© 2005 - 2009 JATIT. All rights reserved.

DEVELOPMENT OF AN INTEGRATED LOGISTIC MODEL IN AN ORGANIZATION FOR AN AUTOMOTIVE APPLICATION PROBLEM

[1]MANJUNATHA, [2]Dr. H.K. SHIVANAND, [3]DR. T.C. MANJUNATH

[1]*Professor & Head, Mechanical Engg. Dept., New Horizon College of Engg., Bangalore, Karnataka, India.*

&

Research Scholar (Doing Ph.D) in Dr. M.G.R. Deemed University, Chennai, Tamil Nadu, India.

Email : manjunath_nhce@yahoo.com

[2]*Assistant Professor, Mechanical Engg. Dept., UVCE, Bangalore, Karnataka, India.*

[3]*Professor & Head, E & C Engg. Dept., New Horizon College of Engg., Bangalore, Karnataka, India.*

Email : tcmanjunath@gmail.com tcmanjunath@rediffmail.com

ABSTRACT

This paper presents a novel method of developing an integrated logistics model for an industry / organization using the supply chain management system, thus providing a greater visibility of logistic model for an organization & eliminating the drawbacks of the current integrated logistics models. An algorithm is developed for this integrated logistics model in this research paper. This concept is being implemented by using a suitable example with an automobile, thus showing the effectiveness of the developed method.

Keywords : *Logistics, Supply chain management, Manufacturing, Integration, Optimisation, Modelling, Analysis.*

1. INTRODUCTION

Integrated Logistics is the disciplined and unified management of the technical logistic disciplines that plan and develop logistics support requirements for industrial organizations and which will ensure system product quality in terms of reliability, availability, maintainability & testability. Firstly, let us go deep into the world of logistics. Logistics is the collection of activities associated with acquiring, moving, storing and delivering supply chain commodities (i.e., products in all stages of manufacture, service and information). Logistics encompases the business functions of transportation, distribution, warehousing, material handling and inventory management, and interfaces closely with manufacturing [Ratliff & Nulty, 1996].

Four levels of manufacturing logistics systems are as follows : Production Unit (PU), Supply Chain (SC), Production Facility (PF) and Enterprise (E). An enterprise is a business entity that consists of multiple manufacturing plants as well as other aspects of the business such as design, engineering, marketing, and sales. Also, practical logistics problems are at enterprise level [Wu *et.al.*, 1999]. Manufacturing logistics refers to all planning, coordination and service functions required to carry out manufacturing activities.

A narrow and more traditional view of manufacturing logistics includes the planning, scheduling and control of all activities resulting in the acquisition, processing, movement and storage of inventory. These activities include order acceptance, production planning and scheduling, inventory control, inventory distribution, and the design of the corresponding decision processes and decision support systems.

A more appropriate, broader view of manufacturing logistics considers the flow of material, information, and services across enterprise, industry and national boundaries. Coordinating these complex activities may require integration of multiple facilities and firms, integration of manufacturing and service functions including sales, marketing, and information technology, and integration with traditional logistics functions such as transportation, warehousing and distribution. While research topics falling into the narrower view of manufacturing logistics have been studied intensively, many issues

© 2005 - 2009 JATIT. All rights reserved.

involved in the broader view are still not well understood [Wu, *et.al.*, 1998].

Based on the preliminary results, we are confident that rather high logistics integration of companies in a value chain from producers to retailer creates competitive advantages. In order to realize such competitive advantage, cooperation, co-ordination and the process for closer relationship among the participants in the value chain is a criterion for success. Questions like; what is the best-suited integration level, and how to integrate, are the main challenges in order to ensure an efficient value chain. ILS is sometimes integrated with System Safety engineering.

In general, this means that ILS is the management organization that plans and directs the activities of many technical disciplines associated with the identification and development of logistics support and system RAMT/S requirements for military systems or equipment / parts. There are comparable organizations outside the military which provide the same capabilities. In a commercial company, this organization may be called product support, customer service or many other similar names.

ILS is a technique introduced by the US Army to ensure that the supportability of an equipment item is considered during its design and development. The technique was adopted by the UK MOD in 1993 and made compulsory for the procurement of the majority of MOD equipments. The end goal of ILS is to create systems that last longer and require less support and thereby to Save Money by achieving a higher return on long term investments. The aim of ILS is to address three aspects of supportability during the acquisition and whole life cycle of the system / equipment.

The word 'system' is here, defined as: "The whole composite of hardware, software, personnel, procedures, tools and facilities. The elements here of are used together in the intended operational or support environment to perform a given task or achieve a specific purpose, support or mission requirement".

Integrated Logistic Support will provide important means to identify (as early as possible) reliability issues / problems and can initiate system or part design improvements based on reliability, maintainability, testability or system availability analysis (for example by the proper use of detailed functional and/or piece part FMECA techniques, Event tree and fault tree analysis / assessments, Reliability Block Diagrams, Importance measurements, Reliability centered maintenance (RCM) / Maintenance steering Group 3 (=civil aerospace variant of RCM) and Monte-Carlo techniques).

Influence on design can also be the result of the use of a Failure Reporting and Corrective Action Systems (FRACAS) during in-service phases. ILS can have a strong link with System Safety engineering due to the common use of several sources of data (like: failure mode- and failure rate- and failure mechanism information, system effect (criticality) behavior, fault detection, human error (maintenance task related or operational task related) predictions, human factors, and system basic reliability or operational reliability (availability) calculations.

ILS is an iterative process during the design of the equipments to ensure that supportability aspects are adequately addressed. This ensures that user maintenance and routine servicing tasks are minimized (optimized) and can be performed with sufficient ease, and that utilization of existing tools and techniques is maximized. Further, it may be required to demonstrate supportability of the equipment during logistics, maintenance & manpower demonstration to ensure that supportability has been adequately addressed. ILS can furthermore provide input or be part of a quality control system, because it has the capability to identify the most critical parts for system operation and support, which should need the most attention from a quality point of view.

The paper is organized in the following sequence. A brief introduction to the related work and the literature survey was presented in the previous paragraphs. Section 2 gives information about the model generation. Overview of existing logistic model & the complexity in existing model is discussed. Analysis of the logistic model to improve its visibility is presented in the next section, i.e., in the section 3. Further, the conclusions, appendices, acknowledgement & the references with the author autobiographies follow this section 3.

2. OVERVIEW OF THE INTEGRATED MODELS

In this section, we discuss about the generation of the integrated logistics model for a suitable application. To start with a brief overview of the existing models are discussed. The problems in the existing models are also taken into consideration while designing our model. Based on the drawbacks of the existing models, a new model is developed by us. The increasing importance of supply chain management is forcing the organizations to rethink how their purchasing and

© 2005 - 2009 JATIT. All rights reserved.

sourcing strategies fit with and support broader business and supply chain objectives.

Supply chains involve multiple organizations as we move towards the raw material suppliers or downstream toward ultimate customers. Simple supply chains pull materials directly from their origin, process them, and ship them to customers. A brief overview of the existing logistic models is depicted in this section. For this purpose of evaluation of the existing logistic models, let us consider an example of a car manufacturing industry (automobile industry). In today's world the automobile sector contributes to about 40% revenue of any nation. This becomes the main reason for selection of an automobile industry as the source for our research work undertaken in this paper. In any automobile industry, major contribution is from the engine side only. Hence, this aspect is more focused in this paper.

Before going on to the model, let us first see what an automobile is. An automobile is a self-propelled vehicle, which is used for the transportation of passengers and goods upon the ground. A vehicle is a machine, which is used for the transportation of passengers and goods. A self-propelled vehicle is that in which power required for the propulsion is produced from within, i.e., Bus, Car, Jeep, Truck, Tractor, Scooter, Motor cycle [R.B.Gupta., 2006].

The modern automobile, in general, is essentially a transportation equipment unit to transport people, goods from one place to another place. It consists of a "frame" supporting the "body" and certain "power developing and transmitting units" which are further supported by "tyres and wheels" through "springs and axles". An "engine" supplies the power, which is delivered by the "transmission system" to the wheels through the clutch or fluid coupling.

Now, let us consider the automobile manufacturing industry. For the products such as automobiles, which feature multiple products, technologies, and process the supply chain becomes more complicated. The material planning, and logistics supply chain for an automotive company is shown in the Fig. 1, which illustrates the complexity of the chain, spanning from automotive dealers back through multiple levels or tiers of suppliers. The automotive company's supplier network includes the thousands of firms that provide items ranging from raw materials, such as steel and plastics, to complex assemblies, such as transmissions, brakes, and engines.

The complexity involved in the existing models is explained as follows. The transportation and logistics system's complexity resides in the nature of the structure, dynamics and adaptation. The respective properties to define the complexity in logistics are structural property, dynamic property and the property of adaptation. Accordingly, we can say that there is a problem in manufacturing industry to apply the logistics in order to improve the work-flow. This means that we have to improve the existing logistic model to suit the industry according to the situation. [Waidringer, & Jonas, 2001].

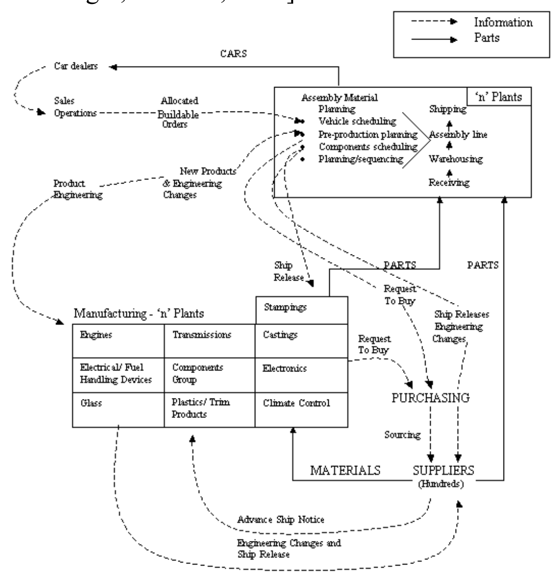

Fig. 1: An automotive supply chain

3. DEVELOPMENT OF THE INTEGRATED LOGISTSIC MODEL

All the drawbacks in the existing model are studied and these drawbacks are overcomed in the present model, which is developed by us. Taking the dynamic property of the automobile into consideration, we move on to provide an enhanced / refined view of the logistic model in a simplified way. A brief analysis of the logistic model to improve its visibility is conducted & presented in this section. Considering the same example of an automotive industry, let us move to improve its visibility by following the steps given below.

Step 1 : First step is to find out the various basic finished or semi finished parts producing departments/ organizations leading to the final part / product.

Step 2 : Concentrate on the part which is of immediate interest.

Step 3 : For the chosen part, prepare the work flow and process flow diagram.

Step 4 : For the chosen part, identify the various components, its raw materials, semi-

© 2005 - 2009 JATIT. All rights reserved.

finished parts etc., and get their relation ships.

Step 5 : From the obtained relation, prepare the material flow diagram.

Step 6 : From the prepared material flow diagram, the material movement information is obtained.

Step 7 : Optimize the material travel.

These steps of the algorithm are further explained as follows for the development of the integrated logistics model.

Step 1: First step is to find out the various basic finished or semi finished parts producing departments / organizations leading to the final part / product. For the automobile (car), the step 1 is done as follows: Every automobile consists of the following two main parts: [R.K. Rajput., 2007]

1. Machine portion.
2. Carriage portion, i.e., body.

Every automobile irrespective of its country of manufacture or model consists of the three basic units as shown in Fig. 2, leading to the machine portion, the chassis and transmission, the engine & the electrical equipments.

1. The “engine”.
2. The “electrical equipment”.

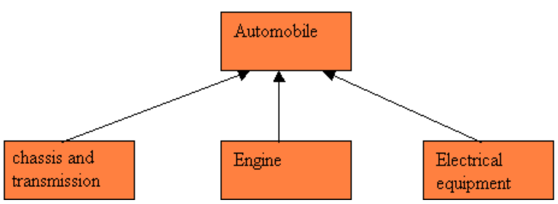

Fig. 2 : Basic units of automobile

The different departments involved in an automobile industry are as shown in the Fig. 3.

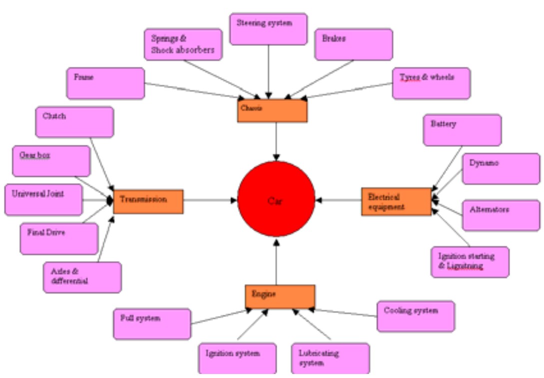

Fig. 3: Automobile departments

Various departments in an automobile sector contribute to the cost of functionality of the industry. In order to reduce them, we should analyze each department individually in order to optimize the cost.

Step 2: Concentrate on the part, which is of immediate interest. On the processes of selection of the department of the automobile industry, engine department is chosen where most of the material, information and cost transfer occur. This is because; we have wide variety of components that are supplied by various suppliers from various locations. Hence we have numerous factors affecting the Logistic model of the industry. The body panel and engine constitute a major portion of the total cost of car manufacture. A typical cost structure for car is as given in the Table 1.

Table 6.1: Typical cost structure for car manufacturing

Parts / assembly	%age of total manufacturing cost
Glass	5
Brakes / wheels / axes	6
Interiors	7
Transmission system	7
Ignition / exhaust system	8
Steering / suspension	9
Comfort fittings	11
Engine	16
Body	18
Others	13

Different parts of an automboile’s IC Engine are as shown in the Fig. 4. The parts are explained as follows one by one. A typical IC engine consists of the following components :

Camshaft = The shaft which carries the various cams required for the operation of inlet, exhaust, fuel, and starting air valves.

Connecting rod = the engine part which connects the piston to the crankshaft. It changes reciprocating motion of the piston into rotary motion of the crankshaft or vice versa.

Crankcase = the middle part of the engine structure surrounding the working parts.

Crankpin = that part of the crank to which the connecting rod is attached.

Crankshaft = that part of the engine which transmits the reciprocating motion of the pistons to the driven unit in the form of rotary motion or that part to which the connecting rods are attached.

Crankshaft cheek = part of the crankshaft that connects the crankpin to the main crankshaft journal.

© 2005 - 2009 JATIT. All rights reserved.

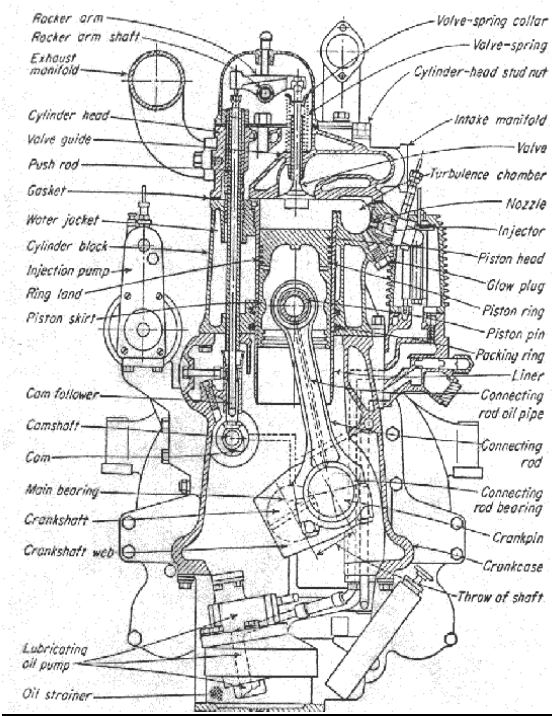

Fig. 4: Cross section of an IC Engine

Crankshaft journal = part of the crankshaft which rotates in the main bearings and transmits the torque developed by the engine.

Crankshaft web = the crankshaft cheek.

Crosshead = the part of an engine to which are attached the piston pin with the connecting rod and the piston rod and which is supported on guides.

Crown = the top of an engine piston.

Cylinder = The cylindrical part of the engine in which the piston moves, and in which combustion takes place.

Cylinder block = A number of cylinders cast in one piece.

Cylinder bore = the inside diameter of an engine cylinder. Also, it is the surface of the cylinder in which the piston slides or moves.

Cylinder head = the part which covers and seals the end of the cylinder and usually contains the valves.

Cylinder - head stud = Threaded round steel rod, one end of which screws into the cylinder block, the other being threaded to take a nut which holds the cylinder head in correct position.

Cylinder liner = A cylindrical lining that is inserted into the cylinder jacket or cylinder block and in which the piston slides.

Engine = A machine which produces power to do work, particularly one that converts heat into mechanical work.

Exhaust manifold = the pipe that collects the burnt gases as they are expelled from the cylinders.
Exhaust pipe =Piping through which exhaust gases from an engine pass out to the atmosphere.

Exhaust valve =The valve through which the burnt gases are allowed to pass out to the exhaust manifold.

Filter = A device to remove dirt and other impurities from air, oil, or water.

Flywheel = the wheel on the end of the crankshaft that gives the crankshaft momentum to carry the pistons through the compression stroke.

Fuel injector = the device which sprays the fuel into the cylinder.

Fuel knock = A noise produced in the cylinder of a diesel engine during combustion, usually when the fuel oil has a low ignition quality.

Fuel pump = the pump that delivers the fuel to the injector.

Fulcrum = the support on which a lever turns.

Gasket = Packing placed between two surfaces that must have a leak proof joint.

Governor = A mechanism used to control the speed of an engine.

Injection = The forcing of fuel oil into the combustion chamber of a diesel engine by means of high pressure.

Injection pump = the pump used to inject fuel oil into the combustion space of a diesel engine.
Inlet cam = the cam that controls the operation of the air inlet valve in a four-stroke engine.

Inlet manifold = The main pipe that lies alongside the cylinder heads and from which branch pipes take the air charge to the separate cylinders.

Inlet valve = the valve through which air or the air-fuel mixture is admitted to the cylinder of a four-stroke engine.

Lubricating pump = A pump which handles lubricating oil in an engine.

Manifold =A pipe with a number of inlets to, or outlets from, the several cylinders of an engine.

Mechanical injection = Injection with the fuel-valve operated mechanically from a cam. Sometimes, although wrongly, used to indicate airless injection in general.

Muffler = A device used to diminish noise of the intake or exhaust. Sometimes it is referred as a silencer.

Oil-control rings = The piston ring, usually located at the lower part of the piston, that prevents an excessive amount of lubricating oil from being drawn up into the combustion space during the suction stroke. Also called oil ring and oil scrapper ring.

© 2005 - 2009 JATIT. All rights reserved.

Oil grooves = The passages cut in bearings for distributing the lubricating oil.
Piston = A cylindrical part which reciprocates in the cylinder bore of an engine and transmits the force of the gas pressure through the connecting rod to tine crankshaft.
Piston crown = the top of the piston; the piston head.
Piston head = the top of the piston or that part of the piston against which tire gas pressure acts.
Piston pin = A pin that rests in two bored holes in the piston and passes through the eye of the connecting rod, to join the two together flexibly.
Piston-pin bearing = the bearing either in the eye of the connecting rod or in the bored bosses of the piston, in which the piston pin rocks.
Piston-pin boss = that part of the piston on the inside, through which the hole is nude to take the piston pin.
Piston-pin lock = the device used to hold or lock the piston pin in the piston.
Piston ring = A split ring placed in a groove of the piston to form a leak proof joint between the piston and the cylinder wall.
Piston-ring gap = the space between the ends of the piston ring when it is in the cylinder bore.
Piston-ring land = the part of the piston on the outside surface located between the piston-ring grooves.
Piston skirt = the part of the piston below the piston-ring grooves.
Poppet valve = A valve opened by the action of a cam and closed by a spring.
Port = An opening hole or passage.
Push rod = the rod that transmits the action of a cam to the cam-operated valve.
Ring grooves = Grooves cut in the piston barrel to hold the piston rings.
Rocker arm = A lever that transmits the action of the cam, usually by means of a push rod, to the stem of the intake or exhaust valve, sometimes also to the starting-air valve and fuel valve.
Rocker-arm shaft = the shaft, usually at the top of the cylinder, that serves as a fulcrum for the rocker arms.
Valve = in a combustion engine, an intake or exhaust valve usually consists of a disk with a stem, which is opened by a cam and closed by a spring.
Valve seat = That part of the valve mechanism upon which the valve face rests to close the port.
Valve Spring = the spring which is used to close a valve.
Valve-spring retainer = The part which is held against a groove or grooves on the valve stem and in turn holds the valve spring in a state of compression.
Water jacket = the outer casing forming a space around an engine cylinder to permit circulation of cooling water.

In this paper, different significant parts of an IC engine, which affect the performance of the engine, are considered.

Step 3: For the chosen part, prepare the workflow and process flow diagram as shown in the Fig. 5. This figure shows the workflow diagram, which defines the different raw materials, semi finished components required for manufacturing the engine components.

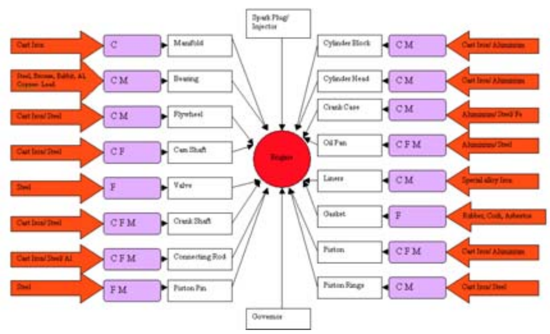

Fig. 5 : Work flow diagram

Note that in this figure, the terminologies C, F & M depict as follows : C – Casting process, F – Forming process, M – Machining process.

Step 4: For the chosen part identify the various components, its raw materials, semi-finished parts etc., and get their relation ships. Let us now define the different raw materials, semi finished components and the engine components symbolically which is shown as follows :

Raw materials	Code Nos.
• Cast Iron	M01
• Aluminum alloys	M02
• Cork	M03
• Asbestos	M04
• Rubber	M05
• Copper	M06
• Special alloy Iron	M07
• Ferrous alloy/ Semi steel/ Steel	M08
• Bronze	M09
• Babbitt(Lead/ Tin based)	M10
• Copper –Lead	M11
• Pattern material	M12
• Sand	M13

© 2005 - 2009 JATIT. All rights reserved.

- Binder M14
- Additives M15
- Furnace Fuel M16
- Cutting Fluid M17

Semi finished Components	Code Nos.
• Timing gear	SFP01
• Oil Pump	SFP02
• Dampers	SFP03
• Gear/ Sprocket drive	SFP04
• Valve Seats	SFP05
• Valve Guides	SFP06
• Fasteners	SFP07
• Springs	SFP08
• Rocker Arm	SFP09
• Tappet	SFP10
• Push rod	SFP11
• Bushes	SFP12
• Circlips	SFP13
• Governor	SFP14
• Spark Plug/Injector	SFP15
• Oil Strainer	SFP16

Components of the Engine	Code Nos.
• CB	Cylinder Block
• CH	Cylinder Head
• CC	Crank Case
• OP	Oil Pan
• CL	Cylinder Liners
• G	Gasket
• P	Piston
• PR	Piston Ring
• PP	Piston Pin
• CR	Connecting Rod
• CS	Crank Shaft
• MB	Main Bearing
• FW	Fly Wheel
• V	Valve
• CaSf	Cam Shaft
• M	Manifo

Step 5: From the obtained relation prepare the material flow diagram.

The Fig. 6 shows the material flow diagram for the manufacturing of an engine. From the material flow diagram, we get a clear picture regarding the material flow between the various departments in an organization. The algorithm used for developing the integrated logistics model is shown in the Fig. 7.

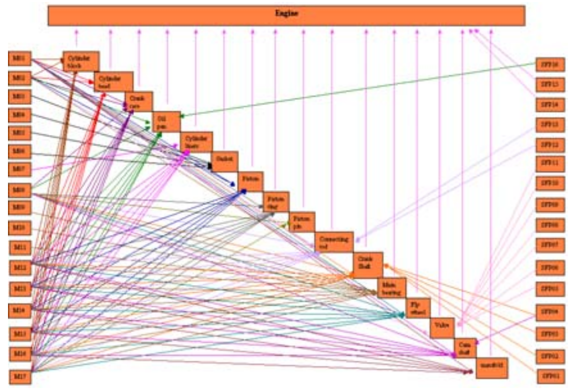

Fig. 6: Material flow diagram

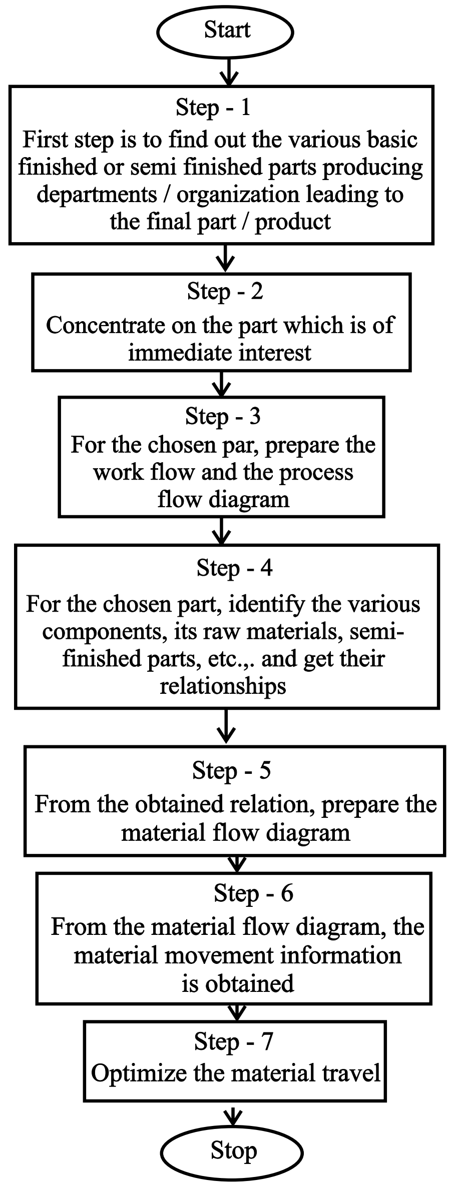

Fig. 7 : Algorithm for developing the integrated logistics model

© 2005 - 2009 JATIT. All rights reserved.

Step 6: From the material flow diagram, the material movement information is obtained. For each component the material movement information can be obtained with the help of material flow diagram. Each material movement will be associated with suppliers, sub suppliers, contractors, and dealers etc., each of them needs to be clearly identified and defined.

Step 7: Optimizing the material travel is the main part of the research work undertaken & presented in this paper. Since the problem resembles the real life problem operation research method for optimizing the distance of material traveled is adopted. This part can be dealt as a future work of this paper.

4. Conclusions

An integrated logistics model for a supply chain management considering an automobile as an example is developed in this paper. Supply chains involve multiple organizations as we move towards the raw material supplier or downstream towards the ultimate customers. The existing logistic model lacks in the case of visibility and control, which is taken care of in our developed model, and thus, the model developed in this paper is more sophisticated and an improved version of the existing integrated logistic models.

For the simplification purpose, automobile-manufacturing industry has been taken into consideration. Also, a brief analysis of the integrated logistic model is carried out to improve its visibility. In construction and identification of this integrated logistics model, we identified the primary processes as logistics processes concerning all the participants of the integrated value chain. It is reasonable to consider transfers and transaction of products and information as primary processes, when logistics functions are in focus. The support processes are identified as other relevant processes among the participants.

Just In Time (JIT) concept can also be incorporated to improve further the integrated logistics model which can be considered as a future work.

5. Acknowledgements

We would like to acknowledge Shri. Mohan Manghnani, Chairman, NHEI & Dr. H.G. Chandrakanth, Principal of NHCE for providing the facilities for writing the paper in this renowned institution, the NHCE. We also thank all our colleagues directly or indirectly for helping us while developing this paper. We also thank the support provided by the staff of Dr. MGR Deemed University.

6. References

[1] Berrin Denizhan, Harun Taşkın, "Manufacturing Logistics Model: Application on A Electrical Component Manufacturer", *Proceedings of 5th International Symposium on Intelligent Manufacturing Systems*, May 29-31, pp. 1314-1322, 200.

[2] Eirik Borgen, Heidi Dreyer, Håkon Hynne, Kristin Olstad Schea, "Integrated Logistics and Value Chain Management (A new model approach to value chains)", *Int. Conf. Paper*.

[3] http://en.wikipedia.org/wiki/

[4] Womack, James P., Jones, Daniel T., and Roos, Daniel, The Machine That Changed the World, 1990.

[5] Automotive News calls Toyota world No 1 car maker, reuters.com.

[6] Toyota Production System, Taichi Ohno, Productivity Press, pp. 8, ISBN 0-915299-14-3, 1998.

[7] Manjunatha & H.K. Sivanand, "Complexity perspective in Lean Manufacturing", *Proc. National Journal of Manufacturing Technology & Management*, Vol. II, No. 2, 2008.

[8] Administering SAP R/3, "The Production and Planning Module", Authored by, *ASAP World consultancy, an international SAP consulting company specializing in SAP implementation*.

[9] Manjunatha & H.K. Sivanand, "Logistics Model for Supply chain Optimization", paper accepted for publication in the *International Journal of South Asian Journal of Management*.

[10] Helper. S., "Supplier relations in Japan and the United States: Are they converging ?" *Proc. Sloan Management Review*, Vol. 36, No. 3, pp. 77 - 84, 1995.

[11] Manjunatha & H.K. Sivanand, "Logistics in Molding line", *Proc. International Conference on Total Engineering, Analysis & Manufacturing Technologies*, Bangalore, 2004.

[12] Lambert, D.M. and Stock, J.R., "Strategic Logistic Management", 3rd Edn., Homewood, IL: Irwin, 1993.

[13] Manjunatha & H.K. Sivanand, "Logistics in foundry - A conceptual approach", *Proc. International Summit on Agility, Design and Manufacturing - Expo 2005*, Bangalore, India.

[14] Lumsden, Kenth, Hulthén, Lars and Waidringer, Jonas, "Outline for a Conceptual Framework on Complexity in Logistic Systems", *Proc. Opening markets for Logistics, the Annual Conference for Nordic Researchers in Logistics - 10th NOFOMA 98*, (Eds, Bask, A. H. a. V., A.P.J.) Finnish Association of Logistics, Helsinki, Finland, 1998.

[15] Lambert, Douglas. M., Cooper, Martha C., and Pagh, Janus D., "Supply Chain Management: Implementation Issues and Research Opportunities", *Proc. International Journal of Logistics Management*, Vol. 9, No. 2, pp. 1 - 18, 1998.

© 2005 - 2009 JATIT. All rights reserved.

[16] Manjunatha & H.K. Sivanand, "Logistics Link Model - A Tool for Lean Manufacturing", *Proc. International Conference on Total Engineering, Analysis & Manufacturing Technologies*, Bangalore, 2006.

[17] Mac Duffie. J. P., "Human Resourse bundles and manufacturing performance: Organisational logic and flexible production systems", *Proc. world auto industry, industrial and labor relations review*, Vol. 48, No. 2, pp. 197, 1995.

[18] Manheim, Marvin L., "Fundamentals of Transportation Systems Analysis", Cambridge: *MIT Press*, Mary Poppendieck, LLC., 1979.

[19] Manjunatha & H.K. Sivanand, "Lean Manufacturing-The vision to technology", *Proc. of the National Conference on Mechanical Engineering Trends* (COMET - 2006)", 2006.

[20] Monczka, Trent, Handifield, "Purchase and supply chain management", 3rd edition, Thomson publication.

[21] NIST / MEP, Principles of Lean Manufacturing with Live Simulation. Gaithersburg: *National Institute of Standards and Technology Manufacturing Extension Partnership*, 1998.

[22] R T Miles, The role of logistics in developing business strategy.

[23] SAP R/3 Client – User Interface.

[24] Manjunatha & H.K. Sivanand, "Optimization by Logistics Model - A Tool for Lean Supply Chain", *Proc. of the International Conference on Total Engineering, Analysis & Manufacturing Technologies*, 2007.

[25] Waidringer, Jonas, "Complexity in transportation and logistics systems: A conceptual approach to modelling and analysis," Report 52, Department of Transportation and Logistics, Chalmers University of Technology, Göteborg, Sweden, 2001.

[26] Wilding, R., "The supply chain complexity triangle: Uncertainty generation in the supply chain," *Proc. International Journal of Physical Distribution & Logistics Management*, Vol. 28, No. 8, pp. 599-616, 1998.

[27] Manjunatha, "Integration of logistics model and SAP/3 system in lean manufacturing", *Ph.D. Thesis* (submitted) to Dr. M.G.R. Deemed University, Chennai, Tamil Nadu, India.

BIOGRAPHY:

Mr. Manjunatha, born in Gadag, Karnataka, India on 1st May, 1967 received the B.E. Degree in Mechanical Engineering from the Jagadguru Mallikarjuna Murugarajendra Institute of Technology, Chitradurga from the University of Mysore in 1989 in First Class with distinction and M.E. in Mechanical Engineering with specialization in Production Engineering Systems Technology in the year 2004 in First Class with Distinction from Govt. BDT College of Engg., affliated to Kuvempu University, Karnataka, India, respectively. He has served 10 years in the Mysore Kirloskar Industries Ltd., Mysore and 2 years in Kirloskar Ferrous Industries Ltd., Mysore. Since 2003 he is working in New Horizon College of Engineering as a faculty in the Department of Mechanical Engineering. He is currently, Professor & Head in the Department of Mechanical Engineering, New Horizon College of Engineering, Bangalore, which is affiliated to Visvesvaraya Technological University, Belgaum, Karnataka, India. Simultaneously, he is also doing his Ph.D. in the field of Lean Manufacturing from the prestigious Dr. M.G.R. Deemed University in Chennai, Tamil Nadu, India. He has published a number of papers in the various National, International journals and Conferences and published one text-book on Management titled, "Entrepreneurship & Management". He has also guided a number of undergraduate and post-graduate projects. Some of them include the prototype on wind-mill & four wheelers. He has also presented, participated, conducted a number of guest lectures and various seminars & workshops, conferences, symposiums. His current research interests are in the area of Lean Manufacturing, CAD, CAM, CIM, Industrial Automation, Machine Design, Theory of Machines & its allied subjects.

Dr. H.K. Shivanand, born in Bangalore, Karnataka, India on 16th October 1970 received the B.E. Degree in Mechanical Engineering from Bangalore University in First Class and M.E. in Mechanical Engineering with specialization in Manufacturing Engg. in First Class with Distinction from Bangalore University, Karnataka, India, & Ph.D. in the field of Mechanical Engg. from Bangalore University, Karnataka, India, respectively. Since 2006, he is working as faculty in University Visvesvaraya College of Engineering, Bangalore, in the Department of Mechanical Engineering, which is affiliated to Bangalore University, Bangalore, Karnataka, India. He has published more than three dozen papers in the various National, International journals and Conferences. He has also guided a number of undergraduate, post-graduate projects & guiding a number of research scholars. His current research interests are in the area of Material Science, Composites, Metal matrix composites & its allied subjects.

Dr. T.C. Manjunath was born in Bangalore, Karnataka, India on Feb. 6, 1967 & received the B.E. Degree from the prestigious R.V. College of Engg. (Bangalore University) in 1989 in First Class and M.E. with specialization in Automation, Control and

© 2005 - 2009 JATIT. All rights reserved.

Robotics from L.D. College of Engg. (Gujarat University) in 1995 in First Class with Distinction and Ph.D. in the field of Systems and Control Engineering from the prestigious Indian Institute of Technology Bombay (IIT Bombay) in the year 2007, respectively. He has got a teaching experience of nearly 20 long years in various engineering colleges all over the country (Karnataka, Tamil Nadu, Gujarat, Maharashtra) and is currently working as Professor and Head of the Department of Electronics and Communication Engineering in New Horizon College of Engineering in Bangalore, Karnataka, India. He also worked as a Project Assistant and as a Research Engineer in the Systems and Control Engineering (IIT Bombay, India) for nearly a year and worked on control of space launch vehicles using FOS feedback technique. He has published a number of papers in various National, International journals and Conferences and published three textbooks on Robotics, one of which has gone upto the fourth edition, titled, 'Fast Track to Robotics' and the other, which has gone upto the fifth edition, titled, 'Fundamentals of Robotics' in 2 volumes, Vol.-1 and Vol.-2 along with a CD which contains about 150 C / C++ programs for performing various simulations on robotics. He has also published a research monograph in the International level from the Springer-Verlag publishers based on his Ph.D. thesis topic titled, "Modeling, Control and Implementation of Smart Structures", Vol. 350, LNCIS, costing 79.95 Euros & was a student member of IEEE for 6 years (currently, a member), SPIE student member and IOP student member for 4 years, life member of ISSS (India), life member of the ISTE (India), life member of ISOI (India), life member of SSI (India) and life member of the CSI (India) and life member cum fellow of the IETE (India). He has also presented a number of guest lectures and various seminars and participated in more than a dozen CEP / DEP courses, seminars, workshops, symposiums in the various parts of the country in different institutions and also conducted a few courses. He has visited Singapore, Russia, United States of America and Australia for the presentation of his research papers in various international conferences. My biography was published in 23rd edition of Marquis's Who's Who in the World in the 2006 issue. He has also guided more than 2 dozen robotic projects (B.Tech./M.Tech.) in various engineering colleges where he had worked so far. Many of his guided projects, interviews have appeared in various national newspapers and magazines. He has also presented a number of guest lectures and various seminars and participated in more than a dozen CEP / DEP courses, seminars, workshops, symposiums in the various parts of the country in different institutions and also conducted (convened & coordinated) more than 1 dozen courses / workshops / symposiums / technical festivals. He has also reviewed many research papers for the various international conferences such as IEEE IECON-06, IEEE-ISIE-2007, NSC-07, SICE-2009, IEEE-WCSN-07, IEEE-PSACO2008, etc., and has also reviewed many journal papers for journals such as IJAMT, etc.,. He has also given many invited talks / plenary lecturers in various national & international conferences, workshops, symposiums and chaired many sessions & also conducted more than half a dozen courses / workshops / technical paper fests / student level technical symposiums, etc., in various colleges where he has worked. My Ph.D. research work was based on the mathematical modeling, control and implementation of smart structures and its applications to Robotics, Aerospace & Civil Engg. His current research interests are in the area of Robotics, Smart Structures, Control systems, Network theory, Mechatronics, Process Control and Instrumentation, MATLAB, Signals and systems (CT and DT), Industrial automation, Artificial intelligence, Digital signal processing, Digital Image Processing, Periodic output feedback control, Fast output feedback control, Sliding mode control of SISO and multivariable systems and many of the control related subjects and its allied labs and their various applications.