ-GPM [39], (vi) the "Human-integrated assist system" based on the "Human intelligence production operating system" [40], (vii) the "Comparing experienced and inexperienced machine workers" [41], and (viii) the "Gaining Mutual Trust between Logistics Providers and Shippers" [42]. Through the above research cases, the manufacturing, production engineering, production management, purchasing management, and information system - related departments are currently collaborating with one another, and results are being obtained in which the previously acquired results are being integrated and further developed [14].

4.3. The Effectiveness of Advanced TMS

Some characteristic research cases which contributed to the establishment of Advanced TMS [30,43], the core technology of business and sales, market survey, merchandise planning, purchasing management, publicity and advertisement, and promotions-related departments are: (i) the implementation of the "Intelligent Customer information marketing model, ICIMM" to realize "market creation [30], (ii) the "Scientific mixed media model, SMMM" for boosting automobile dealer visits [44], and (iii) the "Total direct mail model, TMMM" to bring customer [45]. ICIMM effect means the reform of the (dealer) shop front advertising and promotions, sales, and customer services, so that the expected results can be successfully achieved.

Through scientific verification of the customers' purchasing patterns, the mixture effect of advertising promotion, consisting of TV (Television) commercials, newspaper ads, radio ads, flyers, Train-Car advertisements, and DM/DH (direct mail/direct handing) employing SMMM and TMMM, was enhanced to raise the rate of customers' visits to automobile shops, as well as to realize "Market creation".

5. Conclusion

The New JIT established is now being subjected to verification of its validity at a number of Japanese manufacturers with a view to it being further developed and established as the New Japan Management Technology

Model. In recent years, New JIT has been applied at many leading Japanese companies where its effectiveness has been verified, and it is now known as strategic global management technology model - Surpassing JIT.

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