TRANSFER OF TECHNOLOGY: Technical, Technological and Logistic Approach in the Production and Assembly of Vehicles

Dr. Dušan Mežnar
President of Managing Board,
IAC·Inovative Automotive Construction, Maribor, Slovenia
E-mail: dusan.meznar@iac.si

ABSTRACT

The article presents an acceptable methodology for projecting and designing of complex technology transfer. The methodology is concentrated on the problem of building the structure of a product and its functional or designing approach. At the same time, it is necessary to keep in view the level of structure regarding the requirements of the end customer. The modularity structure of a vehicle is the condition of a modern and effective approach to the technology transfer with complete information support.

1. INTRODUCTION

The production and assembly of vehicles are associated with the field of combined mechanical systems with a high application value. The interconnection of technical, economic, logistic and ecological functions dictates some specific approaches in view of technology, organisation and management of processes in the production of vehicles.

From technical point of view, a modular vehicle construction represents the basis for a suitable logistic system for the supply of production line, assembly and related deliveries.

Vehicle is actually a multi-level modular system where modules in a close interacting synergy determine several functions of the vehicle during its application. Technical properties, the level of reliability and adequacy for maintenance are held at a proper level which is required by legislation and also implied by the trademark and customer confidence.

The concept of modular system allows two main principles used for the construction of vehicle, namely:

CKD (Completely Knocked Down) – vehicle completely knocked down to smaller units or parts

or

SKD (Semi-Knocked Down) – partially disassembled system which depends both on producer and customer.

The principle of vehicle construction using the CKD or SKD model also introduces a technology buyer into the system where partners have to make an important decision on whether the buyer can satisfy the demanded criteria for quality, production terms, placement of vehicles and prices, which is usually the crucial factor for the decision.

In view of a broader range of meaning, technology indicates the knowledge necessary for a design and/or production or a servicing set which is strictly prescribed for an individual or organisation. This knowledge is the result of an extended research and development, construction and production, and it is primarily unofficially accessible irrespective of the
collected and prescribed documentation. Only a part of that knowledge is codified in drawings and manuals.

Today, development and other processes of manufacture are based almost exclusively on information technology and supporting software. Therefore, this knowledge is expressed in digital forms of written records and/or in a suitable form of software. This actually means that technology is becoming scientifically designed and the knowledge transferred through technology is codified and as such stored in adequate documents.

Such approach to a technology transfer may require a lesser human involvement, however, no knowledge can be transferred without his direct engagement. This all results in a faster and simpler transfer of technology and its uniformity.

**Fig. 1 Model for technology transfer**

<table>
<thead>
<tr>
<th>Step-by-step</th>
<th>WIDE</th>
<th>COMPLEX TECHNOLOGICAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMALL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technological scope</td>
<td>Number of users/technological applicability</td>
<td></td>
</tr>
<tr>
<td>SIMPLE TRANSFER STEP-BY-STEP</td>
<td>SIMPLE RANGE</td>
<td>NARROW</td>
</tr>
<tr>
<td>(example – bus body)</td>
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</table>

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2. MECHANISMS FOR TECHNOLOGY TRANSFER

Mechanisms for technology transfer can involve the purchase of industrial property rights, licence acquisition, subcontracting, strategic partnerships including joint venture and a research & development activity, the purchase of an innovation company. Here, we should not overlook the possibility of a simple equipment purchase which is often connected with the transfer of certain technologies and of the knowledge and informal forms of technology transfer as for ex. staff getting qualifications abroad, obtaining key staff from competitive companies, copying of competitors, re-engineering, etc.

Fig. 2 shows an outline of different alternatives (trading approach, investment approach) for technology transfer into companies and it is based on the model of a reciprocal co-operation, clear separation of responsibilities and financing, local co-operation and connection of interests.

New technology involves progress and far more favourable prospects for both technology offerer and user.

3. PHASES OF TECHNOLOGY TRANSFER

As a matter of fact, there is no crucial difference between the transfer of technology into a company and the placement of own technology onto other interested markets.

In principle, this process consists of six phases:

1. Searching phase: Fairs, patent bases, informal contacts, presentation brochures, etc.

2. Evaluation phase:

   Technology seller: Analysis of own intellectual property rights, presentation of research methods and of prototype, time limit for development.
   Technology buyer: Market analysis, analysis of necessary material and knowledge suppliers, survey of finance sources and a time framework for efficient application of the acquired technology.

3. First contact and communication: Exchange of information, discussions about expectations of all involved parties, expected goals, knowledge and capacities, other sources, financial aspects, intellectual property rights, project management model.
4. **Formal strategy defining**: A precise schedule which clears all questions about the present state, future goals and development process in order to reach these goals.

5. **Development phase**: A precise market research, production and improvement of present prototypes, checking the market situation with test products, introduction of alternative options for product use, and testing the end consumer with a pilot production.

6. **Starting a full commercial process**: Checking the actual situation – activities as foreseen in the business plan, and in case of larger deviations and changes of market demands also changes and adjustments of the initial plan.

The utilization of complementary advantages among partners in the process of transfer and acquisition of technology is seen from the graphic presentation below.

A joint interest or goal is presumed to be achieved at that moment, **when advanced technology of a suitable quality that is acceptable to customer is acquired at a reasonable cost.**

**Fig. 3.: Strengthening the joint competitive power through the utilization of complementary advantages**

<table>
<thead>
<tr>
<th>Joint position</th>
<th>Supplier's position</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Acquired position</td>
</tr>
<tr>
<td>Low</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>Technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost</td>
</tr>
</tbody>
</table>

4. **CRITERIA FOR PARTNER SELECTION IN TECHNOLOGY TRANSFER**

The simplest form of evaluation techniques is a checking list for all criteria which are considered in the selection of project. The main groups of criteria include:

A. Corporate goals, strategy, policies and values  
B. Marketing criteria  
C. Research and development criteria  
D. Financial criteria  
E. Production criteria  
F. Ecological criteria and environment criteria

On the basis of these criteria, we get a project profile – here, every criterion is evaluated depending upon standard effectivity. Each item has to be defined as to its importance. A sum of the importance parameters and the evaluation of each item shows at the end if the project is suitable for the company.

On the basis of business plan, we get a variety of information about the project itself which helps us in making the decision whether the project is acceptable or not. In addition to the financial plan, it is also necessary to examine all other elements which are necessary for a successful transfer of technology. Human resources are particularly important here, since a
skilled and motivated staff with adequate knowledge can contribute largely to a successful implementation of the idea. Actually, the key to success lies in understanding the market and business principles and in the initiation of new technological solutions for the existing situation which is shown in a well prepared business plan.

5. PRODUCTION PROGRAM

The CKD method (Complete Knock Down) is one of the possible methods for technology transfer. It indicates a finished product that is completely disassembled and ready for re-assembly at some other location. The Mini Bus IAC 080 is such product which is available for external market and can be produced using the CKD method. From the technical&technological view, a bus involves two larger groups of operations for its production and assembly:

   a) Production and assembly of chassis
   b) Production, assembly and superstructure

The first group of operations includes the production and construction of a frame as the vital supporting bus element, followed by the assembly and integration of transmission elements: engine, clutch, transmission gear, wheel steering system, electrical system, cooling and other engine systems, etc. The frame represents the supporting, connecting and integrating bus element which is from the constructional and technical&technological point of view a demanding part in the construction. It allows the implementation of all bus functions and guarantees the fulfillment of safety, ecological and logistic criteria.

The second group of operations involves the integration and connection of functions between chassis and superstructure. The manufacture of superstructure gives priority to an interactive communication between passengers and their comfort while driving: windows, seats, interior, lighting, air-condition, ventilation, luggage rack, etc.

6. TECHNICAL&TECHNOLOGICAL AND LOGISTIC COMPLEXITY

6.1 Local Market

A special assessment of parameters and criteria plays an important role in making the decision of entering the local market and transferring the technology of assembly. The experience and tradition in the production of similar products are very helpful when deciding about the installation of an assembly plant, the acceptance and serial production on the basis of technology as specified. The support of local community for such production has a strong influence upon the start-up and maintenance of dynamics related to the introduction and control of processes and functions.

6.2 Interaction Between Technology Provider and Local Producers

A technology transfer model influences the relations between technology provider and local producers who are in principle very interested in taking over a part of production. The technology provider often relies upon domestic suppliers who are in the early phase offered a part of production, however, only after their capacity, quality and price have been examined in detail first. The supply of simpler parts can be started at a short time while more complex parts require more time. This shows the importance of efficient preparations on the part of suppliers, their training, conformance with standards, legal and other regulations, production technology, environmental protection, etc.

The model for technology transfer also involves the transfer of knowledge and its incorporation into product in all phases of production and assembly. Capacity for the transfer of knowledge and its absorption, usually with a lot of patience and understanding, only emphasizes the necessity for an interactive connection.
6.3 Level of Complexity and Technological Dependence

Bus is a product of a highly technical and technological and logistic complexity. Technical complexity is shown in the integration of chassis and superstructure, and in ensuring a perfect bus functioning that has to conform with project requirements, legislation and the Regulation for Bus Manufacture and with the Road and Traffic Regulations Act. Having that in view, all technical requirements, driving characteristics, safety and ecological properties and characteristics connected with the use and maintenance have to be completely satisfied.

Technological complexity lies in the specialised logics and regulations regarding the manufacture and assembly of subassemblies and parts. Technologically very complex components as for ex. the front and rear bus wall, front and rear bumper, control panel and the inner front lining are computer-supported and constructed elements that are produced with the use of CAM technology and they require a very careful, accurate and constructional approach [2]. As a rule, these elements are CKD or SKD components and they are supplied by the technology provider. A transfer of technology and knowledge for such complex parts is usually the subject of separate negotiations, carried out in the following phase of technology transfer.

A logistic complexity in the process of technology transfer and the organisation of logistic centres at a new location by introducing local producers demands a lot of coordination and kind of a lax approach, in particular at an early stage. Stocks are still in the logistic centres and a transition over to the JIT system (Just-in-Time) depends on the evaluation of the capability of partners and suppliers for such approach.

7. PHASES OF TECHNOLOGY TRANSFER

The table below shows actual phases in the process of technology transfer using the CKD method for the manufacture of the IAC 080 bus.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Qty</th>
<th>Supplied By TVM</th>
<th>Supplied Elsewhere</th>
<th>Manufacture at Partner’s</th>
<th>Assembly at Partner’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>- Test or sample bus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>50</td>
<td>- CKD – part of body remains unfinished</td>
<td></td>
<td>- Finished vehicle body assembly</td>
<td></td>
</tr>
</tbody>
</table>
| II    | 200 | - CKD – chassis (stripped)  
- CKD – vehicle body  
- Demanding subassemblies of vehicle body  
- Part of vehicle body equipment | - Part of chassis equipment  
- Part of vehicle body equipment | - Subassemblies of vehicle body  
- Painting of vehicle body  
- Subassemblies for finish assembly of the vehicle body | - Chassis assembly  
- Vehicle body assembly  
- Finish assembly of vehicle body  
- Bus finish |
Starting point in the process of technology transfer for the production and assembly of buses is a sample product which will be available to potential buyers at the new location at partner's place. This is the zero phase indicating a normal start of the complex task.

The second phase includes assembly of a chassis and a part of vehicle body which is finished at partner’s location after a previous training at partner's or supplier's location together with technical documentation and assembly instructions.

In the third phase, CKD chassis and vehicle bodies are supplied, with partial shipments of parts and subassemblies from partner's suppliers, followed by a finish assembly of chassis and vehicle body.

In the third phase, when the partner has accepted the rules, is in command of the process of manufacture and bus assembly, has control over quality and delivery terms from domestic suppliers, he by himself carries out the assembly of chassis and vehicle body to finish the bus.

Time schedule below shows an example of technology transfer for the manufacture and bus assembly, providing activities, duration and time limits.

### 7.1. Time schedule for realisation of technology transfer

<table>
<thead>
<tr>
<th>TECHNOLOGY TRANSFER</th>
<th>2012</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>TASKS</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1. Starting-points, requirements, adjustments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Preparations for task implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Pre-contract/Letter of Intent, Guarantee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Study of technology transfer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Phases of technology transfer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Realisation of activities by phases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Contract</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Preparations at partner’s location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Documentation acceptance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Control, monitoring, verification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7.1 Implementation of phases

<table>
<thead>
<tr>
<th>TECHNOLOGY TRANSFER PHASES</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter</td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>1. 01–phase: Manufacture of 2 sample buses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 02–phase: Preparations for technology transfer</td>
<td></td>
<td></td>
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<tr>
<td>3. I – phase: CKD š/k – 50 buses</td>
<td></td>
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<td></td>
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<tr>
<td>4. II – phase: CKD š/k – 200 buses</td>
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<td></td>
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<tr>
<td>5. III– phase: CKD š/k – 500 buses</td>
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</tbody>
</table>

Note:
š/k – chassis + vehicle body
2-test buses.: means Assembly + Production

CONCLUSION - EVALUATION OF TECHNOLOGY TRANSFER RESULTS

Initially, the criteria of an effective technology transfer have to be determined already at the beginning, prior to implementation, in particular in order to define the mission of that project and also for the sake of source allocation. Irrespective of the primary goal of technology transfer, the value of the new technology has to be considered in the view of a further research and development or improvement of current processes.

There are three important measurement factors for an effective technology transfer:

- Mechanism of technology transfer: formal mechanisms of transfer as for ex. contracts, licence or staff exchange usually provide an information which can be easier measured. However, this is not true of less formal activities as for ex. technical assistance, informal co-operation, and similar;

- Time frame: Usually, technology transfer is a longer process and therefore measurement should be properly adjusted. It is recommendable to apply three categories of measurement and reporting: short-term, medium-term and long-term;

- Economic&technical influence of transfer: attention is paid in particular to economic influences, i.e. sales volume, savings, number of new employees.

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