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RESEARCH ARTICLE

A NEW JAPAN AUTOMOBILE PRODUCTION ENGINEERING MODEL FOR REALIZING CUSTOMER VALUE CREATION

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Abstract

In this study, the author has established a New Japan Automobile Production Engineering Model (NJ-APEM) for realizing attractive car creation 21C. Specifically, to strengthen auto-corporate management for realizing customer value creation, NJ-APEM develops a dual scientific methodology – Customer Science principle (CSp) and Science SQC in Science TQM activity. To precisely grasp the customer's preferences this model contains a dual management technology: "Exterior design engineering strategy and Driving performance design engineering strategy" through 3 domains of the designing, manufacturing and sales marketing" using Strategic Stratified Task Team Model (SSTTM) for excellent QCD activities employing New JIT strategy. Concretely, by developing Intelligent Customer Information Marketing Model (ICIMM), NJ-APEM consists of 4 core models: the "(1) New Automobile Product Development Design Model (NA PDDM), (2) NA-Global Production Model (NA-GPM) and (3) NA-Global Manufacturing Model (NA-GMM) as a dual sub-core models in New Automobile Product Development Design Model (NA PDDM), and (4) New Automobile Sales Marketing Model (NA SMM) with New Automobile Sales Marketing Model (NA SMM)". As those results and effects, the validity of NJ APEM has been verified through application examples in Toyota and others.

Introduction:-

Nowadays, customers have been selecting automobile's product "Car" that fit their lifestyles and their set of personal values: Appearance design quality and Driving performance (Amasaka, 2024a, 2025a).

There, to win the quality competition through realizing "customer value creation", auto-manufacturers' success or failure in global marketing will depend on whether or not they are able to precisely grasp the "customers' preferences", and are then able to advance their manufacturing to adequately respond to the demands of the times (Amasaka, 2018a, 2019a, 2023a,b,c, 2024a,b, 2025a).

For that accomplishment, integrative strengthening of the "excellent designing, production and sales marketing" becomes indispensable for realization of "super short-term product development design process and high-quality

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manufacturing in optimal locations" for realization of "simultaneous achievement QCD (quality, cost and delivery) (Amasaka, 2017a,b, 2022a,b, 2023a, 2024a,b, 2025a).

In this study, for this reason, to develop the attractive car creation 21C, the author has established a "New Japan Automobile Production Engineering Model" (NJ-APEM) for realizing attractive cars creation.

Then, to precisely grasp the customers' preferences NJ-APEM intends the evolution of "excellent designing, production & sales marketing" in order to realize the "super short-term products development design process, and thereby develops to advance both of the "Appearance quality and Functional quality" in order to realize the "High-Quality Manufacturing in the world".

Specifically, to strengthen auto-corporate management, NJ-APEM develops a dual methodology: "Customer Science principle (CSp) and Science SQC" in Science TQM activity (Amasaka, 2003a, 2004a,b, 2005a, 2008a: Amasaka Ed. 2007a).

This model contains a dual management technology "Exterior design engineering strategy and driving performance design engineering strategy" through 3 domains of designing, manufacturing and sales marketing using Strategic Stratified Task Team Model (SSTTM) developing excellent QCD employing New JIT strategy (Amasaka, 2002, 2004a, 2008a,b).

Concretely, by developing Intelligent Customer Information Marketing Model (ICIMM), NJ-APEM consists of 4 core models: the (1) New Automobile Development Design Model (NA-DDM) for designing, manufacturing and marketing, (2) New Automobile Global Production Model (NA-GPM) for innovating production development and preparation and (3) New Automobile Global Manufacturing Model (NA-GMM) for innovating manufacturing & SCM, as a dual asub-core modes in New Automobile Dual Global Production & Manufacturing Model (NA-DPMM), and (4) New Automobile Sales Marketing Model (NA-SMM) for innovating dealers' business and sales.

The validity of NJ-APEM is verified through the actual studies in Toyota and others (Amasaka, 2023a, 2024b, 2025a).

The key to success in automobile global production for realizing customer value creation

Necessity of automobile business process renovation for realizing "customer demands "Wants"

Nowadays, looking closely at the quality management issues "Unpopularity of appearance design quality and recalls of driving performance" facing Japanese advanced automotive manufacturing industry both domestically and overseas, it has become clear that a "new corporate management technology" by focusing "Product plan and development design" strategy is being strongly sought after (Matsuoka and Harada, 1997; Amasaka, 2002, 2007a,b, 2008a, 2010a,b ; Lockman, 2010).

Today, for this reason, environmental change which surrounds the auto-manufacturing industry in the world is very severe. Particularly, a success of "global marketing" which offers quickly the quality products of late model which raises the customer value can say that they are the indispensable requirements of "surviving" (JD Power and Associate, 1998; Amasaka, 2015a,b, 2018a,b, 2019a, 2021).

Therefore, to provide the attractive products with customer's orientation permanently, the establishment of "new development design technologies" to take customer's needs in advance is today's challenge and current issue.

Then, to realize this, the author has established the Intelligent Customer Information Marketing Model (ICIMM) developing "auto-business process renovation of all departments" for realizing for realizing "customer demands "Wants" as shown in Figure 1 (Amasaka, Ed, 2007b, 2015a, 2023a, 2025a).

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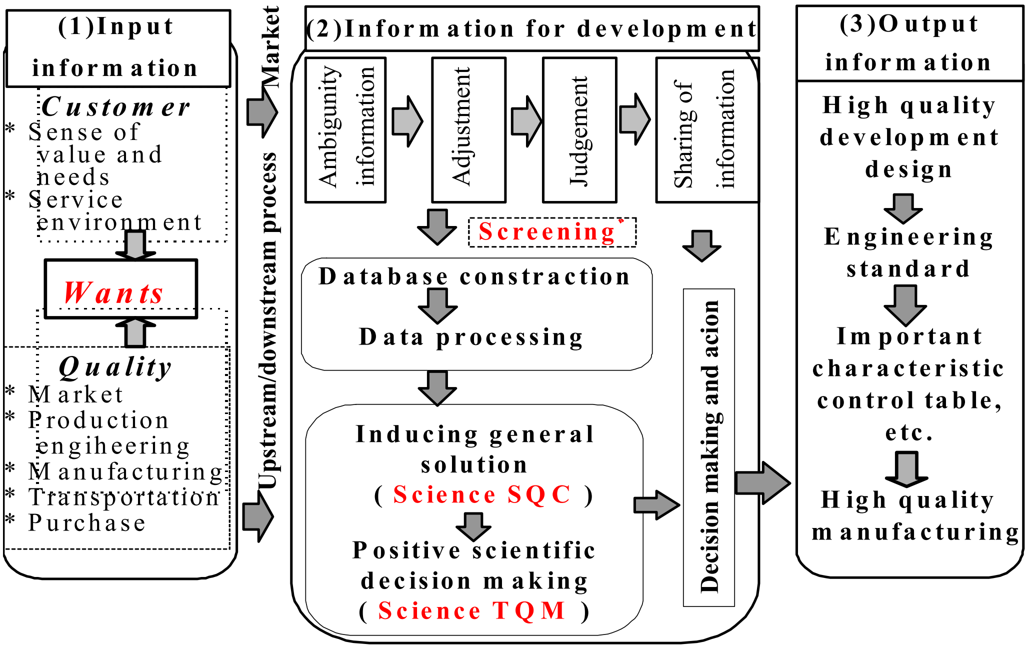

Figure 1. Strategic development of "Intelligent Customer Information Marketing Model" (ICIMM) developing auto business process renovation for realizing "customer demands "Wants"

Specifically, in Figure 1, use this information to create the customers' demands "wants" as part of a market creation activity and also to establish an intellectual structure and system for the "product development design, Production development & preparation, manufacturing and sales marketing" that is capable of offering new products using Customer Science principle (CSp) (Amasaka, 2002, 2005a) (See to Appendix A described in Figure A).

In implementation stage, it is important to apply the Science SQC in Science TQM activity named New Japan Model "Science TQM", via a verifiable scientific business approach, to each step→"Input information, Information for development, and Output information" in the business process of product development designing, manufacturing and sales & marketing for realizing "high quality of development design→Proper engineering standard of production technology and preparation→Important characteristic control table of production management, etc.→High-quality assurance of manufacturing" (Amasaka, 2004a,b, 2005a, 2008a; Amasaka Ed,, 2007a) (See to Appendix B described in Figure B).

This is done to effectively carry out to bring about the evolution of auto-corporate management technology that can ensure high reliability (high-quality) business process which realizes the customer's "Wants" (Amasaka, 2005b, 2007b, 2008a,b, 2007c,e,f, 2015a,b; Amasaka Ed. 2012).

Transitions in automotive development and design processes in Japan:
Currently, to continuously offer attractive, it is important to establish the "new automobile development design model" that predicts customer needs in the world (Amasaka, 2007a,c, 2022a,b, 2023a, 2024b; 2025a; Amasaka, Ed., 2007a,b, 2012).

To do so, auto-manufacturer is a battle against irregularities, and it is imperative to renovate the business process in the development design system and to create a technology for realizing the "customer's "Wants" in auto-appearance design with color" and "solution of quality problems in serious market" with lower cost and shorter development time.

Specifically, Figure 2 shows the "Transitions in the automotive development and design process" in Japan. In General, the model changes in the past (development time of production: approx. 4 years), after the "completing the designing process, problem detection and Improvement" were repeated mainly through the process of prototyping, testing and evaluation.

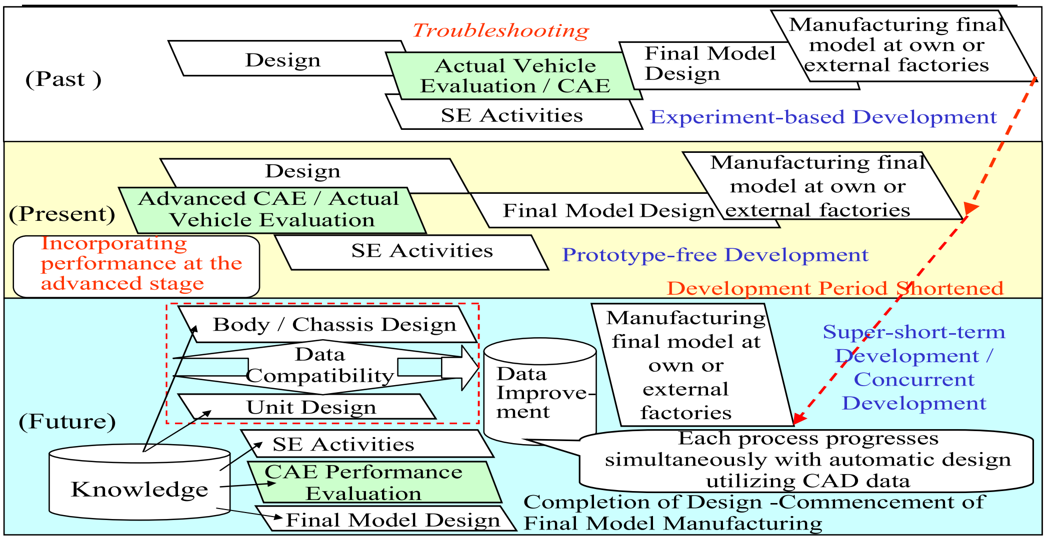

Figure 2. Transitions in automotive development and design processes in Japan

In some current automobile development and design, vehicle prototypes are not manufactured in the early stage of development due to the utilization of "intelligent CAE" (numerical simulation) and "Design CAD (computer aided design)" and "Simultaneous Engineering" (SE), resulting in a substantially shorter development period (Amasaka, 2005a, 2007c, 2008b,c, 2010a,b, 2012, 2015a,b, 2023b,c, 2024b,c, 2025a).

Then, focusing on management technology for the "product development design and production process", it is clear that there has been excessive repetition of prototyping, testing, and evaluation for the purpose of preventing the "scale-up effect" in the bridging stage between "product development design and mass production". This has resulted in unstable built-in quality assurance in the design and development stage, and an increase in the development period and cost.

Therefore, it is now vital to reform conventional design and development processes through the effective use of the "intelligent CAE and Design CAD". For strategic product development design, it is important to explore consumer values, which are the basis for creating customers' "wants," through the collection / analysis of customer information, and to reflect as well as exteriorize such values in product development. In Figure 2, the various issues of auto-corporate management that must be resolved by development design departments include "digitized development and design, product development design process reform, super-short–time process system reform, high accuracy of the prediction and control, and optimization of product development design specifications.

A New Japan Automobile Production Engineering Model for realizing customer value creation

For resolving above various issues in auto-corporate management technology in global production 21C, the author has established a New Japan Automobile Production Engineering Model (NJ-APEM) for the "Evolution of the High-quality assurance (QA), Super-short-term product development design, manufacturing and sales marketing process as the key of "Simultaneous achievement QCD" strategy employing New JIT, new management technology principle (See to Appendix C described in Figure C).

Specifically, to strengthen the "auto-appearance quality & functional quality", this model consists of the typical 4 core model to innovate the "product development design, production technology & preparation, manufacturing and sales & marketing": the "New Automobile Product Development Design Model (NA-PDDM), New Japan Production Management Model (NJ-PMM) and Strategic Marketing Development Model (SMDM) (Amasaka, 2020a,b, 2021, 2022a,b, 2023a,b.c, 2024a,b, 2025a).

To develop the NJ-APEM for realizing attractive cars creation 21C, the author has created 3 core models as follows;

The (1) New Automobile Development Design Model (NA-PDDM) for designing, manufacturing and marketing, (2) New Japan Global Production Model (NA-GPM) for innovating production development and preparation, (3) New Japan Global Manufacturing Model (NA-GMM) for strengthening of global manufacturing as a dual sub-core elements in NA-DPMM and (4) New Automobile Sales Marketing Engineering Model (NA-SMEM) for innovating auto-dealers' business based on the New Automobile Dual Global Production & Manufacturing Model (NA-DPMM) and sales for market value creation. (See to after-mentioned “Section 4” as shown in Figure 4, 5, 6, 7, 8 and 9 in detail).

New Automobile Development Design Model (NA-PDDM) using a Dual Corporate Engineering Strategy - Specifically, for the innovation of product development & design process fundamental, this model contains both of the (a) “Exterior design engineering strategy” and (b) “Driving performance design engineering strategy” using “Customer Science principle” (CSp). Concretely, the foundation of NA-PDDM consists of the (i) Automobile Exterior Design Model with 3 Core of the foundation of NA-PDDM consists of the (i) Automobile Exterior Design Model with 3 Core Methods (AEDM-3CM), (ii) Automobile Optimal Product Development Design Model (AOP-DDM) and (iii) CSp-Customer Information Analysis and Navigation System (CSp-CIANS).

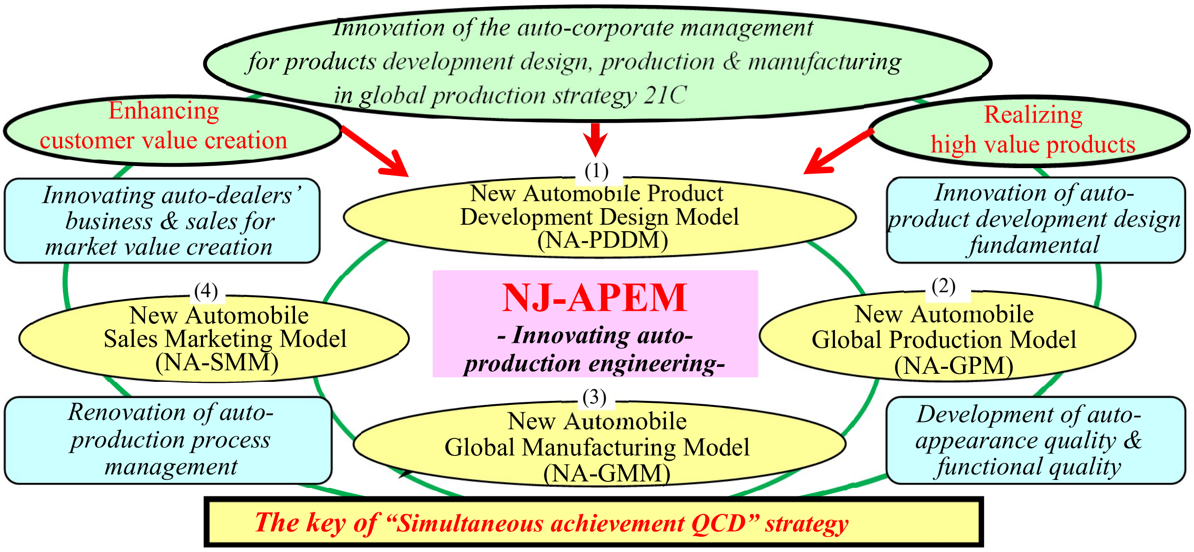

Figure 3. Outline of a New Japan Automobile Production Engineering Model (NJ-APEM)

New Automobile Global Production Model (NA-GPM) using 6 core production engineering strategies - Specifically, this model intends to the “(a) Reform production planning, (b) Reform production preparation, (c) Reform of process management and (d) Reform of working environment employing (e) Globalization of production information and (f) Visualization of production process”. Concretely, to strengthen both “High quality assurance and CS / ES / SS”, the foundation of NA-GPEM consists of the “(i) Highly Reliable Production System (HRPS) using TPS Layout Analysis System (TPS-LAS), (ii) Human Intelligence Production Operating System (HI-POS), (iii) Intelligent Production Operating System (IPOS), (iv) TPS Quality Assurance System (TPS-QAS), (v) Virtual–Maintenance Innovated Computer System (V-MICS) and (vi) Human Digital Pipeline System (HDP)”.

New Automobile Global Manufacturing Model (NA-GMM) using 6 core production engineering strategies - Specifically, this model intends to the “(a) Revolution of operating technology and skill in workplaces, (b) QCD studies of Japan and overseas, (c) Development of the simultaneous achievement of QCD, (d) Strengthening of SCM strategy, (e) Strategic quality management and (f) strengthening of manufacturing technology”. Concretely, to realize the world uniform quality-simultaneous model launches, the foundation of NA-GMEM consists of the “(i) Intellectual Working Value Improvement Management Model (IWV-IMM) as the basic principle of working value, (ii) Strategic Stratified Task Team Model (SSTTM) for the driving force of Problem-Solving, (iii) Intelligence High-cycle System of Assembly Maker Production Process (IHS-AMPP) for preventing defects and achieving quality assurance, (iv) Partnering Performance Measurement Model (PPMM) for assembly makers and suppliers, (v) Performance Measurement Model (SQM-PMM), and (iv) Working Value Evaluation Model (WVEM)”.

New Automobile Sales Marketing Model (NA-SMM) using 6 core sales marketing. engineering strategies - Specifically, for building bonds with customer, this model intends to the "(a) Innovating auto-office / shop appearance and operation, (b) Innovating auto-dealer's sales, (c) CS and CL to boosting marketing effectiveness in CR activities, (d) Realizing customer's "Wants", (e) Strengthen CS, CL & CR activities, and (f) Strengthen sales marketing. Concretely, to develop the for evolution of marketing process management, the foundation of NA-SMEM consists of the "(i) Scientific Customer Creative Model (SCCM), (b) Video Unites Customer Behavior & Maker's Designing Intentions (VUCKMIN), (c) Scientific Mixed Media Model (SMMM), (d) Networking of Customer Science Application System, (NSCp-AS), (e) Auto-shop Sales Marketing Model (ASMM) using CS/CL/CR activities based on the customer type and (f) Auto-Sales Innovation Model (ASIM) developing dynamics of effects of publicity & advertising".

Actual studeis of 4 Core model for NJ-APEM strategy using typical sub-core elements:
NA-PDDM for innovation of auto-product development design fundamental:
First, to realize the "high quality assurance, super short-term products development design process and simultaneous achievement QCD" for the "customer value creation", the author has created a "NA-PDDM" using a "Dual Corporate Engineering Strategy" (Amasaka, 2018a, 2024a,b,c, 2025a).

By these developments, NA-PDDM realizes the "Same quality worldwide and products development design at optimal locations". Specifically, to strengthen both of the "appearance quality and functional quality", NA-PDDM consists of the "Exterior design engineering strategy and Driving performance design engineering strategy" that contributes the Japanese automobile global corporate strategy as shown in Figure 4.

This model with a Dual Corporate Strategy contains the both "Exterior design engineering strategy and Driving performance design engineering strategy" for the developing "appearance quality and functional quality" that contributes to strengthening of Japanese automobile global corporate strategy (Amasaka, 2023c). The foundation of NA-PDDM consists of the "Automobile Exterior Design Model by using "3 core methods: (I), (II) and (III)" described in Figure 3.

Concretely, NA-PDDM with a "Dual Corporate Strategy" contains the both "Exterior design engineering strategy and Driving performance design engineering strategy" for the developing "appearance quality and functional quality" that contributes to strengthening of Japanese automobile global corporate strategy by developing "CSp (Customer Science principle) employing both "Affective engineering and statistical science named "Kansei Engineering and Science SQC" (Amasaka, 2018a).

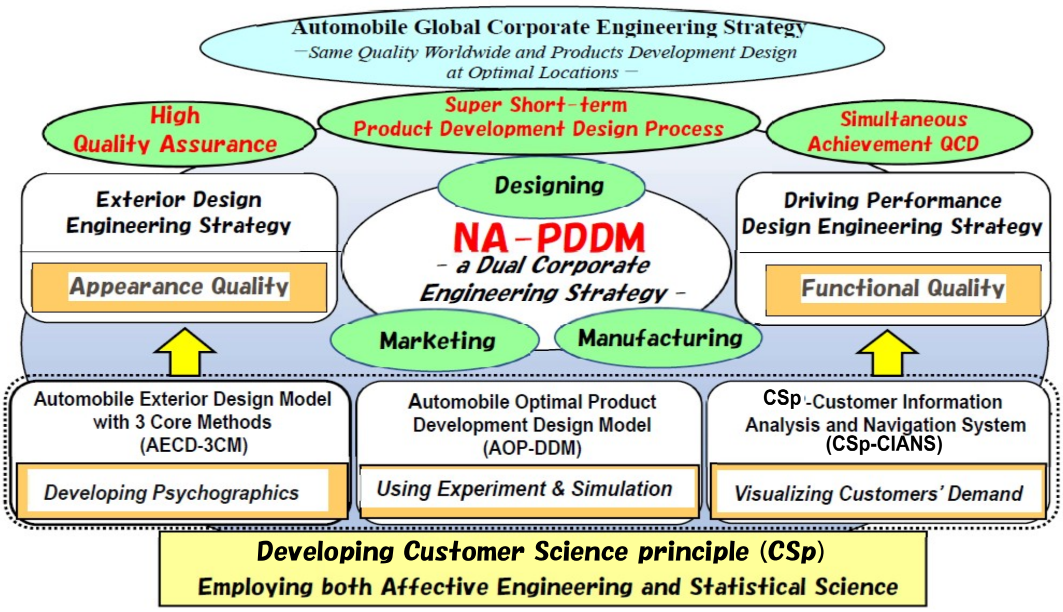

Figure 4. A New Automobile Product Development Design Model (NA-PDDM) using a Dual Corporate Engineering Strategy

NA-PDDM consists of the main “3 core technologies”: “AECD-3CM” (Automobile Exterior Design Model with 3 Core Methods): Automobile Optimal Product Development Design Model), “AOP-DDM” (Automobile Optimal Product Design Model), and “CSp-CIANS” (CSp-Customer Information Analysis and Navigation System) for “Strengthen of designing, manufacturing and marketing and those total linkage” described in Figure 3.

NA-DPMM in order to enable the strategic development of TPS and SCM surpassing JIT:-
NA-DPMM with a dual core model: NA-GPM and NA-GMM contributes the worldwide uniform quality and production at optimal locations as the strategic development of global manufacturing as shown in Figure 5 (Amasaka, 2020a,b, 2021, 2022a,b, 2023a,d, 2024b, 2025a). This model realizes Customer Satisfaction (CS), Employee Satisfaction (ES), and Social Satisfaction (SS) through the “high quality assurance manufacturing” to enable the strategic deployment of TPS (Toyota Production System) and SCM surpassing JIT based on the developing Strategic Stratified Task Team Model (SSTTM) (Amasaka, 2002, 2008b, 2015a, 2018a) (See to Appendix D described in Figure D).

In evolution of fundamentals, NA-DPMM is the systemization of high-cyclization of production process for realizing the simultaneous achievement of QCD requirements. To make this model into a reality it will be necessary to adapt it to handle digitalized production and reform it to realize a renewal production management system. Moreover, other prerequisites for realizing this include the need to create an attractive working environment that can accommodate the increasing number of older and female workers at the production sites and to cultivate intelligent production operators.

One of the technical elements necessary for fulfilling these requirements is the reinforcement of maintenance and improvement of process capabilities by establishing 4 core systems: the “(I) intelligent quality control system. Second, (II) highly reliable production system needs to be established for high quality assurance. Third, reform is needed for the creation of (III) Renovated work environment system that enhances intelligent productivity. Fourth, intelligent production operators need to be cultivated that are capable of handling the advanced production system and (IV) intelligent production operating development system needs to also be established”.

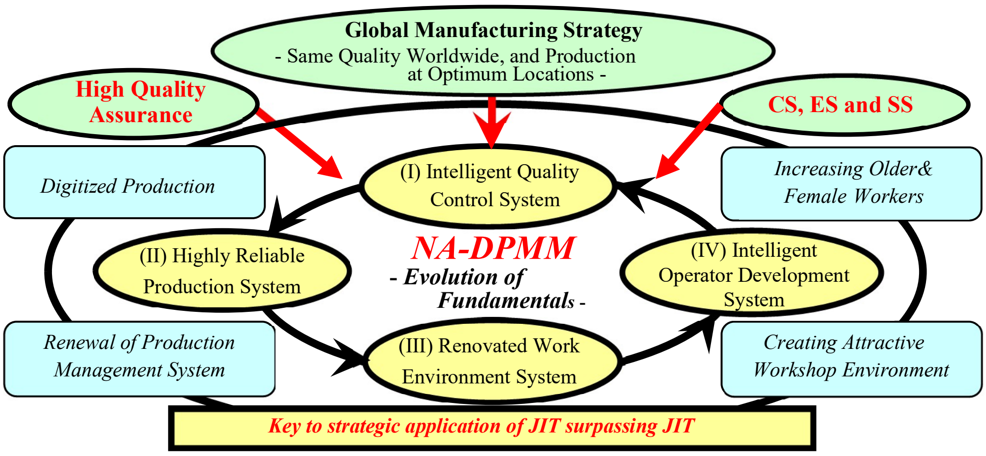

Figure 5. A New Automobile Dual Production Management Model (NA-DPMM)

In 2nd core model of above “4.1, NJ-ADPEM”, NA-GPM is to eradicate ambiguities at each stage of the production process as the “production planning and preparation” through production itself and process management, and between the processes in order to achieve a highly reliable production system for global production which will improve the reliability of manufacturing through the clarification and complete coordination of these processes as shown in Figure 6 (Amasaka, 2020a,b).

More specifically, the model is intended to the “(i) employ numeric simulation (Computer Aided Engineering, CAE) and computer graphics (CG) right from the production planning stage to resolve technical issues before they occur, (ii) reinforce production operators’ high-tech machine operating skills and manufacturing capabilities, and (iii) visualize the above using IT in order to reform production information systems to create a global network of production sites around the world.

The six sub-core management technologies in NA-GPM that constitute this model and their characteristics are described below (Amasaka, 2017a, 2020b, 2021).Reform of production planning: TPS Layout Analysis System (TPS-LAS) is a production optimization intended to realize a highly reliable production system.by optimizing the layout of both the production site as a whole and each production process with regard to production lines (logistics and transportation), robots (positioning), and production operators (allocation and workability) through the use of numeric simulation (Sakai and Amasaka, 2006a).

Reform of production preparation: Human Intelligence Production Operating System (HI-POS) is an intelligent operator development system intended to enable the establishment of a new people - oriented production system whereby training is conducted to ensure that operators develop the required skills to a uniform level, and diagnosis is then carried out to ensure that the right people are assigned to the right jobs (Sakai and Amasaka, 2006b). HI-POS is made up of two sub-systems: Human Integrated Assist System (HIA) and Human Intelligence Diagnosis System (HID).

Reform of the working environment: Intelligent Production Operating System (IPOS) is intended tolead to a fundamental reform of the work involved in production operations by raising the technical skills level of production operators and further improving the reliability of their skills for operating advanced production equipment within an optimized working environment. TPS-IPOS is made up of three sub-systems: Virtual – Intelligent Operator System (V-IOS), Aging & Work Development – Comfortable Operating System (AWD-COS), and Robot Reliability Design - Improvement Method (RRD-IM) (Sakai and Amasaka, 2003, 2007a; Amasaka, 2007c).

Reform of process management: TPS Quality Assurance System (TPS-QAS) is an integrated quality control system intended to ensure that quality is built into production processes through scientific process management that employs statistical science to secure process capability (Cp) and machine capability (Cm) (Amasaka and Sakai, 1998, 2009). TPS-QAS is made up of two sub-systems: Quality Control Information System (QCIS) and Availability & Reliability Information Monitor System (ARIM).
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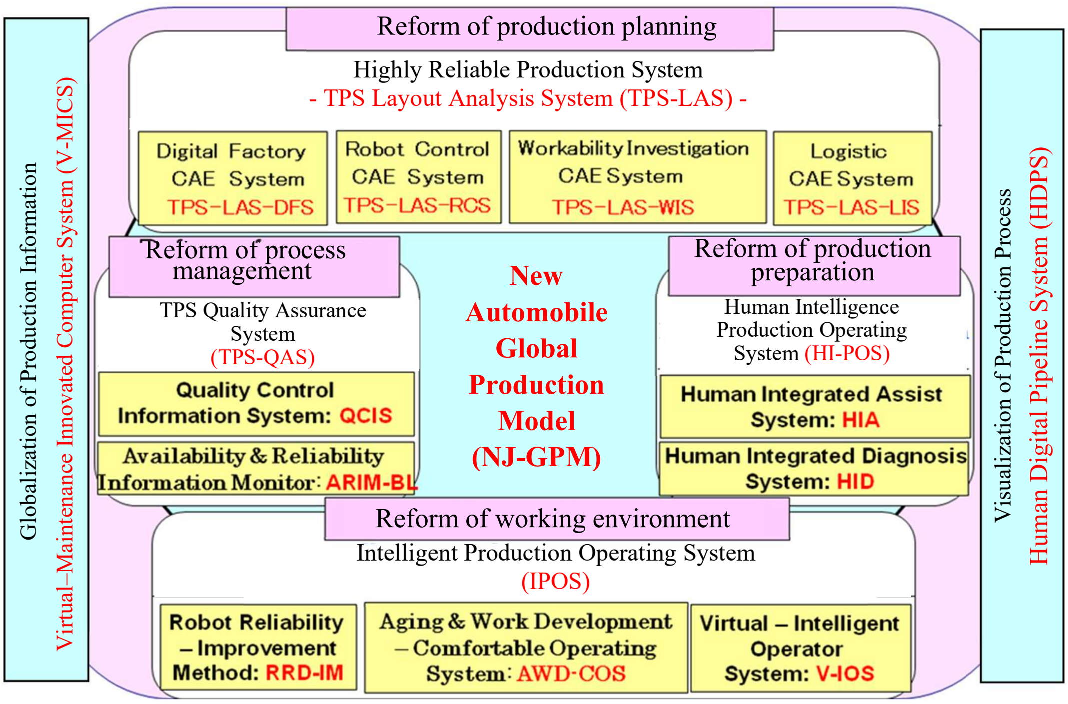


Figure 6. New Automobile Global Production Model (NA-GPM)

Visualization of production processes: Human Digital Pipeline System (HDPS) ensures that top priority is given to customers through manufacturing with a high level of quality assurance (Sakai and Amasaka, 2007b). This involves the visualization of intelligent production information throughout product design, production planning and preparation, and production processes, thereby facilitating the complete coordination of these processes. This system enables the high-cyclization of business processes within manufacturing.

Globalization of production information: Virtual – Maintenance Innovated Computer System (V-MICS) is a global network system for the systemization of production management technology necessary to realize a highly reliable production system, which is required to achieve worldwide uniform quality and production at optimal locations (Sakai and Amasaka, 2005).

Furthermore, in 3rd core model of above "4.1. NJ-APEM", NJ-GMM by using six core models based on the structure of manufacturing engineering as shown in Figure 7 (Amasaka, 2020a). To be successful of global manufacturing, the Japanese manufacturing industry must develop an excellent manufacturing management technology employing the advances in manufacturing engineering that can continuously provide high value products in a timely manner surpassing "Kaizen" (improvement) of manufacture site symbolized by traditional JIT (TPS) based on the three actuals of the actual place, actual part and actual situation (Amasaka, 1988, 2009).

Moreover, a key of global manufacturing is the systematic deployment of SCM on a global scale that encompasses cooperative manufacturing operations with overseas suppliers employing a newly global partnering model (Amasaka, 2004a, 2008b; Ebioka et al., 2007).To realize the world uniform quality-simultaneous model launches, the main characteristics of eachcore model contributes to the advancement of manufacturing management through actual QCD research by using statistical science below (Amasaka, 2017a, 2020b);

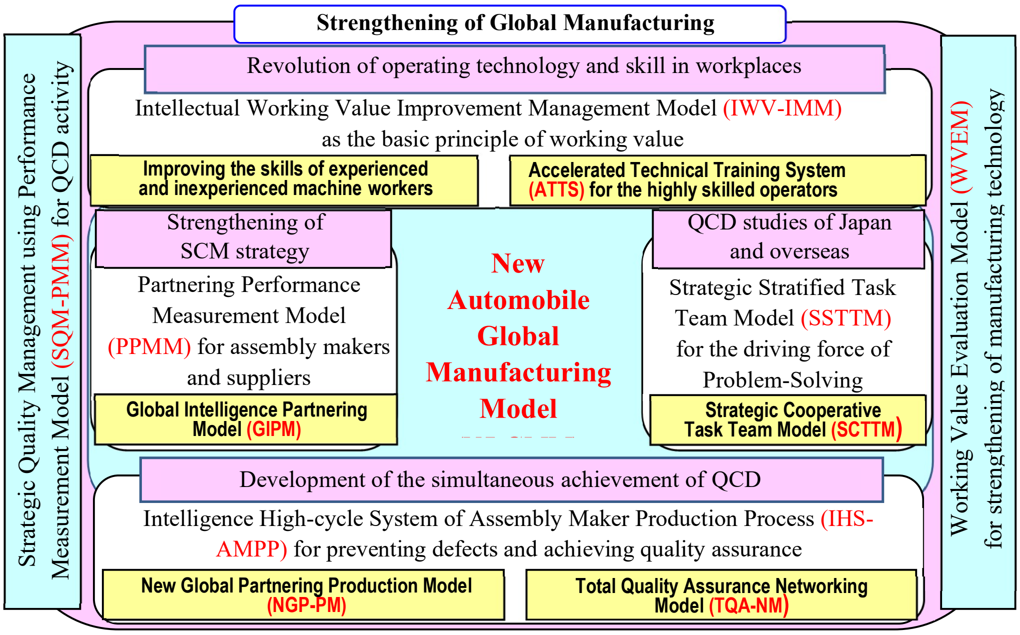


Figure 7. New Automobile Global Manufacturing Model (NA-GMM)

Intellectual Working Value Improvement Management Model (IWV-IMM) as the basic principle of working value intends that the design, production, quality assurance, marketing, human resource development, and administration cooperate and must reform the technologies and skills of the workers for the revolution of operating technology and skill in workplaces (Yamaji et al., 2007a; Tsunoi et al., 2010). In particular, boosting morale, reduction of fatigue, development of physical strength, development of tools & devices, improvement of thermal environment, and prevention of illness & injury are required for evolution.

Partnering Performance Measurement Model (PPMM) for assembly makers and suppliers serves as a formulation model using radar chart for visualization for evaluating the actual status of Japanese partnering between automobile assembly makers and parts suppliers, which has been somewhat implicitly carried out in the past (Yamaji et al., 2008). In connection with the PPMM development, the author creates PPMM-A for assembly makers, PPM-S for suppliers, and PPM- AS for assembly makers and suppliers, as a comprehensive dual performance measurement.

Strategic Stratified Task Team Model (SSTTM) for the driving force of problem-solving contributes to the strengthening of the ties among group manufacturing companies, non-group companies, and even overseas manufacturers (suppliers) (Amasaka, 2004a,b, 2008b). To realize this, the level of problem-solving technology rises in product development strategy I and II through joint task teams of intra-company departments and divisions (Task-1 to Task-6, Group task team, Department task team, Division task management team, Field task management team, Total task management team)called "Internal Partnering". This technology is further expanded to quality management strategy I to II through the domestic affiliated company, domestic non-affiliated company, and overseas non-affiliated company (Task-6 to Task-8, Joint A to Joint C) called "External Partnering".

Intelligence High-cycle System of Assembly Maker Production Process (IHS-AMPP) for preventing defects and achieving quality is effective management of the advanced production process (Amasaka et al., 2008; Amasaka and Sakai, 2010; Amasaka, 2018b). To improve the intelligent productivity of production operators and to consolidate the information about highly cultivated skills and operating skills, IHS-AMPP contains the advanced facilities into commonly shared fore core systems as follows; (I) Highly Reliable Production System (HRPS), (II) Intelligent Quality Control System (IQCS), (III) Renovated Work Environment System (RWES), and (IV) Intelligent Operators Development System (IODS).

Strategic Quality Management using Performance Measurement Model (SQM-PMM) is the criterion of strategic development of NJ-GMM. At a stage of creation of SQM-PMM, specifically, and a survey of top management at Japanese manufacturers was conducted in order to investigate the management achievements as a key to strategic global manufacturing (Survey targeted 898 companies) (Amasaka et al., 1999; Amasaka, 2009; Kozaki et al., 2012). First, the author conducted the graphical modeling method based on the correlations among the 28 practice items of six categories–TQM methods, technological development, CS, quality assurance, corporate culture, and total participation activities. Second, the author performed the formulation of SQM-PMM through canonical correlation analysis. Moreover, the author verified the validity of SQM-PMM standardization.

Working Value Evaluation Model (WVEM) for strengthening of manufacturing technology makes the basic of "Creative workplace" as moving power of SQM-PMM, and evaluates the awareness of the working value of workers by statistically analyzing data collected through actual condition survey on Toyota, Nissan and other three companies (Uchida et al., 2012). This model systematically covers 20 key factors based on the fatigue reduction, disease prevention, comfort, organizations, and intelligence ability. Then, the author received 25 sets of answers from workers in the manufacturing industry, and analyzed their weightings using covariance structure analysis. Also, standardization of evaluation formulas made it possible to compare the strength of each working value evaluation axis in order to deployment and verify the validity of WVEM.

NA-SMM for the innovation of auto-dealers' sales activities in global marketing strategy:-
To realize market creation with an emphasis on the customer by developing CL (Customer Royalty) to boost marketing effectiveness, the aim of SMDM is strengthen of "high quality assurance and innovating dealers' sales activity" in "global marketing strategy: "Same quality worldwide, development design and production at optimum locations" as shown in Figure 8 (Amasaka, 2007c,d,e; Yamaji and Amasaka, 2009; Amasaka Ed. 2012; Okutomi and Amasaka, 2013).

Specifically, to promote market creation and to realize quality management through scientific marketing and sales, not by sticking to conventional concepts by using organized "4 sub-core elements (i)-(iv)": the (i) "New Sales Office Image Model (NSOIM)" is important to achieve a high cycle rate for market creation activities by "innovation for building bonds with customer" and "reform of shop appearance & operation".

In the practice stage, it is more important to develop the (ii) "Intelligent Customer Information Network Model (ICINM)" by "strengthening of merchandise power", (iii) "Rational Advertisement Promotion System (RAPS)" and (iv) "Intelligent Sales Marketing System (ISMS)" by "innovation of sales and after-service" and "innovation

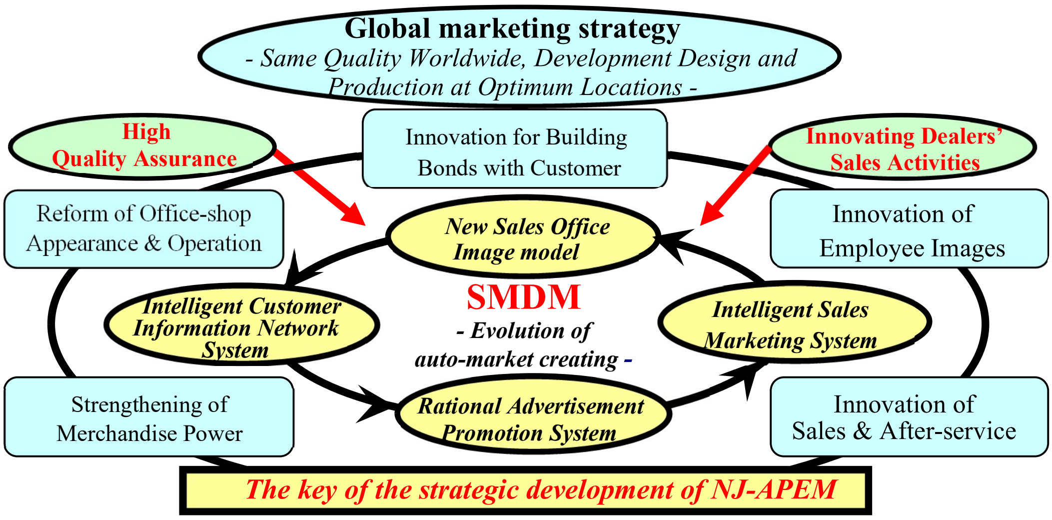


Figure 8. Strategic Marketing Development Model" (SMDM)

of employee images". as the "key of the strategic development of above-mentioned 4.1 NJ-APEM". By these elements, SMDM innovates for bonding with the customer and reforms office-shop appearance and operation (Amasaka Ed. 2012; Amasaka, 2015a, 2017b, 2021, 2022a, 2023b,d, 2025a).Concretely, in 4th core model of above "4.1NA-DPMM", SMDM consists of the 6 sub-core elements to "Developing auto-dealers innovating for customer value creation" as shown in Figure 9.

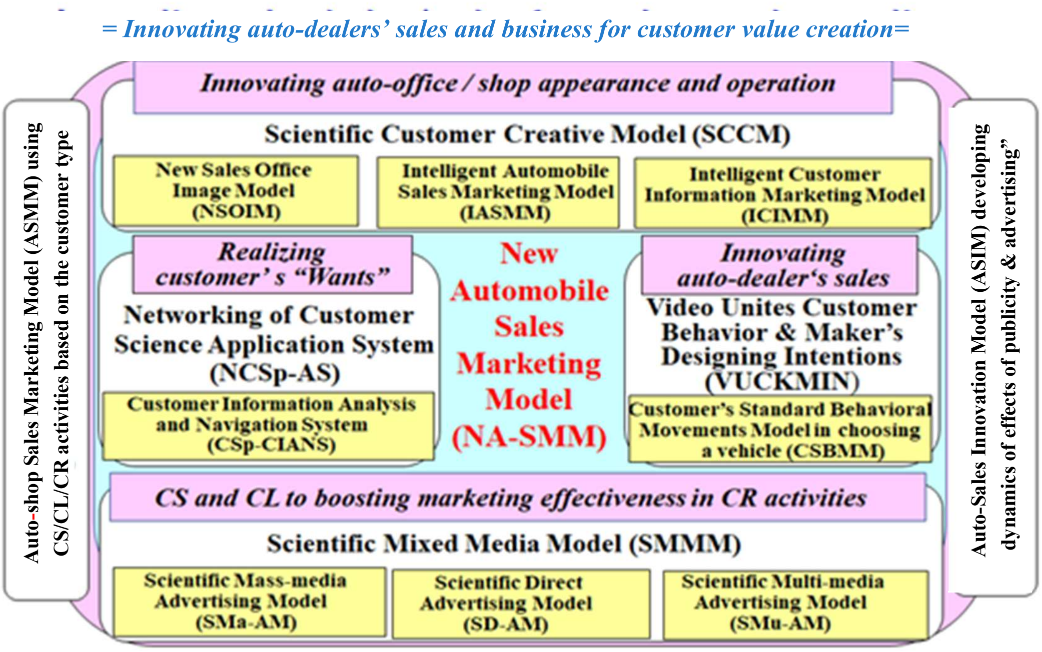


Figure 9. New Automobile Sales Marketing Model (NA-SMM) for innovating auto-dealers' sales

Scientific Customer Creative Model (SCCM) – To strengthen the "Innovative auto-office / shop appearance and operation", SCCM consists of the 3 sub-core model: (i) New Sales Office Image Model (NSOIM), (ii) Intelligent Automobile Sales Marketing Model (IASMM), and (iii) Intelligent Customer Information Marketing Model (ICIMM) which takes the form of strategic marketing using above sub-core elements "NSOIM, IASMM & ICIMM" (Amasaka, 2003b).

Networking of Customer Science Application System (NCSp–AS) – To develop the “Realizing customer’s “Wants”, ICIMM contains the “Customer Information and Analysis and Navigation System (CSp-CIANS) called Toyota’s Intellectual Customer Data Collection / Analysis IntegratedModel (Amasaka, 2005a).

Video Unites Customer Behavior & Maker’s Designing Intentions (VUCKMIN) – To realize the “Innovating auto dealer’s sales”, VUCKMIN develops the “Customer’s Standard Behavioral Movements Model (CSBMM) in choosing a vehicle (Yamaji et al., 2010; Amasaka, 2023b).

Scientific Mixed Media Model (SMMM) – To strengthen the “CS and CL to boosting marketing effectiveness in CR activities, SMMM consists of the 3 sub-core model: Scientific Mass-media Advertising Model (SMa-AM), Scientific Direct Advertising Model (SD-AM) and Scientific Multi-media Advertising Model (SMu-AM) (Amasaka, 2023a,b).

Auto-shop Sales Marketing Model (ASMM) – To improve the repeat customer ratio for vehicles, ASMM named Toyota Auto-shop Sales Marketing Model (T-ASMM) using CS, CL and CR activities based on the customer type, In ASMM development, the author solves problems by using scientific approaches such as “Mountain climbing for problem-solving” for customers of high replacement probability) (Amasaka, 2001, 2007d; Kojima, et al., 2010; Ishiguro, et al., 2010; Ishiguro and Amasaka, 2012).

Auto-Sales Innovation Model (ASIM) developing dynamics of effects of publicity & advertising” - —As part of an organization’s market creation activities, the authors develops the effect of publicity and advertising which contributes to the ASMM. In typical studies, the author demonstrates the effectiveness of the “flyer advertising effect”, “day of the week effect”, “new car effect”. (Amasaka et al., 1998: Amasaka. 2001, 2003b, 2007d, 2009b).

Application examples:

AECD-3CM development usng pychographics for raising customers worth in NA-PMM strategy:

First, to develop the Exterior Design Strategy by using “Psychographics”, the author has conducted the “Advanced Exterior Design Project using Science SQC” named “ADS in Design SQC” for raising customers worth in Toyota and others in the following (Nunogaki et al., 1996; Amasaka et al., 1999a). In “ADS” projects, the author has developed the Automobile Exterior Design Model with 3 Core Methods (AEDM-3CM) for the development of new world car “Lexus” and other model change of various mid-size cars as shown in Figure 10 (Amasaka, 2018).

In core technology (A), the first aim was to hold the characteristic of the profile design (proportion) such as "BMW518, Benz W123, Jaguar X16, etc." placed on the famous car of the world rationally using Design SQC and CS-IDCM. To realize the above knowledge, in core technology (B), the second aim was the realization of the profile design, which is the main elements of exterior design of Toyota’s strategic prestige car “new-model, Lexus” surpassing BMW / Benz by using the “Psychographics” approach method. In core technology (C), the third aim was the realization of the profile design development of various mid-size cars and small size cars (Amasaka, 2018).

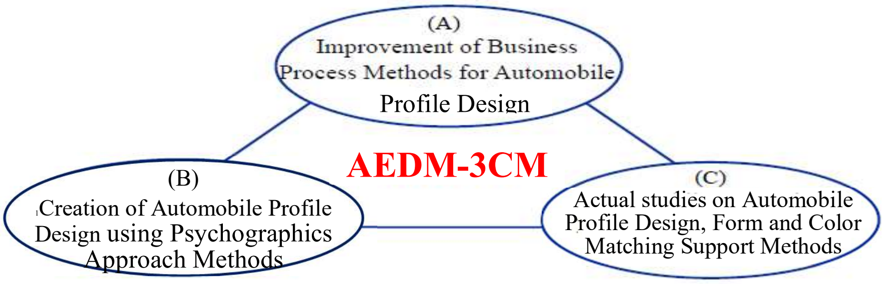


Figure 10. Automobile Exterior Design Model with 3 Core Methods (AEDM-3CM)

Specifically, then, the design work of “APFC-MSM” which is the core technology of the strategic development of ADS projects at present is illustrated by developing the various psychographics approaches as shown in Figure 11 (Toyoda et al., 2014, 2015; Amasaka, 2018). In Figure 11, APFC-MSM starts with the three elements (1) profile design (proportion), (2) form, and (3)) color with the vehicle design concept from product planning stage described in Figure 13, and indicates the applications (I), (II) and (III) (Amasaka, 2015a,b, 2022a,b, 2024a, 2025a).

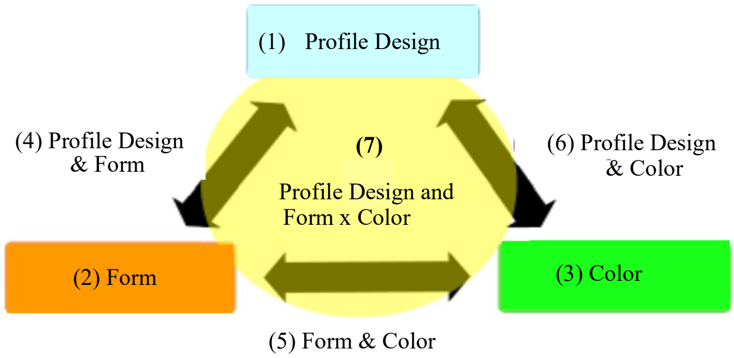


Figure 11. Automobile Profile design, Form and Color Matching Support Methods (APFC-MSM)

As a concrete instance, to develop the AEDM-3CM, the author has established an "Automobile Profile Design, Form and Color Matching Model" (APFC-MM) based on the investigation of "optimum profile design and form matching, form and color matching, and proportion and color matching" described in Steps 1 to 3 of Figure 12. This model outlined was applied to young people in their 20s to see whether the model selected by the method would match their preferences. The effectiveness of the research was thus confirmed as follows (Toyoda et al., 2015; Amasaka, 2018a); In Step 1, the author began by conducting interviews with key automakers and dealers as well as with customers. They also consulted prior research to see which issues had already been addressed and which had yet to be clearly identified.

In Step 2, the author conducted a customer preference survey based on the key issues identified above. In this step, customers were given a questionnaire to find out which vehicles they were interested in, and to pinpoint the main factors they considered when purchasing a vehicle. Once the data was collected, the authors subjected it to a principal component analysis and a cluster analysis in order to quantitatively determine the relationships between different customer senses. In Step 3, the author used the insights gained from the customer preference survey in Step 2 to recruit test subjects that resembled target customers. Once the test subjects were selected, they were each fitted with an eye camera to analyze line-of-sight information. This told the authors where the subjects placed their attention when looking at vehicles. At the same time, an electroencephalogram (EEG) was used to measure brain waves. This device ascertained how the subjects were feeling when they looked at certain parts of the car.

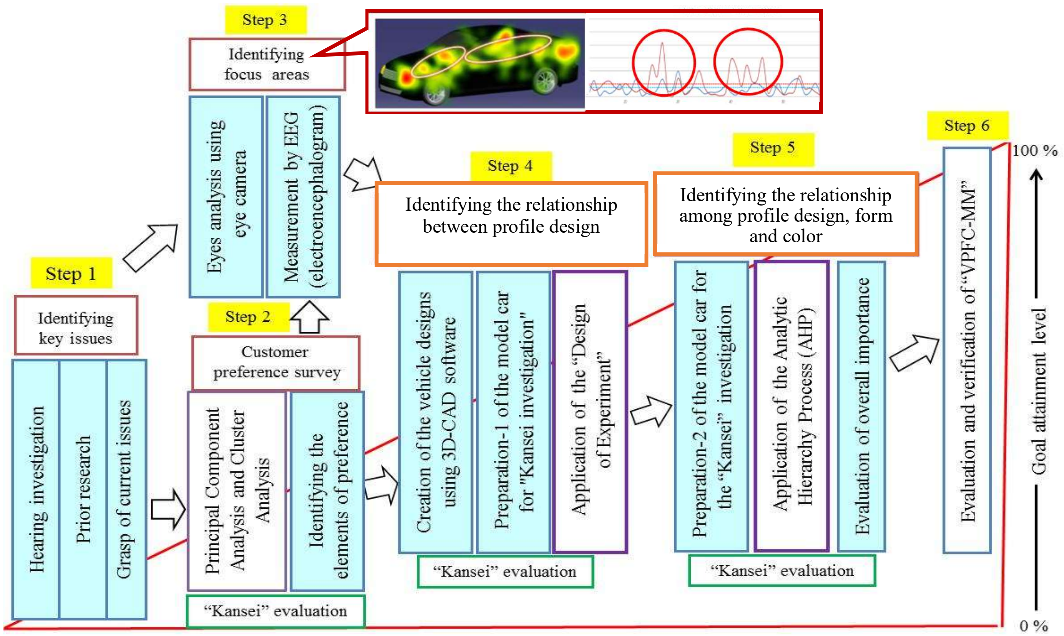


Figure 12. Automobile Profile Design, Form and Color Matching Model (APFC-MM)

In Step 4, the author continued to build upon the information gained in the previous steps in order to identify the relationship between the profile design and the form, two of the critical elements in exterior automotive design. To do this, they used 3D-CAD software to actually convert vehicle characteristics into numerical specifications, thus actually creating the vehicle designs that customers' wants.

In Step 5, the models designed in Step 4 were then analyzed using statistics (Design of Experiments (DOE) and Analytic Hierarchy Process (AHP)) to select the model that had the optimum combination of design elements.

In Step 6, the authors evaluated the success of the model selected in Step 5. Test subjects were again fitted with EEG (electroencephalogram) equipment as the authors compared their reactions to the selected model and other vehicle designs.

Next, each element must be matched: (4) profile design & form, (5) form & color, and (6) profile design & color. Finally, (7) all three elements "profile design, form & color" must be integrated harmoniously to address modern market demands. (Amasaka et al, 1999; Amasaka and Nagaya, 2002; Amasaka, 2002, 2004b, 2005a, 2007c, 2015, 2018; Asami et al, 2010; Takimoto et al., 2010; 2012b; Muto et al., 2011, 2013; Takebuchi et al., 2012a,b; Shinogi, T. et al., 2014; Toyoda et al., 2015; Kobayashi et al., 2016).

In expanding AEDA-3CM and APFC-MCM for the business process innovation that addresses optimizing the automobile exterior design for customer value creation by using CSp-CIANS (Amasaka, 2005a) (See to Appendix E described in Figure E) as follows; (i) compatibility of profile design & package design (interior space) (Okabe et al., 2007; Yamaji and Amasaka, 2009); (ii) Exterior design & interior design color matching (Yazaki et al., Koizumi et al., 2013a, Shnogi et al., 2014), auto-instrumentation design (Yazaki et al., 2012) and (iii) application to exterior design for women customers (Asami et al., 2011).

These studies were carried out in Amasaka New JIT Lab. by collaborating the "Toyota Motor Corp., Toyota Tokyo Design Research Lab., Nissan Motor Corp., Honda Motor Co. Ltd., Mazda Motor Corp., Nippon Paint Co. Ltd., Kansai Paint Co. Ltd. Yamaha Motor Co. LTD, Nippon Research Center LTD. and others (Refer to Amasaka (2018a, 2024a) in detail).

Recently, from these knowledges, the author has created the "Creation of 3 typical "New profile design: (A) Advanced type, (B) Elegant type and (C) Progress type" in near future as shown in Figure 13 (Refer to Kobayashi et al. (2016) and Amasaka (2017c, 2024a,b, 2025) in detail).

(A) Advanced type (B) Elegant type (C) Progress type

Figure 13. Creation of 3 typical "New profile design" in near future

AOP-DDM using "experiment & simulation for high precision & control" in NA-PDDM strategy:
Second, the time between "product development design and production" has been drastically shortened in recent years with the rapid spread of global production. This makes it essential that the development design process - a critical component of Quality Assurance (QA) be reformed to ensure quality (Amasaka, 2010a, 2013).

Specifically, the author shows the "Total Intelligence CAE Development Design Model" (TI-CAE-DDM) as the "typical product development design process" currently as shown in Figure. 15 (Amasaka, 2007d, 2015b; Amasaka, Ed., 2007b). In Figure 15, the author shows that companies first create the "product development design instructions" based on the "market research and product planning". Then, they use these instructions to make development design specifications (drawings) and to promptly convert them to digital format so that they can be suitably processed and applied.

The data is primarily used in numerical simulations known as Computer-Aided Engineering (CAE). CAE and other numerical simulations have been applied to a wide variety of business processes in recent years, including research and development, design, preproduction and testing /evaluations, production technology, production preparation, and Production. These applications are expected to have effective results (Magoshi et al., 2003; Amasaka, 2010b).

In this age of global quality competition, using CAE for predictive evaluation method in design work is expected to contribute a great deal to shortening development design time and improving quality (Amasaka et al., 2012; Amasaka, 2007d, 2008b,c, 2010b). However, generally, at the design and development stage, there is a gap (discrepancy) between "prototype evaluation and CAE analysis results" (Amasaka, Ed., 2007b).

It has become evident that some manufacturers are not fully confident in CAE results. Then, to win for the world quality competition. the author organized both of the "Study group of the ideal situation on the quality management of manufacturing industry" in "Union of Japanese Scientist and Engineers" (JUSE) and "Working Group No. 4 studies for establishment of a needed design quality assurance for numerical simulation at auto-industry in "Japanese Society for Quality Control" (JSQC) (Refer to Amasaka, Ed. (2007a,b) in detail)

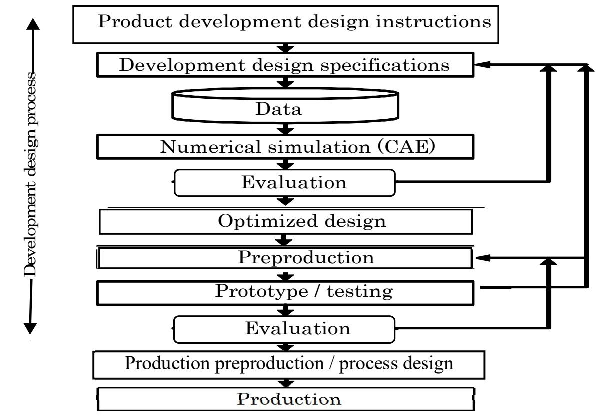


Figure 15. Total Intelligence CAE Development Design Model (TI-CAE-DDM)

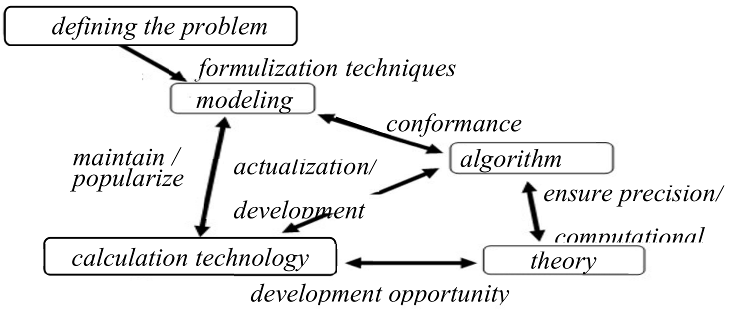


Figure 16. Highly Reliable CAE Analysis Technology Component Model (HR-CAE-ATCM)

Concretely, to develop this model, the author has created the "Highly Reliable CAE Analysis Technology Component Model" (HR-CAE-ATCM) with four components "problem-modeling- algorithm-theory-computer" as shown in Figure 16 was designed to make the shift from conventional prototype testing methods to effectively applying CAE in predictive evaluation methods. The comprehensive issuance of this model is essential to achieving the desired shift (Amasaka, Ed. 2007b; Amasaka, 2007b,d, 2008c,d, 2009b, 2010a,b, 2015a,b).

In Figure 16, the critical aspects of this model include "(i)-(v)"; (i) defining the problem (physically checking the actual item) in order to clarify the mechanism of the defect, using visualization technology to identify the dynamic behavior of the technical issue; (ii) full use of formulization techniques to generate logical modeling (statistical calculations, model application); (iii) constructing compatible algorithms (calculation methods); (iv) developing theories (establishing theories required to clarify problems) that ensure the precision of numerical calculations and sufficient computational capability; (v) comprehensively putting the above processes in action using computer (selection of calculation technology).

As a concrete instance, to develop the HA-CAE-ATCM using CSp, the author has developed the Automobile Optimal Product Development Design Model (AOP-DDM) realizing high precision & control in order to achieve highly-accurate CAE analysis equivalent to prototype testing results as shown in Figure. 17, which contributes to high quality assurance as well as QCD simultaneous achievement in automobile development design (Amasaka, Ed. 2007b, 2012; Amasaka, 2008b,c, 2009c, 2010a,b, 2015a,b, 2017b, 2019b, 2022a, 2023a,c, 2024a,b, 2025a; Amasaka et al., 2012).

Moreover, from the viewpoint of achieving highly-reliable CAE analysis as the applying HR-CAE-ATCM), the author has illustrated the Highly Precise CAE Technology Component Model (HP-CAE-TCM) by realizing "Intelligence CAE software creation requirements" as shown in Figure 18. In described in Figure 18, the author shows the "illustration: Knowhow linkage-cycle with reciprocal action from (i) to (iv) below.;

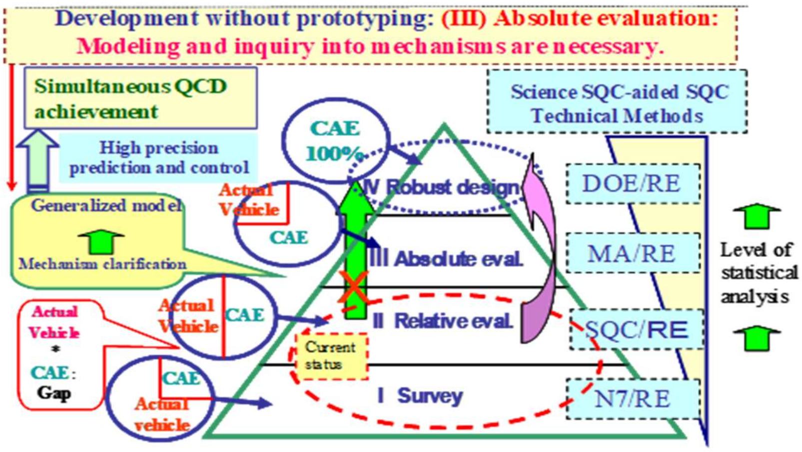


Figure 17. Automobile Optimal Product Development Design Model (AOP-DDM)

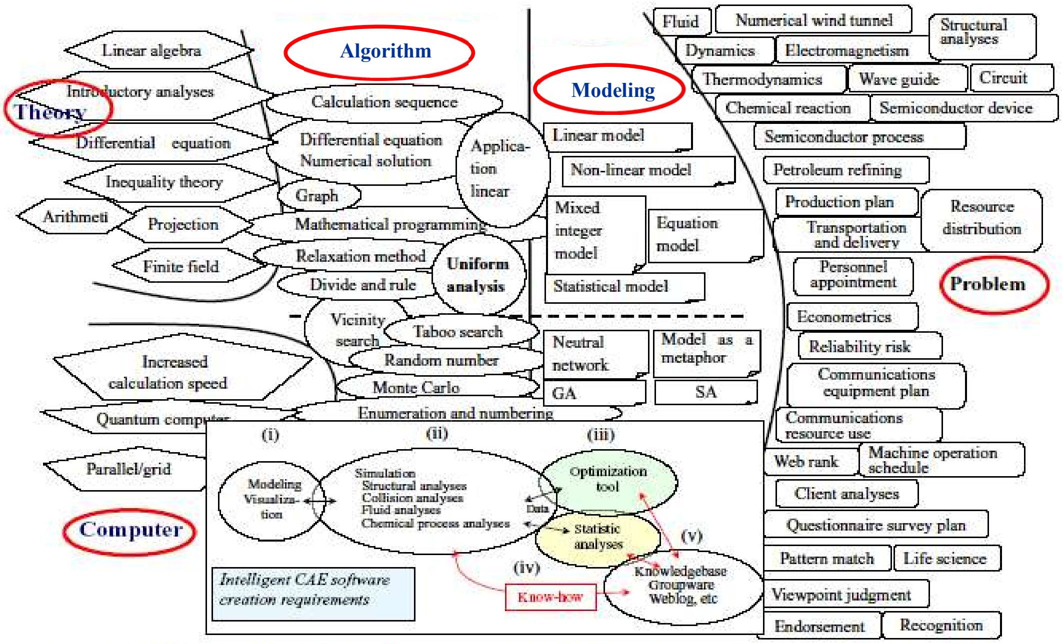


Figure 18. Highly Precise CAE Technology Component Model (HP-CAE-TCM)

Specifically, in Figure 18, the process of CAE first starts with (1) Problem - Setting of problems to be solved, as well as (2) Modeling- Modeling of these problems as some type of mathematical formula.

In CAE, when using calculators as a means to analyze the model, such a means of analysis needs to be provided in the form of a calculation procedure, namely, (3) Algorithms - So that the software can perform calculation. (4) Theory - The validity, applicable range, and performance or expected precision of such algorithms themselves can be deduced from some kind of theory. (5) Computer - Needless to say, the technology related to the computer itself functioning as “hardware” to realize the algorithms, is undoubtedly a factor having a large effect on the success of CAE.

As these results, success in AOP-DDM depends on the “collective strengths” of the elemental technologies. The formulation of such “implicit knowledge” confined to the personal know-how of the engineers is an indispensable step to be taken for sophistication of CAE as the “Problem-Solving methods”.

Then, skilled CAE engineers are not experts in all the fields of the elemental technologies. But they understand their characteristics and interactions as the “implicit knowledge” and thus conduct selection combination to obtain favorable interactions and consequently the desired results. Therefore, it is positioned as a major theme in author’s work (Amasaka, 2007d, 2008c, 2009b, 2010b; Amasaka, Ed., 2007b, 2012, 2017; Amasaka et al., 2013).

As thw actual applications of AOP-DDM using SSTTM named Total Task Management Team Activity (TTMT), the author has contributed to the solution of bottleneck technologies of the auto-makers of the world for realizing QCD filfiment as follows; (Amasaka, 2015a, 2017b).

First, the (1) Brake pad quality assurance (QA) while minimizing squeal through exchange of the result of sensitivity analysis on the causes of squeal and braking perfoemance in Toyota, Aishin-Seiki Co. LTD and Aishin Chamical Xo. LTD below, (Refer to Amasaka, (2012a, 2015, 2024) in detail). As the TTMT activity is remarkable is follows; the (i) Estimated merket claim ratio reduction to 1/6 (from 2.6 % to 0.4 %), (ii) In process fraction defective: down 60 % (from 0.5 % to 0.2 %),, Short convergence of initial failures: from 9 months to 4 months, and Cost reduction: 9.4 % (154 Yen/unit).

Second, the (2) High reliability assurance of the auto-transaxle oil reakage by Toyota and NOK Corporation in TTMT. The oil seal for the drive system works to seal lubricant inside the transaxle unit.

The cause & effect relationship between the oil seal design parameter is not necessarily fully clarified and is not completely eliminated, pressing a continual engineering problem (Lopez et al., 1997).

Then, the auther has develoed the problem-solving as follows; (i) fault analysis and Factor analysis to reaerch the oil leakage mechanism, (ii) In oil seal mechanism solution, clarification of grawring of the forein matter wherr it’s rip rotates in conttact with the bearing surface in drive shaft, and (iii) causing cavitation by visualization. Then, from these results and the knowledge, the author has created the (iv) “Oil Seal Simulator” using above HR-CAE-ATCM. (Refer to Amasaka Ed. (2007b) in detail).

These actual researches led to tow measures to improve design qualty (shape and materials): (1) strengthen gear surfaces to to prevent occurrence of forein matter even after the B10 life (L10 Bearing tto MTBF) to over 400,000 km ‘improve quality of materials and heat treetments) and (2) foemulate a design plan to scientifically ensure optimum lublication of the surface layer of the ioi seal lip where rates in contact with the drive shaft. The result of these countermeasures was a ruduction in oil seal leaks (market complains) to less than 1/20th their original incidence (Refer to Amasaka (2014a, 2023, 2025) in detail).

Recently, in expanding AOP-DDM using HP-CAE-TCM, the author has established the Bolt-Nut Tightening Simulator using Highly Precise CAE Technology Element Model (HP-CAE-TEM) for the solution of the auto-bolt-nut loosening”. This model’s validity is verified with application to study on “loosening mechanism of bolt-nut tightening” as the worldwide auto-manufactures’ bottleneck technology.

In problem-solving using various experiments and CAE, the author has created an excellent “New Design Nut” for the prevention of bolt-nut looseness with “excellent cost performance and reduction of vehicle market claim” (Refer to Amasaka Ed. (2007a,b) and Amasaka, (2022a,b, 2023a, 2024b, 2025a) in detail).

The results of these researches have spreaded in many munufacturing industries below. The (i) "Study grup of the ideal situation the quality management of the manufacturing industry" naned Amasaka's forum (Union Japanese Scientists and Enginees, JUSE) and (ii) "Establishment of a neeeded design quality assurance framework for numerical simulation (Japanese Sosietty for Quality Control, JSQC) which the autior led, Bridgestone Corp., Daikin Jndustries Ltd., Fuji Xerox Co. Ltd., Hino Motors Ltd., NEC Corp., NHK Spring Co., NTT DATA Mathematical Systems Inc., Toyota Moor Corp., Misuho Reseaerch Institute Ltd., Amasaka New JIT Laboratory in Graduate School of Science and Engineering of Aoyama Gakuin University, etc..indicate the case studies which can hold the validity of AOP-DDM strategy for realizing simulteneous QCD.

NA-GPM development for the "Innovation of production engineering & production preparation" using 6 sub-core management technologies in NA-DPMM strategy:

Production planning employing TPS-LAS, HDPS and HI-POS:

First, in TPS-LAS application based on production engineering, the author has developed a simulation of main body conveyance using its four constitute sub-systems ((i)-(iv)) to illustrate a highly liable production process that has contributed to the reform of production planning as shown in Figure 19 (Sakai and Amasaka, 2006a; AmasakaEds.2008; Amasaka and Sakai, 2011).

Specifically, a hypothetical production line is set up within a "digital factory" on a computer. (i) TPS-LAS-DFS is then used to reproduce the flow of people and parts within the production site. This enables any interference between production machinery and production cycle times to be checked in advance using simulations. One type of advance simulation uses (ii) TPS-LAS-RCS for the optimum placement of welding robots for the main body to ensure that no interference occurs.

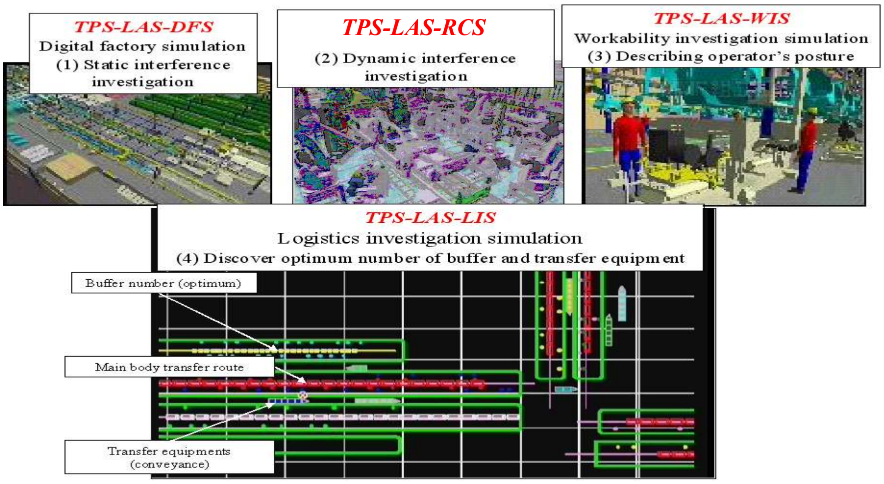


Figure 19. TPS-LAS, Developing the Simulation of Main Body Conveyance

Next, advance verification is performed using (iii) TPS-LAS-WIS to ensure that the predetermined work (standardized work) is carried out within the predetermined cycle time with no waste (muda) or overburdening (muri) and (iv) TPS-LAS-LIS is used to establish optimized conveyance routes between processes and determine optimum buffer allocations.

In addition, in HDP system application using production engineering, the author has carried out the image training of production processes in actual order of automobile assembly operations in order to the innovation of production planning as shown in Figure 20 (Sakai and Amasaka, 2007b). To intellectual training, this is done at the preparatory stage before beginning mass production without having a real product on hand. HDP promotes the leveling of the workload of operators in each process, and then completes the building up of production line even before launching it using Total Linkage System (TLS) of intellectual production information through the product design, production engineering and manufacturing.

Specifically, HDP creates and supplies in advance "Standard Work Sheets" on which production operators have recorded each task in the correct order for jobs such as assembly work, by using design data for new products and facilities prepared from design through to production technology, even if there are no production prototypes. The characteristics of HDP enables visualization training for machining processes step-by-step in the order that parts are built up, even if the actual product does not yet exist. This system is proving to be very effective in raising the level of proficiency for processes requiring skills and capabilities at the production preparation stage.

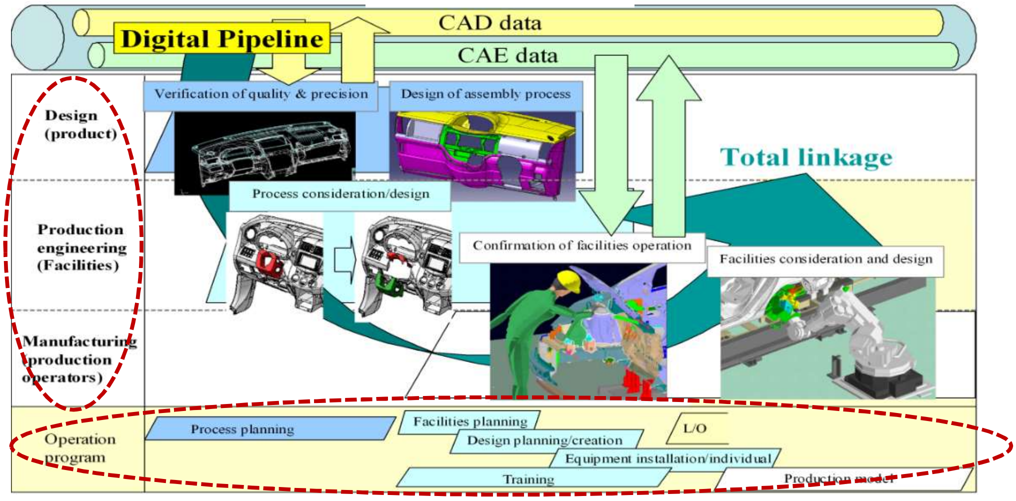


Figure 20. HDP System, Raising the Level of Skills and Capabilities

Furthermore, in HI-POS application employing production engineering, the author has created the intelligent operator development system intended to establish a new people - oriented production system as shown in Figure 21 (Sakai and Amasaka, 2003, 2005, 2006b, 2007a,b, 2008).

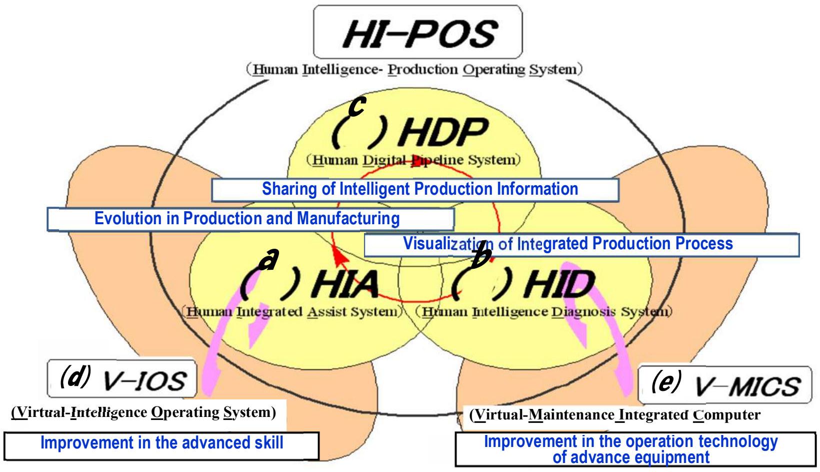


Figure 21. HI-POS, Strengthening of the Intelligent Operator Development System

Specifically, the author has developed three constituent sub-systems–(a) HIA for the evolution in production and manufacturing, (b) HID for the visualization of integrated production process based on the above (c) HDP for the sharing of intelligent production information.

Then, to strengthen the integration of HI-POS, this system is integrated with two support systems–the following (d) V-IOS for the improvement in the advanced skill, and (e) V-MICS for the improvement in the operation technology of advance equipment. The combined applications of TPS-LAS, HDP and HI-POS are currently being contributed as a part of global production, and proving to be effective both in Japan and overseas.

Production preparation engineering employing V-MICS, IPOS and TPS-QAS:
Second, for the strengthening of production process, V-MICS takes a server and client system configuration employing DB (data base) and CG in order to browse information whenever necessary from the client computers at each maintenance station via the network, and can also input any special items as necessary as shown in Figure 22 (Sakai and Amasaka, 2005).

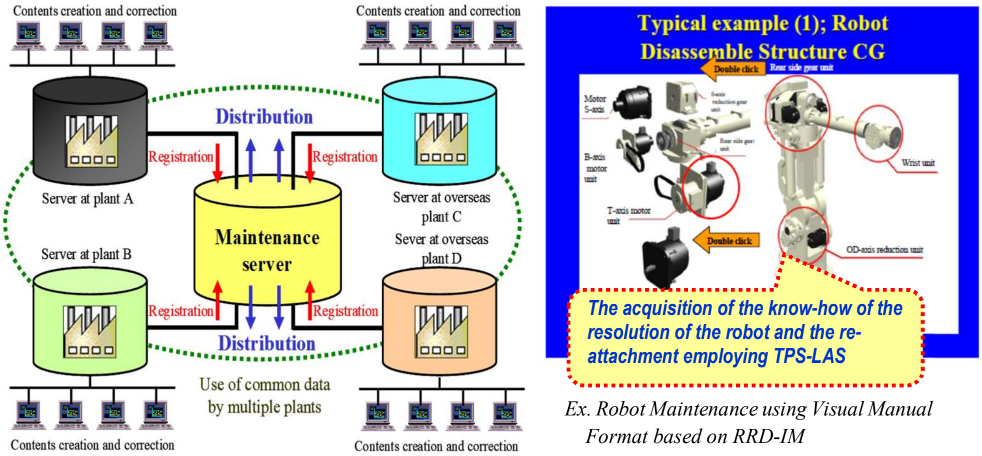


Figure 22. V-MICS, Systematizing "Managerial technique of production facilities"

In V-MICS application using HDP, TPS-LAS, HI-POS, V-IOS and RRD-IM, the author has developed combining both the (i) Production Process Optimization Simulation (PPOS) and (ii) Work Operation Combination Simulation (WOCS) for the high productivity (Sakai and Amasaka, 2007a,b).

PPOS shows the verification of the operators interfering with one another when determining which combinations of vehicle models cause the overlapping of operators in the time series in order to evaluation and problem finding as shown in Figure 23. This is an aerial view of the process in which a vehicle is carried on the conveyor at a fixed speed, and the walking routes of the operators performing assigned work operations are displayed in real time in straight lines.

When multiple operators performing different operations in one process are overlapped (that is when operators' interference occurs), it is displayed instantly, and the information on which combination of models is also output immediately. Verification will be conducted through simulation as to whether operators can complete their entire operation of one process in the set "Takt-Time" and "Heijunka" (Amasaka, 1988, 2009a). Based on the simulation, verification results are displayed showing which process, on which vehicle model, caused the operator to stop the conveyor.

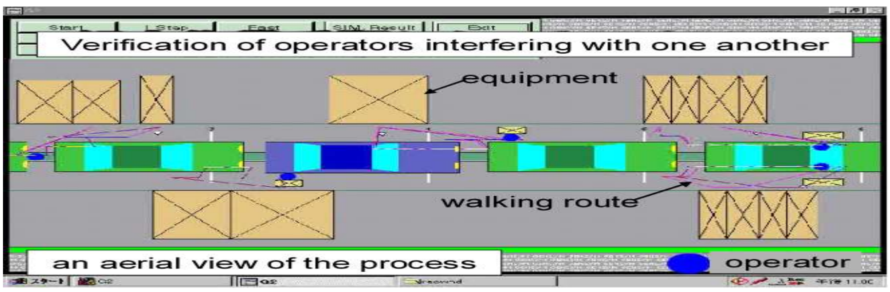


Figure 23. PPOS example of "Verification of operators' interfering with one another

WOCS can be carried out in the real Takt-Time based on Heijunka:-
Furthermore, in Figure 24 (left), by sorting out the working time and walking time from the accumulated time results, the uneven distribution of the net-working time and the non-working time, such as time spent walking, are stratified to serve as a guideline for reviewing the process layout.

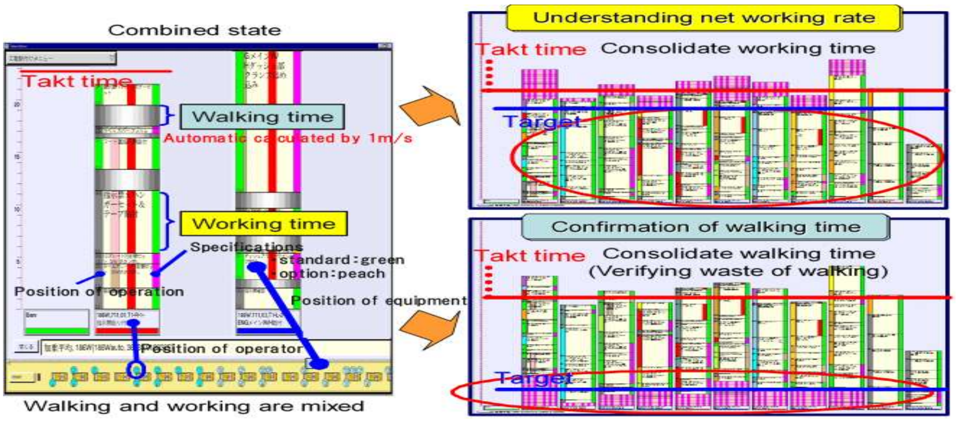


Figure 24. WCOS example of "Accumulated work operations"

Then, Figure 24 (right) shows the re-calculation of the work accumulation after reshuffling the basic work operations between processes. Such changes can be easily made on the accumulative simulation screen by dragging and dropping with the mouse, immediately confirming the work points of previous and subsequent operations while automatically adjusting the walking time involved. Second, to employ I-POS strategically, the author has developed the (i) V-IOS, (ii) RRD-IM and (iii) TTD-IM employing HDP, HI-POS and TPS-LAS below.

V-IOS and (ii) RRD-IM using HID and Visual Manual is intended to improve the skills of new (inexperienced) production operators both in Japan and overseas. In Figure 25, at special training centers with simulations of actual assembly lines, (a) training processes for assembly work, and (b) work training systems for assembly work are employed in the training of operators. Then, once a certain level of skills has been mastered, operators progress to actual assembly lines where they are promptly and methodically developed as highly skilled and experienced technicians using (c) standard work sheets extracted (Sakai and Amasaka, 2003).

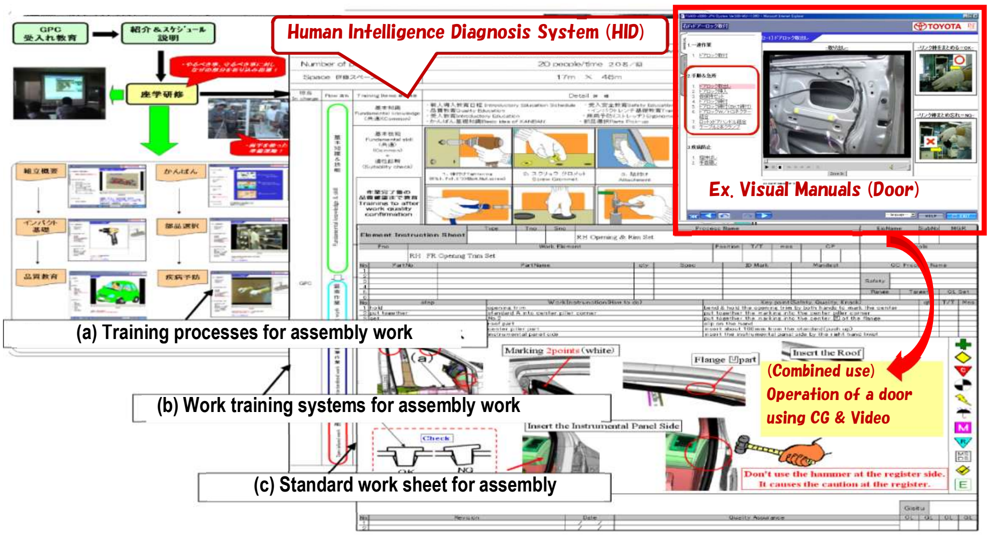


Figure 25. V-IOS example for the Skill strengthening of operators using "Virtual operation"

AWD-COS constitutes a fundamental reform of work and labor named "Toyota's Epoch-Making Evolution in the Environment Model".

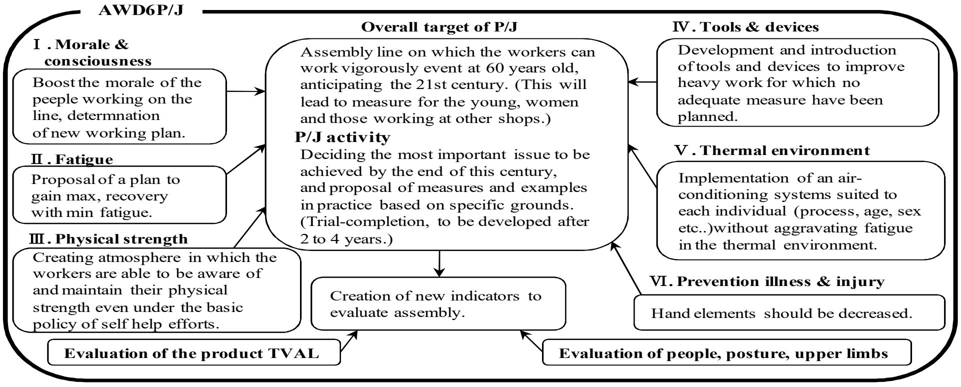


Figure 26. AWD-COS example for the "Aging & Work Development 6 Programs Project"

In Figure 26, the author has initiated a company-wide project called "Aging & Work Development 6 Programs Project (AWD6P/J)" in order to combat the effects of aging as follows; Project I is arousing motivation in workers, Project II is reviewing working styles to reduce fatigue, Project III is creating physical strength under the self-help efforts, Project IV is improving heavy work with user-friendly tools and equipment, Project V is creating thermal environments suited to the characteristics of assembly work, and Project VI is reinforcing illness and injury prevention (Amasaka et al., 2000c; Amasaka, 2004a, 2007c).

For example, Figure 27 illustrates a result of Project II activity as the "Study work of changing the rest pattern to reduce fatigue". In Figure 27(a), fatigue during operation gradually increases with time and decreases after each break shown in Normal Rest Pattern. In Figure 27(b), as the way to minimize fatigue, new 2 rest patterns (A & B) were tested to analyze the difference with the fatigue level of "Normal Rest Pattern". In Figure 27(c), a line stop was cut by half by the decrease in quality defects & human error (⬇In these research effects, Toyota adapts a New Rest Pattern A in Japan and overseas).

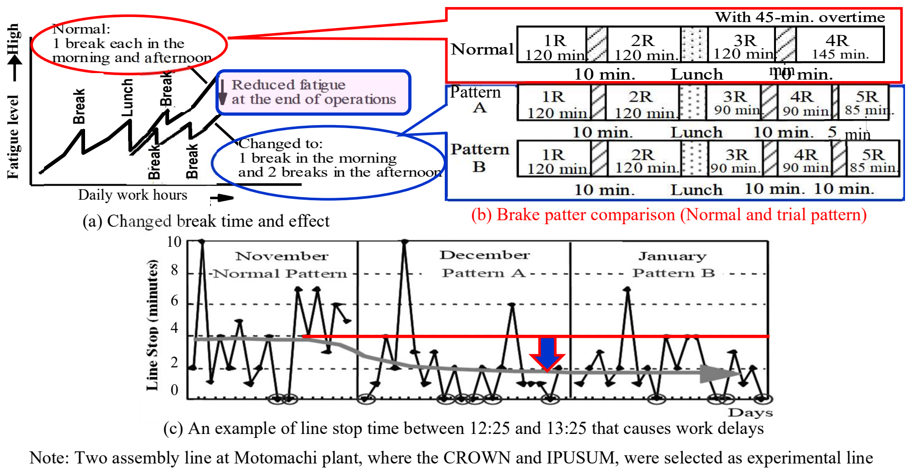
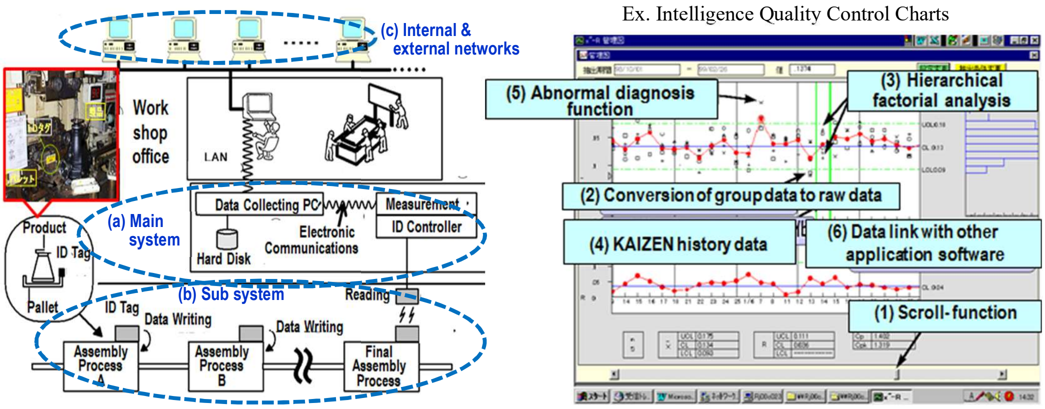


Figure 27. An example of Project II-Study work of changing the rest pattern to reduce fatigue

Third, the author has created the TPS-QAS with two sub-systems–(i) QCIS and (ii) ARIM below (Amasaka and Sakai, 1996, 1998, 2009).

(i) QCIS enables the manufacturing development with "superior quality **&** productivity by "integrating the high-precision quality control system". In Figure 28(a), this shows a hardware system of trans-axle assembly line holding the "(a) main-system**,** (b) sub-system and connects and (c) internal & external networks. In Figure 28(b), this shows a software system of "intelligence quality control charts", and analyzes the "diagnosis of process management abnormalities" holding: the "(1) Scroll-function, (2) Conversion of grouped & raw data, (3) Hierarchical factorial analysis, (4) Kaizen, improvement of history database, (5) Abnormal diagnosis and (6) Data link with other application software".



(a) Outline of hardware system (Trans-axle unit) (b) Outline of software system

Figure 28. An example of QCIS application using Quality Control Charts

(ii) ARIM enables the strengthen reliability of facility operation and maintenance of information management. In Figure 29(a), this shows a hardware system for gathering the operating efficiency and failures with Andon System, and clusters of machinery on each production line in Japan and overseas.

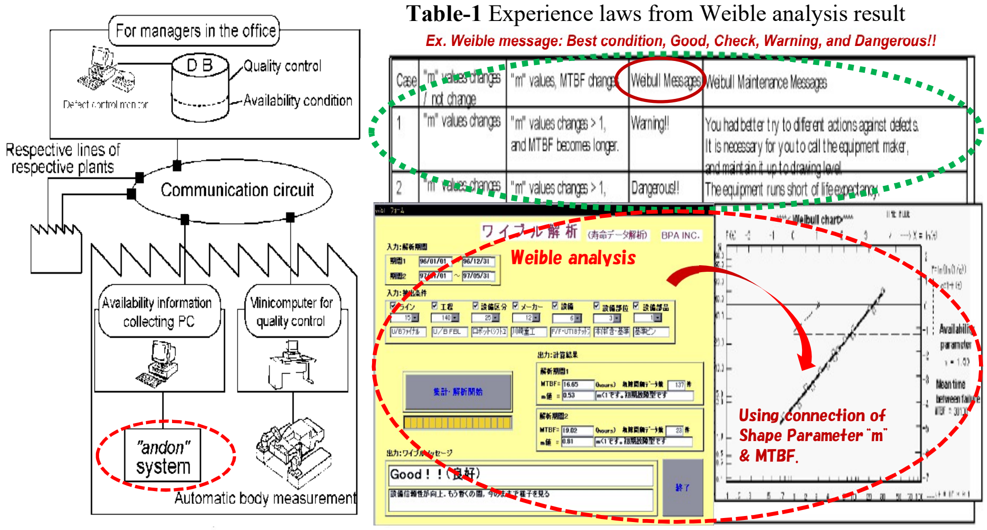


Table-1 Experience laws from Weible analysis result

Case	"m" values changes / not change	"m" values, MTBF change	Weibull Messages	Weibull Maintenance Messages
1	"m" values changes	"m" values changes > 1, and MTBF becomes longer.	Warning!!	You had better try to different actions against defects. It is necessary for you to call the equipment maker, and maintain it up to drawing level.
2	"m" values changes	"m" values changes > 1,	Dangerous!!	The equipment runs short of life expectancy.

(a) Outline of hardware system (b) Outline of software system using Weible analysis

Figure 29. An example of ARIM application using Weible Analysis

In Figure 29(b), for developing the preventive maintenance, this software system performs the Weibull analysis, failure diagnosis and failure life predicting using Table 1 based on the reliability engineering.

NA-GPM development for the "Innovation of automobile manufacturing engineering" using:
sub-core management technology in NA-DPMM strategy:
Improving the skills of experienced and inexperienced machine workers

To develop IWV-IMM and WVEM based on the NJ-GGM, the author has clarified the factors involved in improving the "skills of experienced and inexperienced machine workers" engaged in typical "lathe work" with 6 processing stages of "setup, rough cutting, semi finishing, making adjustments, finishing and completion" by using S45C workpiece (Yanagisawa, et al., 2013). Specifically, using "Electroencephalography" (EEG) and statistical science, the physical and mechanical characteristics of a workpiece are those tensile strength, elongation, hardness, thermal conductivity, density, Young's modulus, shear elasticity modulus and yield strength, and the relative influence of these characteristics are clarified in accordance with the cutting conditions. Through these investigations, the author clarified the important criteria for making decisions based on the chip color and chip shape.

For example, using covariance structure analysis, Figure 30 illustrates an example of clarifying factors for the "chip color during finishing" by experienced machine workers, and clarifies the influence these elements receive from each factor. This research clarifies points where inexperienced workers need guidance such as cutting tool selection, which is beneficial for both the person giving guidance and the person receiving guidance. Moreover, the author has investigated how intuition and knowhow make a difference between the skills of experienced and inexperienced workers based on the validity of other researches (Kawahara et al., 2016). These studies have contributed to technical training of inexperienced workers.

Accelerated Technical Training System for the highly skilled operators:

To realize the shortened training of highly skilled operators in auto-assembly line employing "IWV-IMM and WVEM", the author has developed an "Accelerated Technical Training System" (ATTS) by development of "HI-POS with HIA and HID" above (Sakai and Amasaka, 2006b, 2007b, 2008; Amasaka et al., 2008). Specifically, ATTS contains the four sub-system of vehicle assembly process – (i) Assessment system of aptitude/inaptitude using aptitude test with eight categories of fundamental skills (: tightening, screw grommet, attachment, connector, hose, plug hole, tube and fitting), (ii) "Optimization system" of training steps with flowchart of training program, (iii) "Skill training system" for newly employed production operators, and (iv) "Shortened training system" for new overseas production operators.

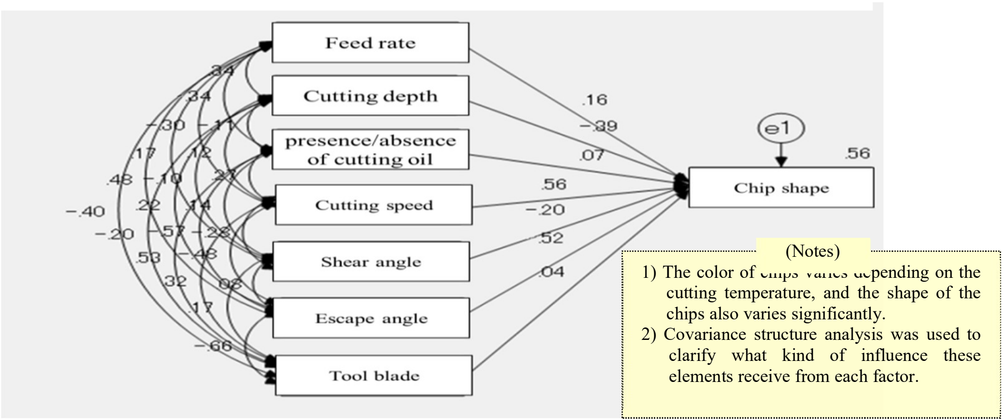


Figure 30. Chip color during finishing using Covariance Structure Analysis

In Figure 31, the author illustrates an application case of "Toyota's shortened training for the new overseas production operators" with four step program based on the courses during 5 courses during five days from "Day 1" to "Day 5"– Classroom lecture, Skill training, Dynamic training with simulating movement and Actual line training. The deployment of ATTS for training newly employed production operators at domestic and overseas manufacturing plants reduced the conventional trainingperiod by more than half, from two weeks to five days, leading the full-scale production to a good start. In this case, the launch of an overseas production plant, the target operating rate was achieved in four months after the start-up.

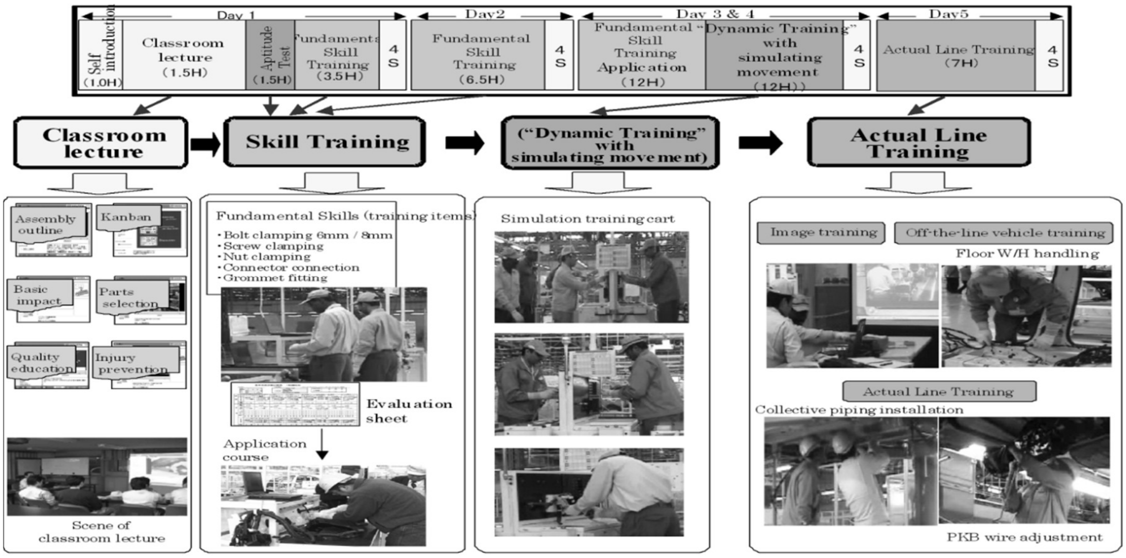


Figure 31. Toyota's shortened training for the "New Overseas Production Operators in ATTS"

Global Intelligence Partnering Model for the global auto-manufacturing strategy:
To develop PPMM above, the authors has established the "Global Intelligence Partnering Model" (GIPM) for the auto-global manufacturing strategy which improves the intellectual productivity of the affairs and management sections (Yamaji and Amasaka, 2007b).

Figure 32 shows the functions of the affairs and management sections as the corporate environment factors for succeeding in global marketing, customer-first, 1) "CS, ES and SS", for 2) high quality product and as a strategic factor to realize it, in order to 3) product reliability (high quality assurance) and corporation reliability (excellent company), and success in 4) intellectual productivity and human resource development.

Figure 32. Outline of GIPM for the global manufacturing strategy

Moreover, 5) global production is realized by these. So the same quality and production at optimal locations are achieved. For that purpose, the highest priority was given to the “i) Intellectual information sharing” and “ii) Strategic Co-Creative Action” so that the “Strategic intelligence application system”, and “Business process high linkage system” can effectively function.

To actualize GIPM, the author has developed the strategic application examples employing Toyota Supply System (TSS) as follows; (a) Creation of “Automobile Exterior Design Model” (AEDM) for raising customers’ worth of world’s prestige car “Lexus”, (b) Improvement of “Paint corrosion resistance and protect plating parts from corrosion” for raising auto-unit-axle reliability, (c) Development of “Mid-frequency tempering equipment using the heating coil of electromagnetic induction” and (d) “Automated straightening equipment” for the realizing high productivity of auto-unit-axle shaft, and (e) “New ceramic materials to the welding nozzle and welding tip” for the improving high operational availability of auto-unit-axle housing” as the epoch-making improvement of QCD (Toyota, 1993; Amasaka, 2004b, 2009a, 2018b, 2019b).

Strategic Cooperative Task Team Model for raising management technology:-
To strengthen promotion of SSTTM and SQM-PMM above, the author has structured the “Strategic Cooperative Task Team Model” (SCTTM) between the auto-maker and affiliated/non-affiliated suppliers as shown in Figure 33 (Amasaka, 2004a, 2008b, 2017b).

To purchase the necessary parts, it will be important for the manufacturer (maker) to mutually cooperate with (a) Supplier I (in-house parts maker (own company)), (b) Supplier II, affiliated maker (capital participation), (c) Supplier III, non-affiliated maker, and (d) Supplier IV, overseas maker (capital participation). In the actual deployment, it is important to strategically organize the stratified task teams for raising management technology as follows: (i) Product strategy, (ii) Engineering strategy, (iii) Quality strategy, (iv) QCD effect, (v) Value of the task teams, and (vi) Human resource strategy.

In SCTTM for the evolution of auto-manufacturing, the important job for the manufacturer’s general administrator is to select jointly from his own company and suppliers: (1) Generators gifted with a special capacity for creating ideas, (2) Mentors having the ability to give guidance and advice, Producers with the capability to achieve and execute, and (4) Promoters capable of implementing things as an organization.

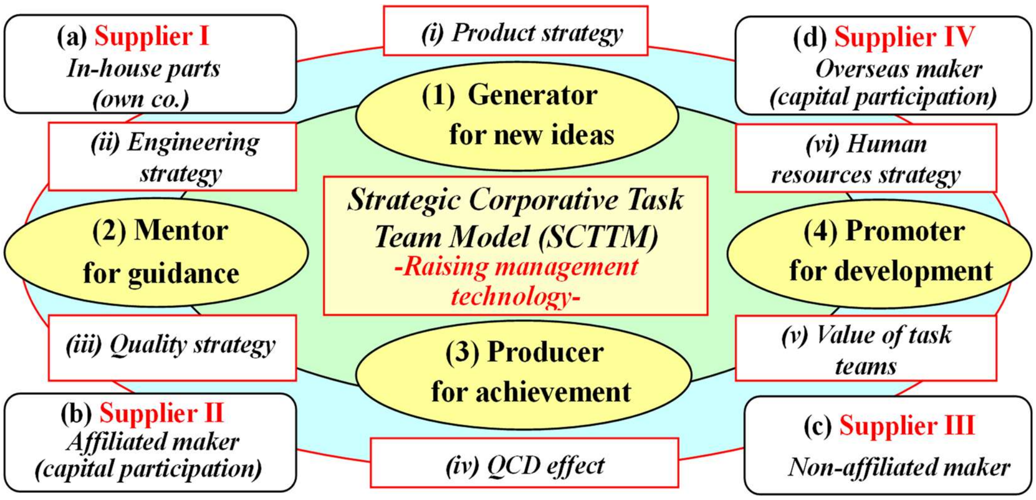


Figure 33. SCTTM for the “Evolution of Japanese Automobile Manufacturing”

Then, as the key to successful SCTTM, the team leader (administrator) should select the members who have at least one of the capabilities for (1) to (4), commission authority and responsibilities to the members, and has himself / herself concentrate on risk management.

To develop this, the author presents typical case studies as the improving of the bottleneck problems of worldwide auto-makers employing “Toyota’s Total Task Management Model” (TTMTM) for realizing simultaneous QCD fulfilment (Amasaka, 2004a, 2017b).

In Suppliers I, II and III, the author developed the establishment of “Brake pad quality assurance” using “Total QA network activity” (QAT) by Toyota, Aishin Seiki, Aishin Chemical and Akebono Brake Industry. The main objective is to establish a technology for attaining satisfactory braking performance while minimizing squeal through the result of sensitivity analysis on the causes of squeal and braking performance.

The result of QAT is remarkable effects as follows; (i) Estimated market claim ratio reduction to 1/6 (from 2.6% to 0.4%), (ii) In-process fraction defective: down 60% (from 0.5% to 0.2%), (iii) Short convergence of initial failures: (from 9 months to 3 months), and (iv) Cost reduction: 9.4% (156 Yen/unit).

Moreover, in other cases of Suppliers I-IV, the author was able to apply the SCTTM as follows; (i) TQM and SQC training for growing human resources of Toyota group in Japan and overseas, (ii) Specific engine fuel consumption improvement, (iii) High reliability assurance of the transaxle oil seal leakage, (iv) Rust preventive quality assurance of rod piston plating parts, (v) Various anti-rusting methods to various section of the vehicle body, (vi) Improvement of total curvature spring back in stamped parts with large curvature, (vii) Improving the reliability of body assembly line equipment, and (viii) Bolt-nut loosening solution by developing “Automobile Optimal Product Design Model” (AOPDM) (Toyota, 1993; Amasaka, 2004b, 2019a,b; Amasaka et al., 2012).

New Global Partnering Production Model for expanding overseas manufacturing:-

To develop “IHS-AMPP using IWV-IMM and WVEM” above, the author has established a “New Global Partnering Production Model (NGP-PM) for Japan’s expanding overseas manufacturing strategy as shown in Figure 34 (Ebioka et al., 2007; Amasaka and Sakai, 2010, 2011).

The mission of NGP-PM is the simultaneous achievement of QCD in order to realize high quality assurance. The essential strategic policies include the following items: First of all, (A) establishment of a foundation for global production, “realization of global mother plants-advancement of Japanese production sites”; Second, (B) achieving the “independence of local production sites” through the incorporation of the unique characteristics (production systems, facilities, and materials) of both developing countries (Asia) and industrialized countries (US, Europe); Third, (C) necessity of developing intelligence operators to promote knowledge sharing among the production operators in Japan and overseas as well as for the promotion of higher skills and enhanced intelligence.

To actualize “NGP-PM”, it is essential to create a spiraling increase in the four core elements by increasing their comprehensiveness and high cycle-ization. Specifically, in realizing “global mother plants”, if Japanese and overseas manufacturing sites are to share knowledge from their respective viewpoints, the core elements must be advanced. To achieve this, a necessary measure is to design separate approaches suited to developing and industrialized countries.

Concretely, in developing countries (1), the most important issue is increasing the autonomy of local manufacturing sites. At these sites, “training for highly skilled operators” that is suited to the manual-labor based manufacturing sites is the key to excellent QCD studies. Similarly, in industrialized countries (2), where manufacturing sites are based on automatization and increasingly high-precision equipment, “training of intelligence operators” resulting in “realizing highly reliable production control systems and ensuring high efficiency” is the key to excellent QCD studies. Moreover, production operators trained at “global mother plants” (3) can cooperate with operators at overseas production bases, and in order to generate synergistic results, can work to “localize global mother plants” in a way that is suited to the overseas production bases.

As the typical examples of “NGP-PM” deployment, the author describes the typical case studies of new integrated local production by partnering Toyota and overseas as follows; (i) “New Turkish Production System” (NTPS), an integration and evolution of Japanese and Turkish Production System”, (ii) “New Malaysia Production Model” (NMPM), a new integrated production system of Japan and Malaysia, (iii) “New Vietnam Production Model” (NVPM), developing hybrid production of “Japan and Vietnam”, and (iv) Developing Advanced TPS at Toyota Manufacturing USA (Amasaka, 2007c, 2016; Yeap et al., 2010; Shan, et al., 2011: Miyashita and Amasaka, 2014, 2016). Deployment and validity of these studies are detailed to Amasaka (2015a, 2017a, 2020b, 2022a).

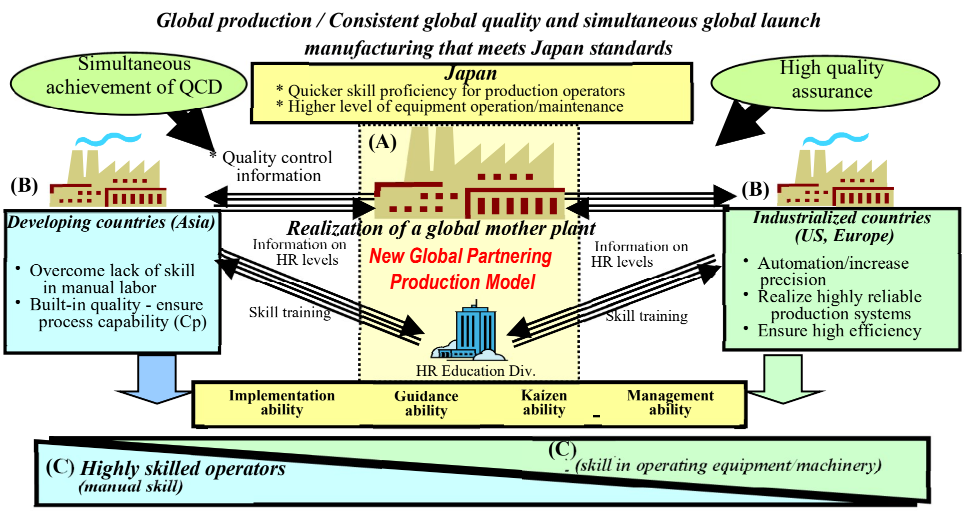


Figure 34. NGP-PM for Japan's expanding overseas manufacturing strategy

Total Quality Assurance Networking Model for Toyota's new defect prevention:-

To survive globalization and worldwide quality competition, Japanese manufacturing must work in order to shorten development times, ensure high quality and lower costs for the shift response to market changes (Amasaka, 2007a). To develop the "IHS-AMPP" above, the author has created the "Total Quality Assurance Networking Model" (TQA-NM) (Amasaka, 2004b; Kojima and Amasaka, 2011).

In Figure 35, TQA-NM focuses on the subject of (A) Clear QA standards that make use of quantitative values (process capability, Cp), (B) Systematic use of know-how and experience resolving part issue, (C) Development of staff (workers) and managers familiar with the site, (D) QA tools for staff (workers) and managers and (E) Process visualization enabled which turned their attention especially to the (F) Stronger partnerships between assembly manufacturers and suppliers".

Then, this model is done through the "defect occurrence prevention / simultaneous achievement of QCD" that come from strategically deploying high-level quality assurance process for the "Swift response to market change and CS, ES and SS" as follows; (I) One of the technological components in achieving these goals is strengthening QA networks, and deploying QA tools, (II) Second is establishing clear quantitative QA standards that are not affected by worker experience, (III) Third is creating a systematic use of know-how that can make use of worker expertise and information on past defects in an organized manner, and (IV) Fourth is the development of workers and frontline staff as the high quality HRD (Human Resource Development) who are familiar with the site.

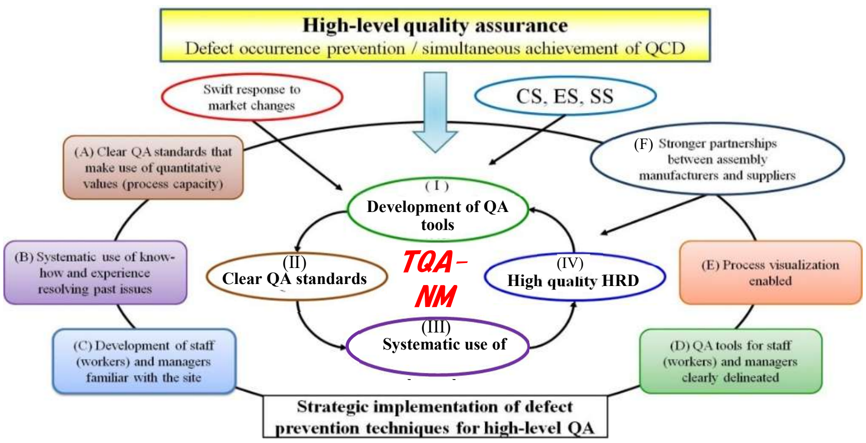


Figure 35. Outline of Total Quality Assurance Networking Model (TQA-NM)

To realize TQA-NM, specifically, the "Total QA Networking Chart" shown in Figure 36 is a defect occurrence prevention technique featuring a combination of QA tools. It also uses the "Quality Function Deployment" (QFD) or "Failure Mode and Effect Analysis" (FMEA), and matrix diagrams to deploy partnerships. The vertical axis identifies joint processes by suppliers and assembly manufacturers, from the arrival of goods to shipment. The horizontal axis lists individual defects.

The degree of QA is indicated where the two axes intersect, which allows a quantitative value indicating the importance of process management tasks to be assigned to each. Each process is comprehensively evaluated on the basis of what the defect occurrence prevention tasks are for that process and how highly they are ranked in terms of QA level using QA matrix. The task of this chart is ensured based on the "Ranking Occurrence and Outflow prevention", and is established a high-level QA system.

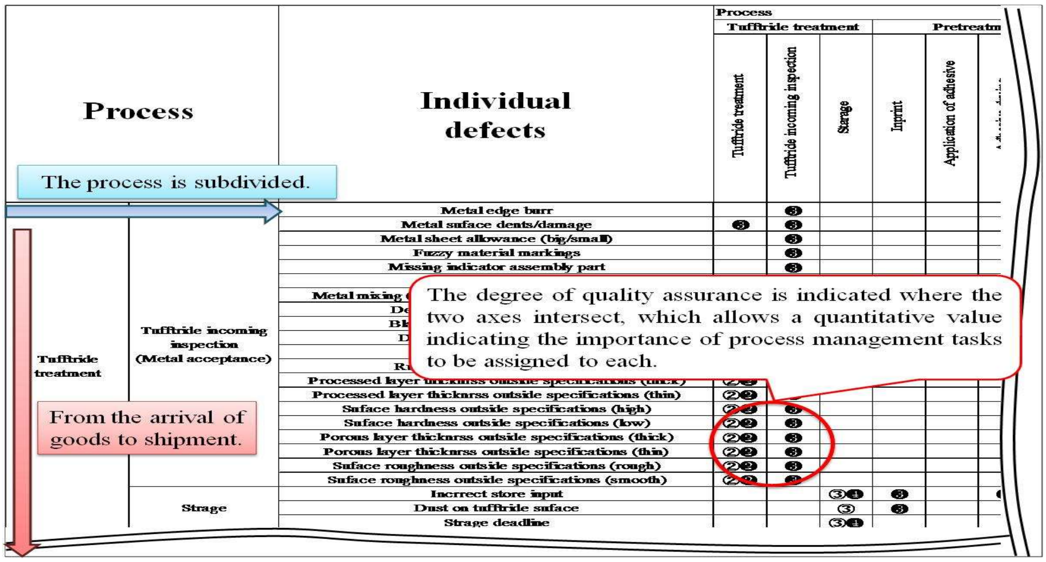


Figure 36. An example of the "Total QA Networking Chart"

As the pioneering examples of TQA-NM deployment of Toyota and Toyota's SCM strategy, the author presents as follows; (i) Establishment of optimum casting conditions for compact DOHC cylinder head, (ii) Development of ferrite heat resistant cast steel, (iii) Measures to be taken for difficulties in the manufacture of aluminum die-casted head cover, (iv) Rust prevention quality assurance of plated components, (v) Improving the brake pads quality of trans-axle unit, (vi) CAE analysis for oil leakage mechanism of transaxle oil seal, and others (Toyota, 1993; Amasaka, 2004b, Amasaka Ed.,2012; Amasaka, et al., 2012). Deployment and validity of these studies are detailed to Amasaka (2015, 2017a, 2020b).

New Automobile Sales Marketing Model" for innovating auto-dealers' sales in SMMM strategy:-

Scientific Customer Creative Model (SCCM) to strengthen auto-products plan and marketing The author presents a "Scientific Customer Creative Model" (SCCM) for innovating-auto office / shop appearance and operation which takes the form of strategic marketing using 3 sub-core elements "NSOIM, IASMM & ICIMM" as shown in Figure 37.

In Figure 37, the entire structure consists of 3 domains as the Open marketing activities that can be performed through steady linkage with all other divisions in a company-wide framework; (1) Marketing Strategy, (2) Manufacturing Process and (3) Market & Customers. In each domain, the key marketing items are linked by paths to show how they are associated (Amasaka, et al., 2005: Shimakawa et al., 2006).First of all, in the (1) Marketing Strategy domain, the key point is how the market segment and the target market are determined. In general, the target market is determined based on the company's core competencies, competition strategy, and resource strategy over the medium and long-term basis. By introducing a scientific analysis approach that uses IT, it clarifies a potential target market from the changing market or the customer structure analysis.

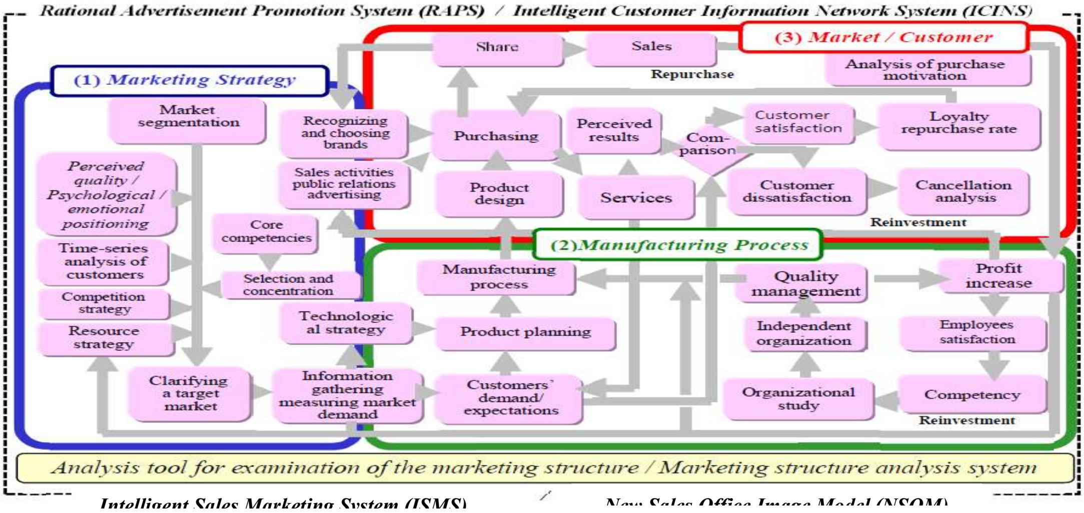


Figure 37. Scientific Customer Creative Model (SCCM) to strengthen auto-products plan and marketing

Secondly, in the (2) Manufacturing Process domain, the key point is to collect/analyze customers' demands and expectations precisely. At this time, it is important to consider what value the customers want. When implementing information collection/analysis, customer value is described in numerical form from many different viewpoints, and a new product which is aimed at enhancing customer value is implemented through the flow of planning→ development→ production. Thirdly, in the (3) Market / Customer domain, the key point is to learn the structure of the customer's motivation to buy products in CS and CL (Customer Satisfaction and Customer Loyalty) activities. Then, it is necessary to extract the elements for CR (Customer Retention) activity from this data and utilize it for specific kaizen activities such as reflecting it in future products. It is important to develop an "analysis tool for close examination of the marketing structure" and a "marketing structure analysis system" that will support marketing activities in these three domains stated above from a strategic marketing viewpoint. Then, to development of the SCCM, the author illustrates the NA-SMM with 6 sub-core elements "①-③") and those characteristics as follows;

① New Sales Office Image Model (NSOIM)－In 1st sub-core element, to evolute the auto-business and sales, NSOIM develops the innovation of office/shop appearance and operation: (a) Innovation for building ties with customer, (b) Innovation of business negotiation, (c) Innovation of after-sales service, , and (d) Innovation of employee images as shown in Figure 38 (Amasaka et al., 1998: Amasaka, 2011).

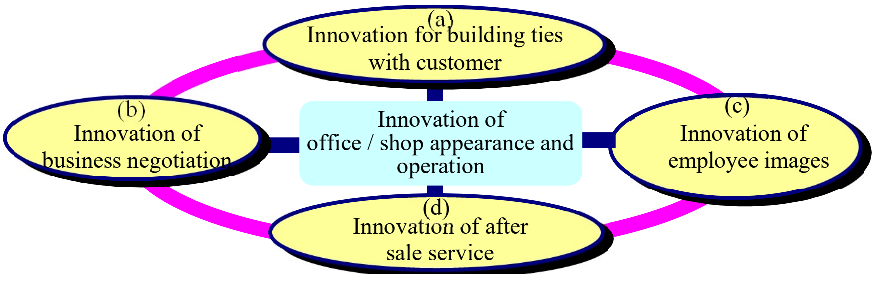


Figure 38. New Sales Office Image Model (NSOIM) for innovation of the business and sales activities

Intelligent Automobile Sales Marketing Model (IASMM)－In 2nd sub-core element, to increase the rate of dealer visits and vehicle purchases by current loyal users, IASMM develops based on customer type by classifying high-probability customers (HPCs), medium-probability customers (MPCs) and low-probability customers (LPCs) into those who visit the shop and those who must be visited by our staff, taking characteristics at new car purchase into account as shown in Figure 39. Further, IASMM adapts the various advertisements and telephone calls for customers, and can also be made use of when visiting customers, and to help acquire new customers at the time they visit a dealer. Now, IASMM is being developed as the "Toyota Sales Marketing System" (TSMS) (Amasaka, 2001, 2003b, 2011).

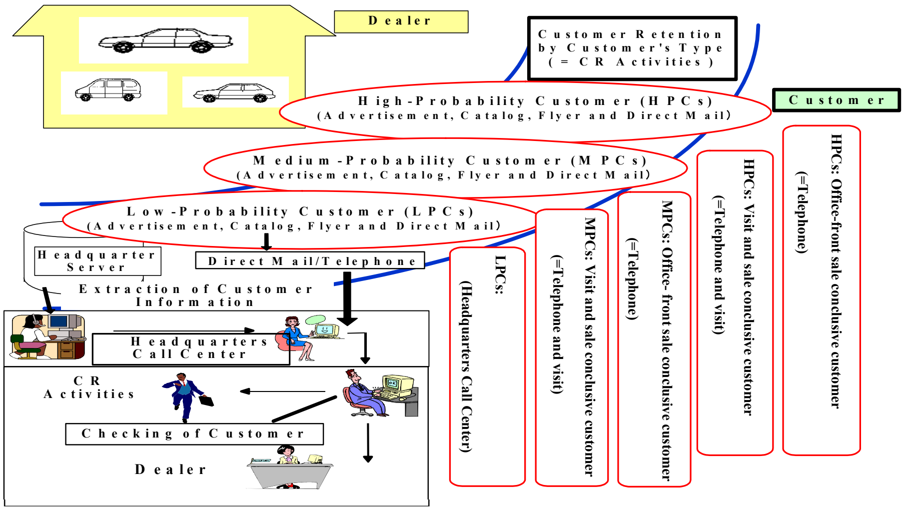


Figure 39. Outline of "Intelligent Automobile Sales Marketing Model" (IASMM)

③ Intelligent Customer Information Marketing Model (ICIMM)– In 3rd core element, to strengthen auto-marketing, ICIMM develops to create customer's "Wants" as part of the market creation activity and also to establish a structure for development and production that is capable of offering new products as shown in Figure 40 (Amasaka, Ed., 2007; Amasaka, 2008).

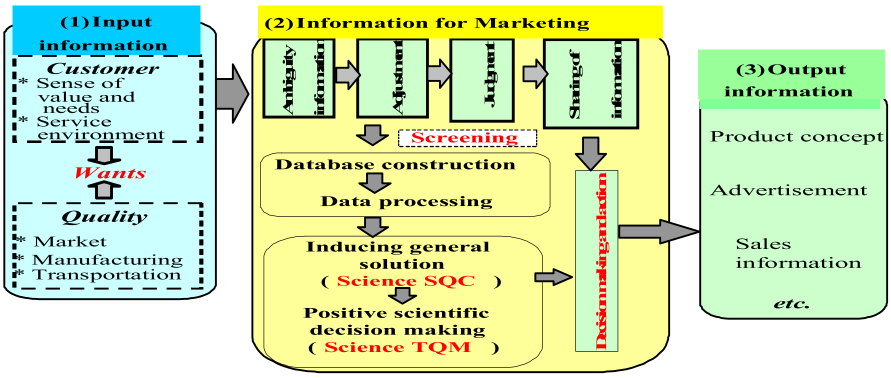


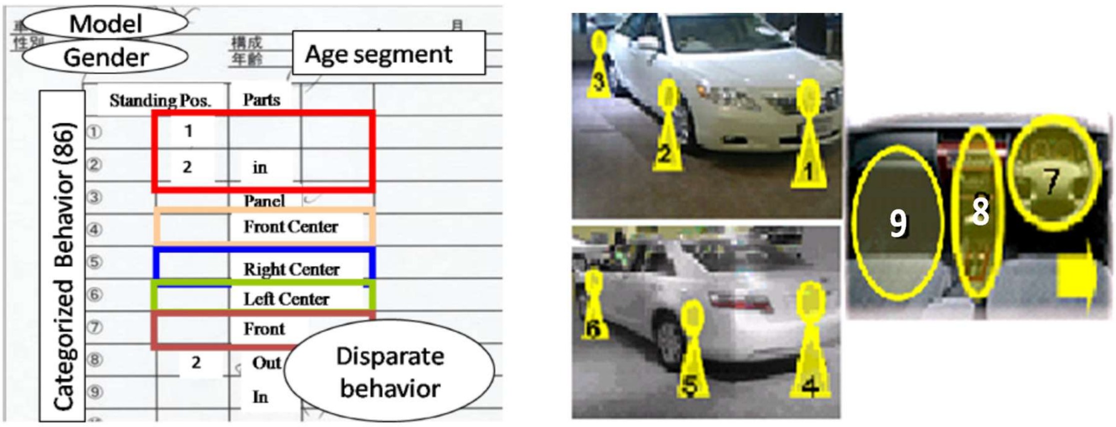
Figure 40. Outline of "Intelligent Customer Information Marketing Model" (ICIMM)

This is done in order to effectively carry out by each step of the (1) Input information, (2) Information for marketing and (3) Output information for evolution of the business process of "auto-shop, products development design and manufacturing.

Networking of "Customer Science Application System" (NCSp-AS) realizing customer's "Wants":-
To strengthen SCCM development, the author introduces the typical "Customer Science Application System" (CSp-AS) in order to evolve customer information-sharing through the collection / analysis of customer information. Specifically, the author develops a typical sub-core element "Customer Information Analysis and Navigation System" (CSp-CIANS) for creating customers' demands" in sub-section 4.1 (Amasaka, 2005a, 2018a) (See to Appendix E described in Figure E).

Video Unites Customer Behavior & Maker's Designing Intentions (VUCKMIN) for the "Innovating: Auto-dealer's sales:

Specifically, the author has created a Video Unites Customer Behavior & Maker's Designing Intentions (VUCKMIN) as a sub-core element named Toyota's Customer's Standard Behavioral Movement Model (CSBMM) in choosing a vehicle. As a concrete instance, the author conducted the following survey to investigate customer behaviors as shown in Figure 41 (Yamaji et al., 2010; Amasaka et al., 2013).



(a) Survey sample (The enlargement of Sample 1) (b) Sample 1 of Customer standing positions

Figure 41. Video Unites Customer Behavior & Maker's Designing Intentions (VUCKMIN)

In Figure 41(a), the author shows the enlargement of and the target car (vehicle) model is 1, gender 2, age 3, standing positions 4, and vehicle part focused on is 5. Among those items, standing positions are categorized as shown in Figure 41(b).

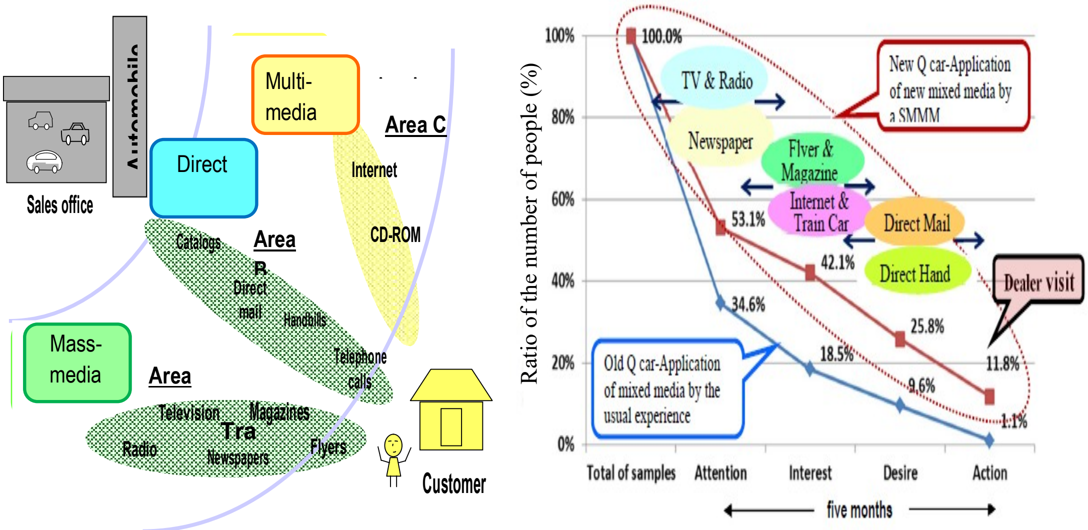
As a result, front is 1, front fender (driver seat) 2, rear fender (driver seat side) 3, trunk is 4, rear fender (passenger seat side) 5, front fender (passenger seat) 6, handle 7, shift lever 8, near passenger seat is 9. In total, all customer behaviors (standing positions, getting in and out, operation, walking time, etc.) are categorized into 85 distinct types of behaviors.

Scientific Mixed Media Model (SMMM) to realize the automobile market creation:-

To contribute the "Innovation, the author develops a "Scientific Mixed Media Model (SMMM)" named "New Mixed Media Model" as the "CS and CL" to boosting marketing effectiveness in CR (Customer Retention) activities. SMMM takes the form of auto-marketing creation using 3 sub-core elements "SMa-AM, SD-AM & SMu-AM" that each of the scientific "mass-media ads., direct ads. and multi-media ads." were optimized rationally due to "CSp and Science SQC" (Yamaji et al., 2010; Koyama et al., 2010; Ishiguro and Amasaka, 2012; Amasaka et al., 2013; Ogura et al., (2013, 2014).

Specifically, Figure 42(a) illustrates a graphical representation of customer motives for visiting auto-dealers using a typical mixed media with the various advertising. Area A: Mass-media advertising (: television (TV), radio broadcasting, flyers, public transportation (train cars), newspapers, magazines, etc.), Area B; Direct advertising (: catalogs, direct mail (DM), handbills (directly handed (DH) to customers), telephone calls, etc.) and Area C: Multi-media advertising (internet, CD-ROMs, etc.).

Figure 42(b) shows the verification results from application of "New Mixed Media" by SMMM for raising the percentage of people affected, and use as the new strategic advertisement in nine media elements (TV, radio, newspapers, internet, train cars, flyers, magazines, DM and DH) designed.



(a) Graphical representation of customer motives for visiting auto-dealers using typical mixed media

(b) "Ratio of the number of people" in visiting an auto-dealer by using typical mixed media

Figure 42. An effectiveness of Scientific Mixed Media Model (SMMM)

A field survey on vehicle advertising was conducted to identify 3 sub-core elements of each media type to visualize the relationship between those elements and the media as well as the causal relationships between each media type and (i) vehicle attention, (ii) vehicle interest, and (iii) desire to visit dealers. A total of 318 valid responses (197 male and 121 female, generally uniform age balance) were collected. The investigation period was the five months leading up to the release of the "new Q model" by an advanced manufacturer: Toyota.

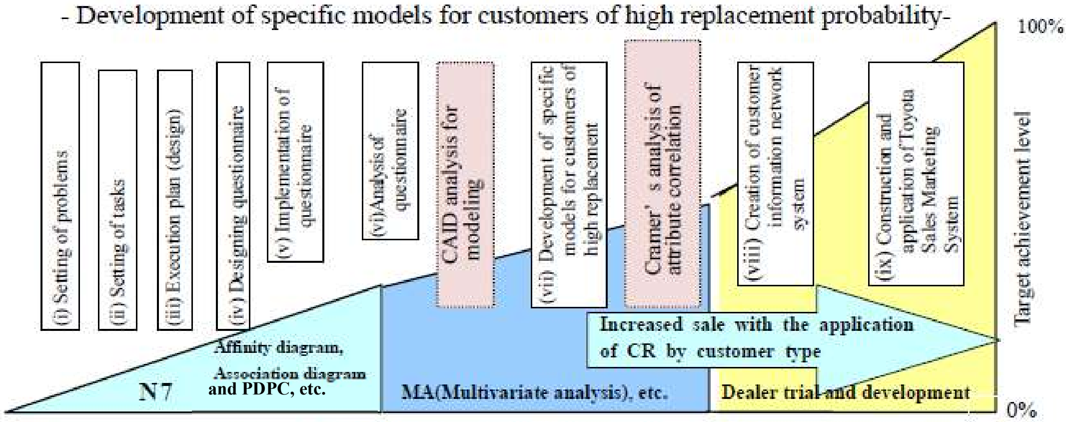
In Figure 42(b), the author shows the result of a follow-up survey using SMMM, where 16 people (percentage of people affected: 11.8%) actually visited the dealer, while 8 people signed a sales contract. Comparative verification was done by looking at the results of the usual experience of mixed media" when the dealer in the figure announced the old model Q car (: 4 years ago in a survey of similar size). In this case, the percentage of people affected was just 1.1%, thus validating the effectiveness of SMMM (Amasaka, 2015, 2022a,b, 2023a).

Auto-shop Sales Marketing Model (ASMM) using CS /CL/CR activities based on the customer type:-
As a typical example, to contribute the auto-dealers' sales and business for customer value creation through a typical example, the author has developed the "Auto-shop Sales Marketing Model" (ASMM) named Toyota Sales Marketing Model (TSMM) to improve the repeat customer ratio in Toyota vehicles as the scientific "CS, CL and CR" activities as shown in Figure 43 (Amasaka Ed, 2012; Amasaka, 2015a, 2022a, 2023). (Refer to Amasaka et al. (1998), Amasaka (2001, 2007d, 2009d) and Amasaka Ed. (2012) in detail).

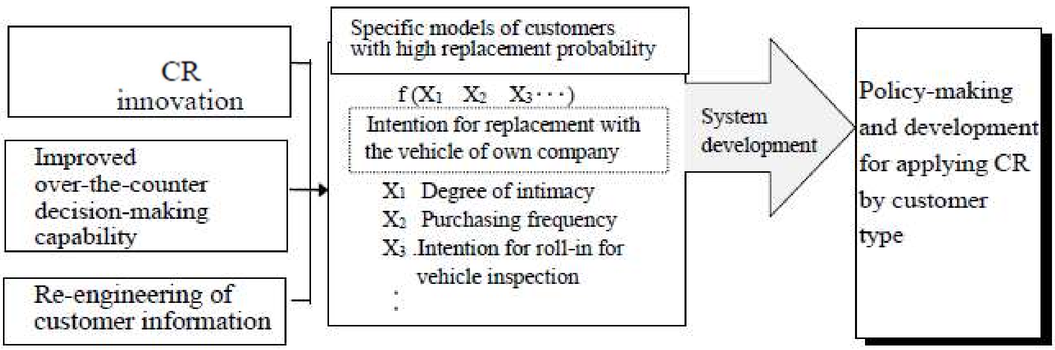
① Trial for increasing sales through CR based on customer type

First, the achievements of present research are currently being applied at Netz Chiba and other Toyota dealers using CSp and Science SQC. Then, the author solves problems by using scientific approaches such as "Mountain climbing for problem-solving" (development of specific models for customers of high replacement probability) following the steps from (i) to (ix) described in Figure 43(a). In steps (i) and (ii) shown in the figure, consideration was given to the development of specific models for "high replacement probability customers" described in Figure 40(b), an "Application type" association diagram (Step (i)-(iii)). Then, in step (iii), a scenario of implementation plans for about a year was established. In steps (iv) through (vi), the graphical "Categorical Automatic Interaction Detector" (CAID) analytical method was implemented (Murayama, 1998; Amasaka, 2001). In CAID, the author has been developed as the new multivariate analysis, and was necessary for the qualitative and categorical data analysis required for questionnaire design, implementation and analysis.

In the next step (vii), the sales method capable of deploying CR based on customer type was obtained using the Cramer's analysis of attribute correlation as the base for developing the customer information network system in step (viii). In the final step (ix), the scenario at Toyota "Netz Chiba" was examined as the basis for deployment to all Toyota dealers in Japan for the establishment of ASMM (T-ASMM).



(a) Mountain climbing for problem-solving using SQC Technical Methods



(b) Application type" association diagram (Step (i)-(iii))

Figure 43. Auto-shop Sales Marketing Model (ASMM) using CS /CL/CR activities based on the customer type

② Development of specific models for high replacement probability customers

(i) Second, the author shows the "Objective & explanatory variable for planned questionnaire form";

1. Objective variable: Intention to replace with Toyota vehicle: (Yes, No)
2. Explanatory variable: Records of roll-in (oil change, inspection and maintenance, fault repair, accident repair, vehicle inspection), number of new cars purchased, referral for new car purchase, voluntary insurance contract, degree of intimacy, degree of Toyota card usage, sex, age, etc. (categories 3 to 6).

Then, the author shows the "4 measures to achieve design and implementation of effective questionnaire" (See to Appendix F described in Table A).

(ii) Third, the author illustrates a "Questionnaire analysis with CAID & Cramer's analysis of attribute correlation" as shown in Figure 44. In Figure 44, after analysis of the questionnaire data, the results of analysis of causal relations were indicated graphically to accurately show the proposed measures and decision-making process that led to increased sales through the application of CR based on customer type.

Then, CAID analysis and Cramer's analysis of attribute correlation was applied to enable collation using empirical rules to form "Analysis I and Analysis II" as follows.

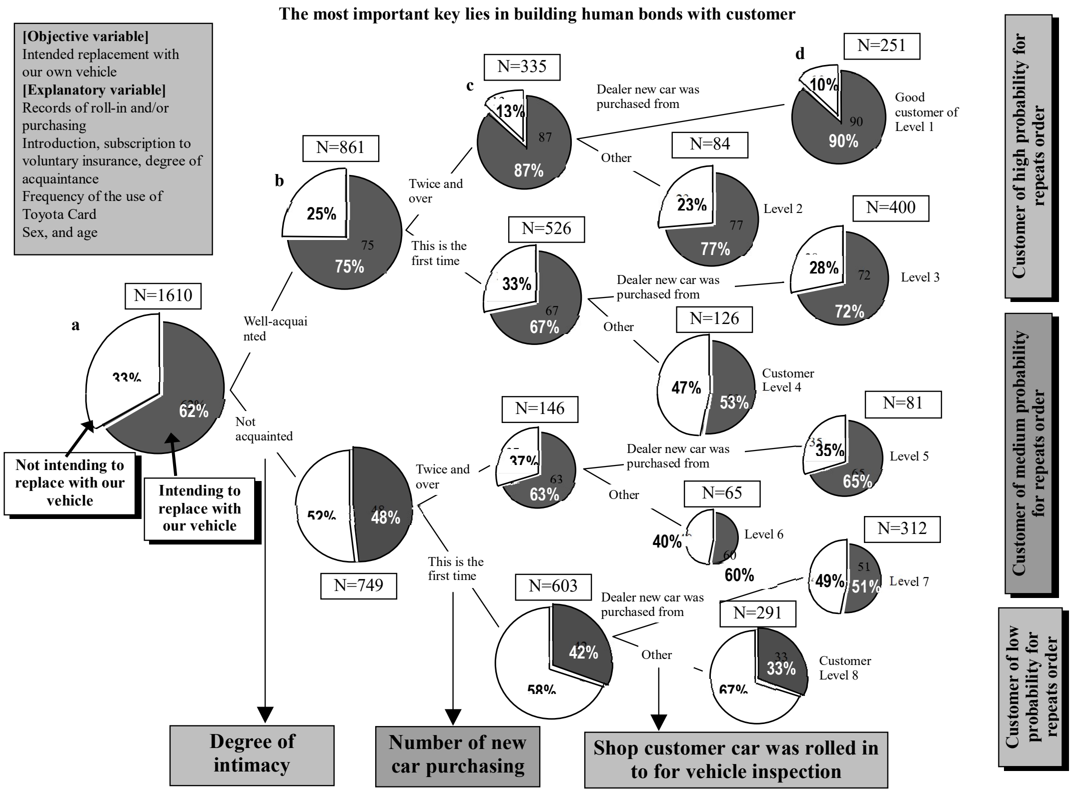


Figure 44. CAID*[1] Analysis (Step (vi))

*[1]: Multiple Cross-section Analysis (Categorical Automatic Interaction Detector)

"Analysis I" involves arranging customers having a high-probability of replacement with Toyota vehicles into a model using intelligent CAID analysis. Factors affecting replacement by high-probability customers are rearranged in the same manner as the variable designation method of multi regression analysis. This is conducted repeatedly based on empirical techniques of the staff and managers of business/sales divisions (so as to match their experience). Then, the characteristics and changes in the customers' orientation are ascertained on the basis of actual contact with customers. Customers are stratified into customer types (customers of high, medium and low repeat business probabilities) from the customer CR point of view.

"Analysis II" involves conducting factorial analysis using "creation of ties with customers" as the key point to map out our business and sales policies (Cramer's analysis of attribute correlation, etc.). In practice, correlation among influential factors is extracted by "intelligent CAID", including the degree of intimacy and roll-in for vehicle inspection and all other question items using the "Cramer's analysis! of attribute correlation. For example, factors which improve the degree of intimacy with customers are identified from the "sales activity and after-service activity" viewpoints, aimed at deployment for sales policies.

In "Analytical result with CAID (Analysis I; from Step vi to step vii), Figure 44 shows the legends of the analytical results. "Analysis a" in the figure indicates that 62% of 1,610 users who answered the questionnaire intend to replace their vehicles with a Toyota vehicle, while 38% do not.

Next, "analysis b" is the division by the primary influential factor of the "degree of intimacy". The upper setting of having "intimacy" (customers having good acquaintance with sales staff) indicates that 75% intend to buy Toyota for replacement, and the lower setting of having "no intimacy" (customers not having good acquaintance with the sales staff) indicates that 48% intend to buy Toyota.

The difference between them is as much as 27%. Thereafter, c indicates the analytical result for users who bought Toyota for the first time and those for two times and over (no significant difference among 2nd to 5th time purchasers). Similarly, analysis d stratifies the users by the “intention for roll-in for vehicle inspection service”.

From Figure 44, it is known that 90% of customers of level 1 (regular customers) indicated in the top position of d intend to buy a Toyota vehicle for replacement. The figure combines customer types of whom 70% intend to buy Toyota (b, c and d) on customer levels 1 through 3 (regular customers), and classifies them as customers of high probability. Likewise, customer types of whom 50% intend to buy Toyota on the customer levels 4 through 7 are classified as customers of medium probability.

Customers on level 8 are classified as customers of low probability since they fail to hold a majority. The author does not discuss other influential factors (such as **e**: introduction, **f**: sex, and so forth) where difference is noted between two dealers “Netz Chiba and Netz Ehime”.

Fourth, the author illustrates an “Analytical result with Cramer’s analysis of attribute correlation: (Analysis II: Step vii - step viii):
Practical and detailed analysis is conducted from the sales policy standpoint aimed at increasing the frequency of contact with customers. Here, the correlation between the degree of intimacy extracted in step (vi) and all other questions is explained using a factor and result diagram based on the Cramer’s analysis of attribute correlation as shown in Figure 45.

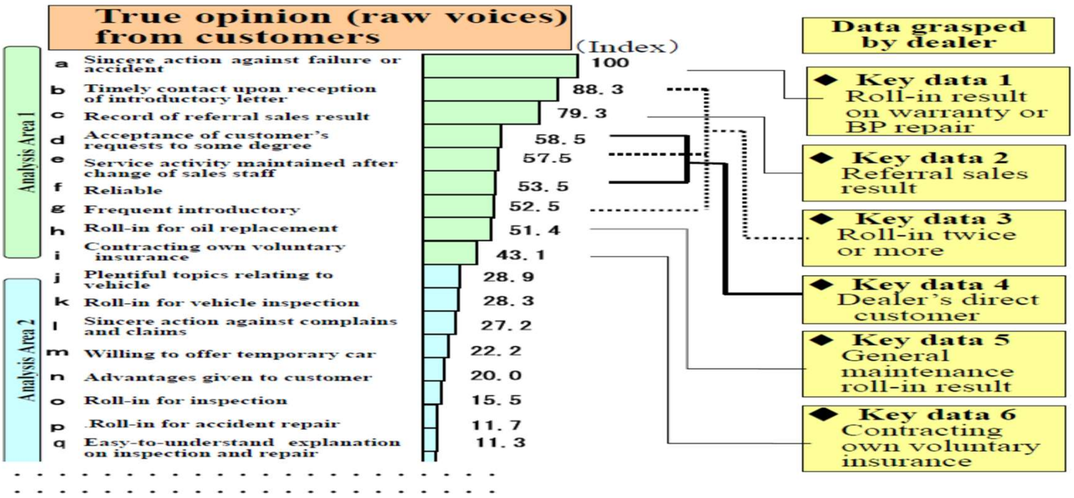


Figure 45. Factor analysis of Cramer’s Analysis of attribute correlation

Area 1 in the figure contains factors a through i influential to the degree of intimacy and area 2, factors j through w affecting the roll-in destination for vehicle inspection. “Index” in the figure represents the customer information numerically. For example, the 0.14 of “sincere action against failure or accident” is an index when the Cramer’s factor correlation coefficient is assumed to be 100. It is technically possible to correlate all factors in area 1 with the 6 key data shown in the figure. Based on the information obtained as a result of these analyses, practical policies can be established for promoting sales and after-service activities capable of improving the degree of intimacy with customers who can be handled by a dealer.

Fifth, furtheremore, the author develops the Intelligent Automobile Sales Marketing Model (IASMM) named TSMS (Toyota Sales Marketing System): The information can also be used for simulation for sales expansion, which is the basis of innovation for creating strong contact between the dealer and its customers. As a result, in step (ix), the author has constructed the “Toyota Sales Marketing System (TSMS)**”** described in Figure 39 above. For practical application, the questionnaire in step (vi) is reanalyzed at trial stages of the system in steps (vii) and (viii) of above Figure 43(a) in order to ensure replacement by Toyota vehicles by adding the following strategies.

The CR activities described in above Figure 39 based on customer type are adopted by classifying high- and middle-probability customers into those who visit the shop and those who must be visited by our staff, taking characteristics at new car purchase into account.

A system is established so that the shop manager directly receives “Medium-Probability Customers (MPCs)” upon their visit to the shop without fail in order to promote visits to the shop by “High-Probability Customers (HPCs)”. Thus, the frequency of contact with customers is increased. Further, sales and service activities focus on telephone calls for customers who visit the shop, and telephone calls and home visits for those who require visits by our staff, as shown in the figure.

As for “Low-probability customers (LPCs)” who have less contact with the sales staff, a telephone call center is established within the dealer as shown in the figure to accumulate know-how related to the effective use of customer information software.From this knowledge, the two-step approach is adopted as the practical sales policy where telephone calls described in Figure 36 are used to follow up on the effect of publications, advertisements, catalogs, fliers and direct mail as the developing “Auto-Sales Innovation Model (ASIM) which shows it in the following “⑥”.

Auto-Sales Innovation Model (ASIM) developing dynamics of effects of publicity & advertising:
As part of an organization’s market creation activities in NA-SMM strategy, it is important to gain a quantitative understanding of the effect of publicity and advertising, which contributes to the above “ASIM” development. Specifically, the author demonstrates the effectiveness of the “flyer advertising effect”, “day of the week effect”, “new car effect” as shown in Figure 46 (Refer to Amasaka et al. (1998) and Amasaka (2001, 2003b, 2007a, 2009, 2023a,b) in detail).

In this case study, due to time constraints in the object period for analysis, the author used “Quantification class I” for the current factorial analysis of the survey data in time series. In Figure 46, the author illustrates the “flyer effect”, the “day of the week effect”, and the “new car effect”, which influence the number of visitors (Y0) to the sales office. Confining the discussion to the current range of investigation, the following can be observed from Figure 46.

(i) Item 1 shows that the greater the number of flyers distributed, the more customers visit the dealer.
(ii) Item 2 shows that the effect is greater on Saturdays and Sundays, while the number of visitors is more or less constant on weekdays.
(iii) Item 3 shows that the “new car effect” continued for two months in the current analysis, including the first month the new car went on sale. The effect contracted in the period from three to five months after the new car went on sale. From this result, as expected, excellent results have been reported at Netz Chiba and other Toyota dealers who introduced this system by applying the Toyota Sales Marketing System constructed as above.

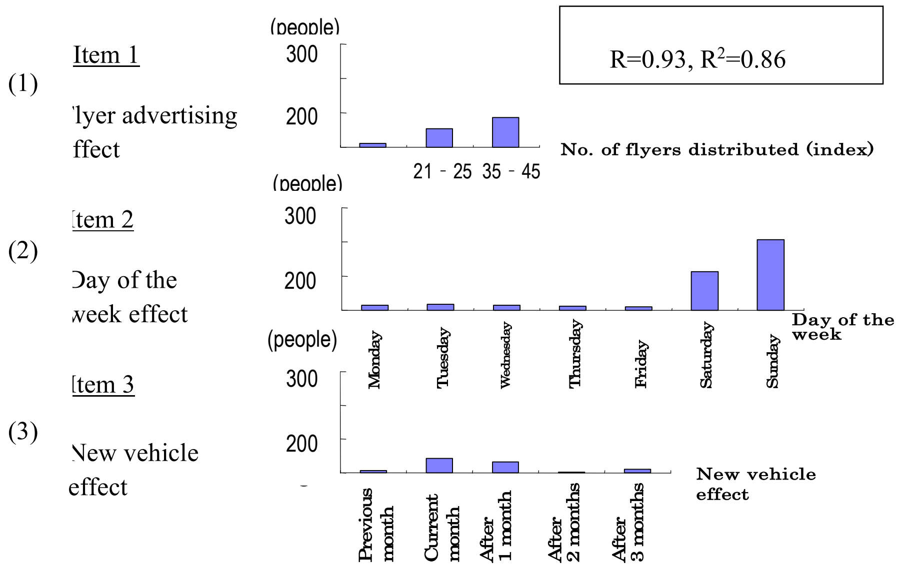


Figure 46. Quantification Class I (Graph of the category quantities)

In parallel to this study, the author studied so called "Database Marketing" where the effects of publications, advertisements, catalogs, fliers and direct mail are quantitatively analyzed to enable effective support for this system (Amasaka, 2001, 2007: Kojima, et al., 2010: Ishiguro, et al., 2010, 2012).

Then, the application of TSMS has recently contributed to an increase in the sales share of Toyota vehicles in Japan (40% in1998 to 46% to 2008) (Nikkei Institute, 1999).

Appendic A Customer Science principle for aiming customers' demand scientific analysis:
The product development methodology - "Customer Science principle" (CSp) shown in Figure A is what gives concrete shape to such customer wants (Amasaka, 2002a, 2005a, 2015a).

It is intended to present a mode of (an approach to) a new business process for creating "wants" which is indispensable for manufacturing attractive products.

As depicted in Figure A called objectification of subjectivity wherein the image of customers' words (implicit knowledge) is expressed in a common language (lingual knowledge) and then, by incorporating technical words (design drawings, etc.) as well as correlation techniques, it is further interpreted appropriately (into explicit knowledge).

This refers to the "CSp" that converts subjective information (**y**) and objective information (**y**) reasonably to two-way through application of correlation technology^

When using "CSp" for approaching various customer-related situations, such as why the customers are satisfied or dissatisfied with a particular product, what is the underlying feeling behind a certain expression, what kind of products then need to be offered, or in what specific situation a recall case occurs, the situations can then be interpreted into a common language, and further converted into the language of technology.

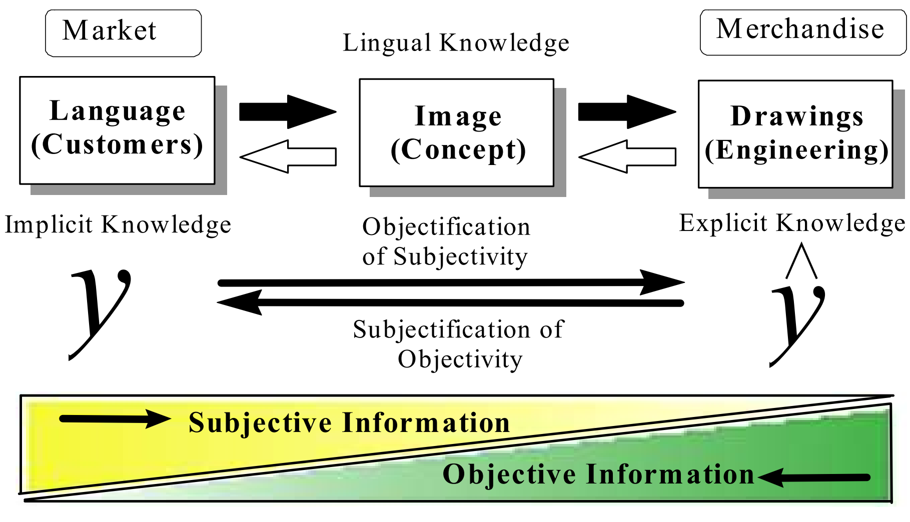


Figure A. Schematic drawing of Customer Science principle (CSp)

Appendix B "Science SQC, new quality control principle" with four core elements for developing auto corporate technological quality strategy

In developing CSp, the demonstrative-scientific methodology for realizing this conversion is named "Science SQC, new quality control principle" (Amasaka, 2003a, 2004b), in which SQC is utilized systematically and organically under a new concept and procedures so as to allow the four core elements “(1) - (4)” as shown in Figure B to mutually build on one another below.

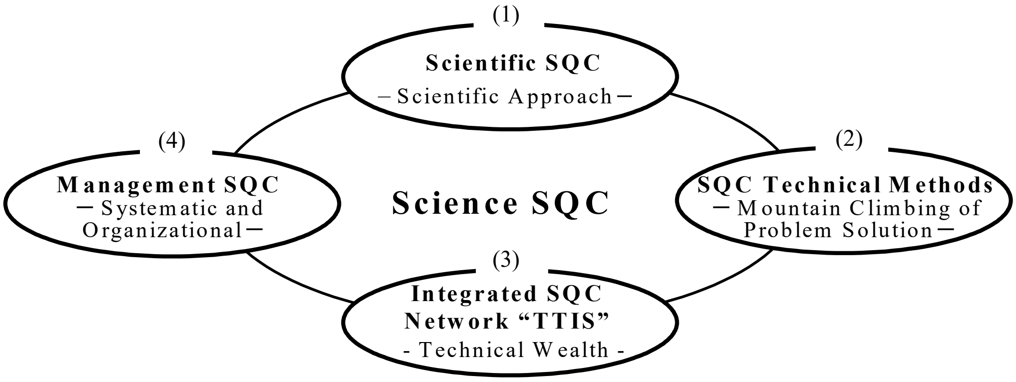


Figure B. Schematic drawing of “Science SQC, new quality control principle

1st core element “Scientific SQC” is to carry on excellent QCD research activities through insight obtained by applying “statistical science, SQC”, to scientific and inductive approaches in addition to the conventional deductive method of tackling engineering problems, and to scientifically use SQC in each stage from problem structuring to goal attainment by grasping the desirable form.

Second core element “SQC Technical Methods is possible to “Mountain-climbing for possible to improve experimental and analysis designs using a proactive combination of the “N7” (New seven tools) & typical basic SQC, MA (multivariate analysis), DE (design of experiment), “RA” (reliability analysis). Furthermore, recent various statistical science as may be required using multivariate analysis amalgamated with engineering technology for efficiently improving the jobs of businessmen.

3rd core element “Integrated SQC Network “TTIS” (Total SQC Technical Intelligence System) supports “engineering problem-solving as an “technical wealth”. and contains the 4 core systems:
TSIS (Total SQC Intelligence System) can be referred to as library of SQC applications.
TPOS (Total SQC Promotional Original Soft) is an SQC software package.
TSML (Total SQC Manual Library) is a library of classified technical methods.
TIRS (Total SQC Information Retrieval System) is the technical reports and engineering books.

The 4th element “management SQC” named “ Total QA High Cycleization Process System” (TQA-HC-BPM) is to support quick solution of deep-rooted engineering problems.

For problem solving, it is necessary for the “planning, design, manufacturing and marketing departments” to clarify the six gaps, in other words to turn tacit knowledge on the business process to explicit knowledge for good understanding and coordination among the departments in developing “CSp”.

Concretely, for organizationally managing the development of Science SQC, the author has developed the “Management SQC” through “Strategic Stratified Task Team Model” (SSTTM) activity (See to after-mentioned Appendix D described in Figure D).

Then, specifically, “Science SQC” forms the nucleus of “TQM-S” (-using Science SQC) activities in “Toyota”, and intends strengthening of business process in order to realize the improvement of today’s various management technologies as the scientific quality management named “Science TQM” called “New Japan Model” at the advanced car manufacturers in Japan.

For details on the demonstrative research, refer to references (Amasaka Ed., 2007a, 2012; Amasaka, 2004a, 2015a, 2022a,b, 2023a, 2024a,b, 2025a).

Appendix C New JIT using integrated five core elements (1)-(5) for corporate management:

Each of "TDS, TPS, TMS, TIS and TJS" consists of organized "five sub-core elements (a)-(e)" as shown in Figure C as follows;

The significance of "TDS" is to create the optimum product design based on the common knowledge by shared use of information, and to systematize the development design methodologies through the (a) design based on the internal and external information with stress laid on design philosophy, (b) development-design management aimed at a reasonable design process, (c) creating general solutions based on the most advanced design technologies, and (d) clarifying the design behavior based on the design policy of a development designer (: theory-action-decision making).

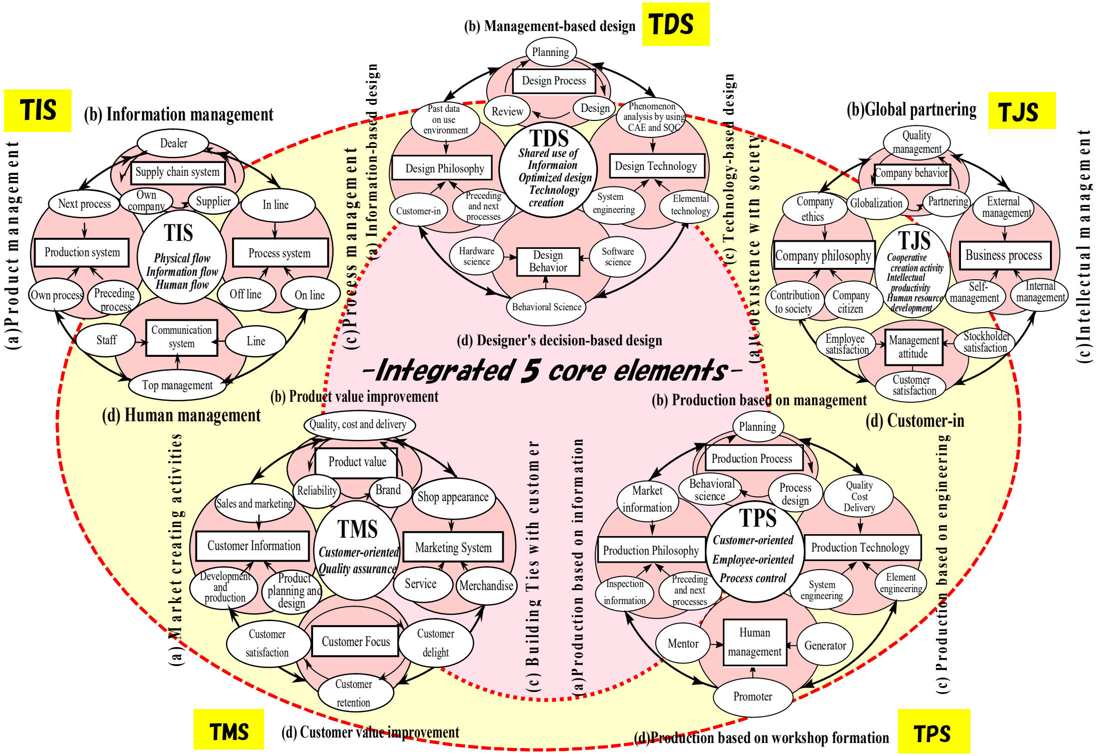


Figure C. New JIT using "Integrated Five core elements" for "Evolution of Management Technology" using high-linkage cycle for the improvement of business process in all departments on information.

The main objective of "TPS" is the process management laying stress on customers and employees to realize working environment leading to skill improvement. To improve the reliability of entire based on workshop formation. production based on management, (c) production based on engineering, and (d) production

Similarly, "TMS is to develop quality management to be relied on by customers through scientific marketing and sales not sticking to conventional concept.

Specifically, to realize quality assurance with an emphasis on the customer, "TMS" is composed of strategic sub-core elements: (a) market creating activities, (b) product value improvement, (c) building ties with customer, and (d) customervalue improvement.

The aim of "TIS" has a function of new management technology system for the development design, production and sales departments in the inner circle by linkage with the indirect office department in the outer circle. "TIS" is composed of organized sub-core elements: (a) product management, (b) information management, (c) process management, and (d) human management based on the integrated cooperative activities.

Similarly, "TJS" has a function for improving intellectual productivity by employee training and internal/external partnering to strengthen global marketing. "TJS" is composed of intellectual sub-elements (a) coexistence with society,

(b) global partnering, (c) intellectual management through human resource development, and (d) customer-in management activity, to grasp the importance of cooperative creation activity.

At the stage of the concrete development of New JIT strategy, the author has created has created a high linkage of advanced management system - Advanced TDS, TPS, TMS, TIS & TJS named New Japan Global Manufacturing System (NJ-AGMS) (Refer to Amasaka (2007a,b, 2008a, 2009a, 2023d).

Appendix D. Strategic Stratified Task Team Model to strengthen NJ-APEM strategy:
To develop "CSP" using "Science SQC" to strengthen NJ-APEM strategy, the author has created the "Strategic Stratified Task Team Mode" (SSTTM) for realizing high-quality assurance, as shown in Figure D (Amasaka, 2004a, 2017b; Yamaji and Amasaka, 2007b, 2008; Amasaka, Ed., 2012).

The expected role of "SSTTM" and benefits it provides are not limited to cooperation among the departments inside the company. It contributes to strengthening the ties among group manufacturing companies, non-group companies, and even overseas manufacturers.

This system consists of Task-1 to - 8 teams involving the group, department, division, field, whole company, affiliated companies, non-affiliated companies, and overseas affiliates.

In Figure E, The level of problem-solving technology rises in "product development strategy I and II" through joint task teams of intra-company departments and divisions (Task-1 to -5, Group Task team, Department task team, Division task management team, Field task management team and Total task management team) in proportion with the improvement of stratified task level.

This technology is further expanded to quality management strategy I to II through the domestic affiliated company, domestic non-affiliated company, and overseas non-affiliated company (Task-6 to -8, Joint A to C). Task-6 (Joint A) is aimed at establishing a collaboration with the group suppliers with whom domestic affiliated company has a capital tie-up, and Task-7 (Joint B) is aimed at a collaborationwith suppliers that are not within its group. Task-8 (Joint C) is to strengthen cooperation with overseas suppliers.

As the driving force of "SSTTM" in NJ-APEM strategy, it is vital to reinforce Japanese-style partnering, or "Japan Supply Chain Management" between auto manufacturers and parts suppliers.

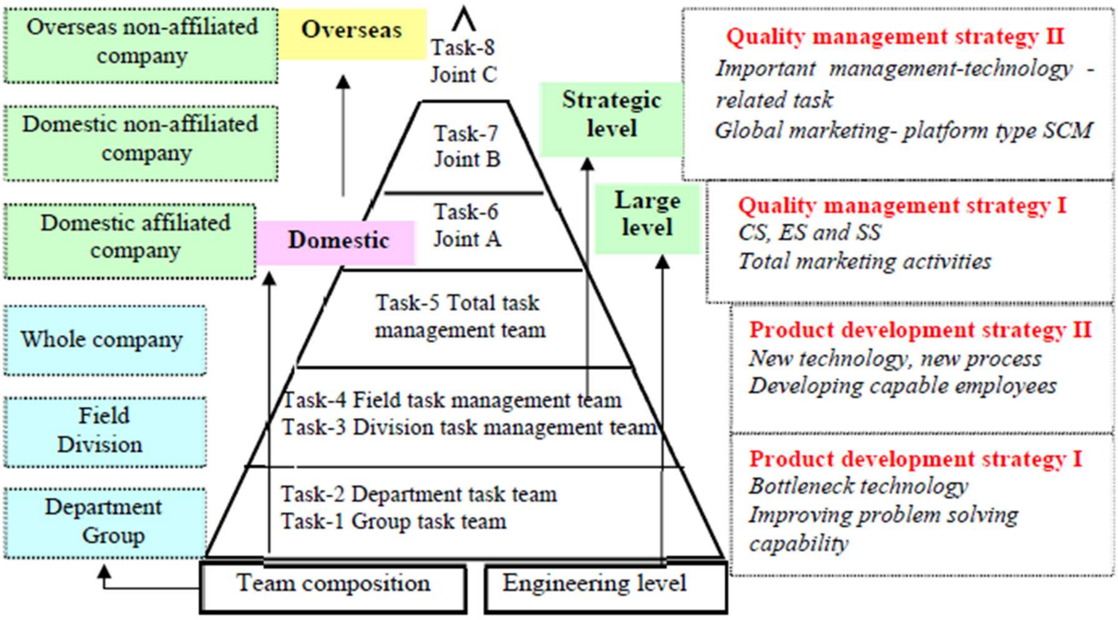


Figure D. Strategic Stratified Task Team Model (SSTTM)

Appendix E. CSp-Customer Information Analysis and Navigation System (CSp-CIANS) for visualizing customer's demand:
To develop NA-PDDM using "CSp" using Science SQC, the author has established the "CSp-Customer Information Analysis and Navigation System" (CSp-CIANS) for the "strategic product development design" employing "AEDM-3CM and AOP-DDM" as shown in Figure E (Amasaka, 2005a, 2015a).

Specifically, this system enables the networking the (1) Merchandise Div. to strengthen strategic product planning which explores customer value creation and (2) each division of the "Product Planning, Development and Design" to regularly receive customer data from (3) domestic and overseas dealers which are exposed to the front line of the customer desires through their marketing /sales / service activities. Similarly, the collection of customer data is also possible through (4) Consulting Spaces, namely, the showrooms promoting the company's own products or public facilities for discussions and consultations from the customers.

Moreover, (5) Marketing Research Companies via (6) an exclusive company WEB. All these sections are connected through on-line networking for building (7) a Data Base (DB) via a server of the company's own information system division. Into this system using statistical science approach - Science SQC (8) (Amasaka, 2004b).

Actually, the core system of SQC integration network system contains the "Total SQC Technical Intelligence System" (TTIS) including four core elements: the "Total SQC Intelligence System" (TSIS), "Total TQM Promotional Original SQC Soft" (TPOS), "Total SQC Manual Library" (TSML) and "Total Technical Information System" (TIRS). These are accessible for utilization from (9) Analytical case Data Base (DB).

Particularly, cooperation requests for analysis can be submitted to (10) a special SQC adviser in Quality Assurance division (Amasaka, Ed., 2012)CSp-CIANS is designed in such a way that the collection of analytical results created by total linkage of the merchandise planning, product design, sales marketing and service for the successive development of analytical technology (Amasaka, 2015a,b, 2022a,b, 2023a,b,c,d, 2024b, 2025a).

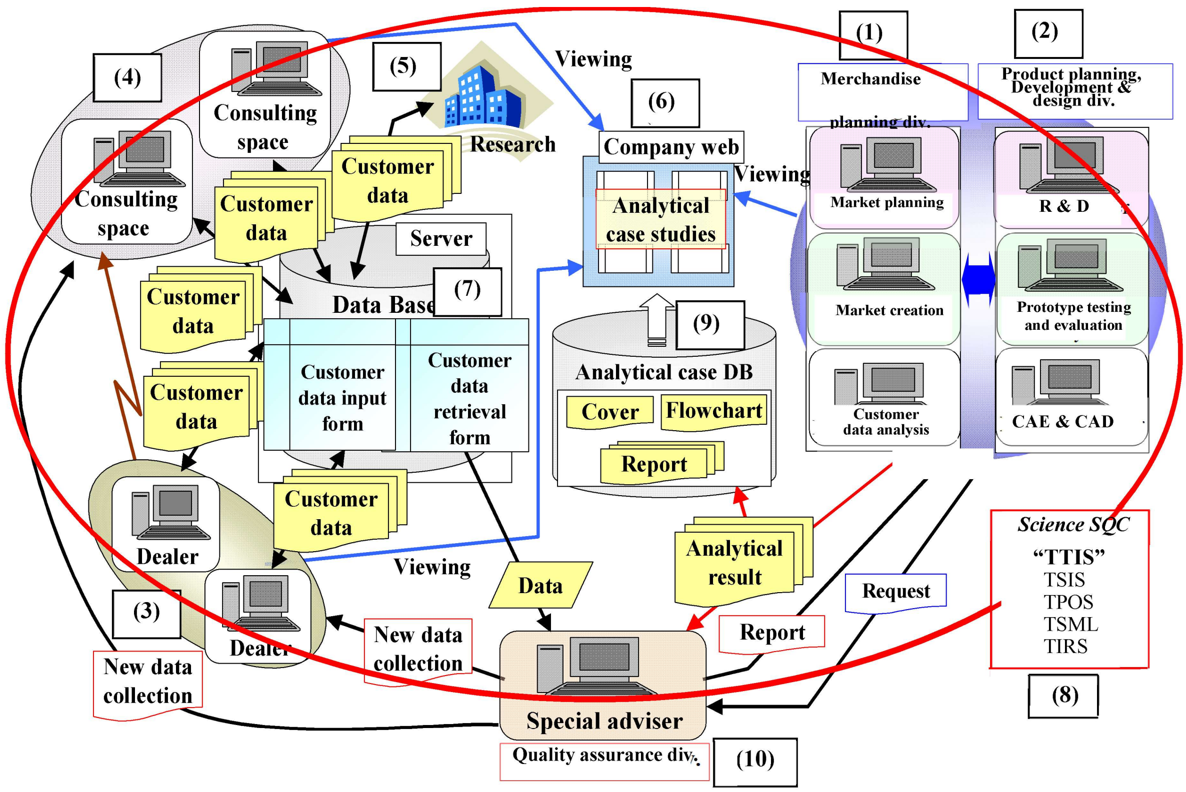


Figure E. CSp-CIANS, Networking of Customer Science application system

Appendix F: 4 measures to achieve design & implementation of effective questionnaire:

The subjects were required to answer methodically within about 15 minutes. Furthermore, introduction of a Questionnaire Information Box helped raise the recovery rate to over 40% (normally 20%) and the valid reply ratio to 98% (normally 70%) (Amasaka et al., 1998; Amasaka, 2001, 2007e, 2009b, 2011).

Table A. Typical example of questionnaire form

(Case-1) Designing and implementation of questionnaire

= We like to inquire on the after-sales service of your dealer =

Q1: Please let us know the present state of the maintenance, fault, repair and other your vehicle-related after-sales service (Please give us an answer for each item from ① to ④)

	①Dealer used	②Reason for using	③Method of payment	④Method of roll-in
1. Oil change (please name a principal shop / station you use)	1. Dealer you purchased a new vehicle from 2. Other dealer 3. Vehicle maintenance service shop 4. Car shop 5. Gas station 6. Other ( )	1.Because of acquaintance 2. High level of technique 3. Low price 4. Privilege offered 5. Nearness of location 6. Other ( )	1. Cash 2. TOYOTA CARD 3. Other cards 4. Other ( )	1. Drive to the shop 2. Have the vehicle picked up 3. Other ( )
2. Inspection and maintenance service of your vehicle (Please name a principal shop you use)	1. Dealer you purchased a new vehicle from 2. Other dealer 3.Vehicle maintenance service shop 4. Car shop 5. Gas station 6. Other ( )	1.Because of acquaintance 2. High level of technique 3. Low price 4. Because of guidance 5. Nearness of location 6. Other ( )	1. Cash 2. TOYOTA CARD 3. Other cards 4. Other ( )	1. Drive to the shop 2. Have the vehicle picked up 3. Other ( )
3. Repair service of fault of your vehicle (please name a principal shop you use)	1. Dealer you purchased a new vehicle from 2. Other dealer 3.Vehicle maintenance service shop 4. Car shop 5. Gas station 6. Other ( )	1. Because of acquaintance 2. High level of technique 3. Low price 4. Good attending attitude 5. Nearness of location 6. Other ( )	1. Cash 2. TOYOTA CARD 3. Other cards 4. Guarantee 5. Other ( )	1. Drive to the shop 2. Have the vehicle picked up 3. Other ( )
4. Repair service of your vehicle after an accident (please name a principal shop you use)	1. Dealer you purchased a new vehicle from 2. Other dealer 3.Vehicle maintenance service shop 4. Car shop 5. Other ( )	1. Because of acquaintance 2. High level of technique 3. Low price 4. Good attending attitude 5. Nearness of location 6. Other ( )	1. Cash 2. TOYOTA CARD 3. Other cards 4. Guarantee 5. Other ( )	1. Drive to the shop 2. Have the vehicle picked up 3. Other ( )
5. Next vehicle inspection (what type of service shop would you select?)	1. Dealer you purchased a new vehicle from 2. Other dealer 3.Vehicle maintenance service shop 4. Car shop 5. Other ( )	1. Because of acquaintance 2. High level of technique 3. Low price 4. Because of guidance 5. Nearness of location 6. Other ( )	1. Cash 2. TOYOTA CARD 3. Other cards 4. Other ( )	1. Drive to the shop 2. Have the vehicle picked up 3. Other ( )
6. Purchase of a new vehicle (what type of shop would you select to purchase from?)	1. A shop you purchased your present car from 2. A shop other than one you purchased your present car from 3. Other ( )	1. Because of acquaintance 2. Sales staff is enthusiastic 3. Good attending attitude 4. Using the shop for the check-up and maintenance service of your vehicle 5. Good purchasing condition 6. Other ( )	1. Cash 2. Installment 3. Lease 4. Other ( )	1. Drive to the shop 2. Have a sales staff come to see me 3. Other ( )

Conclusion:-

In this study, the author has established a NJ-APEM (New Japan Automobile Production Engineering Model) for customer value creation. To strengthen the auto-corporate management, NJ-APEM developed a dual scientific methodology – "CSp (Customer science principle) and Science SQC" in Science TQM activity. Specifically, to precisely grasp the customers' preferences of the vehicle, this model contains a dual management technology: "Exterior design engineering strategy and Driving performance design engineering strategy through 3 domains of the "designing, manufacturing and sales marketing" employing SSTTM (Strategic Stratified Task Team Model) for excellent QCD employing New JIT strategy. Concretely, by developing ICIMM (Intelligent Customer Information Marketing Model), NJ-APEM consists of 4 core models: the NA-PDDM (New Automobile Product Development Design Model), NA DPMM (New Automobile Dual Production Management Model) with a dual core model "NA-GPM and NA-GMM", and SMDM (Scientific Marketing Model) with a core model "NA-SMM" (New Automobile Sales Marketing Model). As those results and effects, the validity of NJ-APEM has been verified through the actual applications in Toyota and others.

Acknowledgements:-

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