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THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

A Government of India /UNDP/ UNIDO Project

An analysis a quarter of a century afterwards*

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(Figure 1: The ARAI complex today - picture)

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Preface

This analysis was undertaken upon a visit of two working days from 30 November to 2 December 1998 to the facilities of ARAI by Oscar Gonzalez-Hernandez, evaluation officer of UNIDO. During this abbreviated period, an intensive exchange of information and views took place between the Director and managers of ARAI and the author. The installations were thoroughly visited and work in process observed. In addition, it was possible to discuss the work of ARAI with three of its many end users: one joint venture in Pune and two Indian companies in the Ludhiana area, visited later. Because of its short duration, this exercise does not pretend to be a full fledged in-depth evaluation. Its main aims are to ascertain the progress achieved by the institution well after all previous technical cooperation was completed - that is nine years ago since the last project was completed - and to draw lessons for institution building technical cooperation projects dealing with industrial technology at a sub-sector level.

The evaluator wishes to thank the Director and managers of ARAI, particularly the manager of the Fatigue Testing Laboratory, for all the support and information provided to this exercise.

The views expressed in this analysis are those of the author and do not necessarily represent the views of ARAI, UNDP or UNIDO.

Summary

Based on coinciding ideas of research work undertaken by UNIDO and by the Association of Indian Automobile Manufacturers, the laboratories of the Automotive Research Association of India (ARAI) were established during 1975 under a UNDP-financed project. This cooperation was complemented with other projects dealing inter alia with fatigue testing and emission control. Total external funding was around \$ 6.1 million.

ARAI today employs over 360 people of which 200 are professional. The technical cooperation projects in support of ARAI are considered efficient, effective and have achieved the desired impact. Dynamic sustainability up to present has been quite satisfactory.

Since 1995, the institution receives no public subsidy and invoices Rs. 121 million per year for services rendered.

ARAI has to face in the future a series of challenges which result from the transformation of the Indian Automotive Industry. Thus, Indian Automotive Industry is becoming less protected and foreign multinationals have entered the market either through acquisition or green field projects.

Advanced and updated process and product technologies are much in demand. Pollution control is getting enforced and tightened.

ARAI will have to keep on top of technology advancements. For this purpose it may have to limit the breadth of its activities. Quality control and certification will be in increasing demand possibly at the expense of R&D activities.

A number of lessons learned for technology centers are derived from this experience and are stated in the report.

UNIDO AND THE AUTOMOTIVE INDUSTRY

Since its inception, UNIDO has paid attention to the participation of developing countries in the manufacture of transportation equipment, in general and of road vehicles, in particular.

In the late 1960s UNIDO prepared a number of studies on the subject which culminated in a international seminar organized in February 1969. This seminar was attended by representatives of all automotive multinational companies and of the most significant developing countries already involved in this sub-sector.

The proceedings of the seminar contained a series of guidelines for the establishment and development of automotive industries in developing countries encompassing subjects such as minimum internal markets to justify assembly or production, local contents, degree and types of protection, types of vehicles and components to be considered for manufacture, inter-country cooperation, the role and need of supporting and ancillary industries, and of common support services. UNIDO continued to study these subjects and apply them in a variety of technical cooperation services. Accordingly, in March 1971 UNIDO prepared a study which advocated the creation of a cooperative arrangement between the public and private sectors, applicable to a particular developing country with good prospects for automotive manufacture, in the form of an Automotive Industry Center which aimed at providing the following services:

- S Extension services to assemblers and parts manufactures in a variety of disciplines;
- S Policy advice to governments related to the automotive industry;
- S Testing, calibration and certification facilities;
- S Assistance in the development/adoption of automotive standards; and
- S Cooperation with and advice to educational and training establishments on manpower resources needed by this sub sector.

What today seems to smack of public “dirigisme” and interventionism was at that time widely accepted, considering the then prevailing role of government in supporting industrialization all the way down to specific sub-sectors. However, UNIDO advocated for the proposed Center a strong industry participation, including financial support. Despite the present generalized attention given to market forces to guide industrialization, governments even in developed countries still play today a role in promoting specific industrial sub-sectors through a variety of support measures and incentives.

INDIAN AUTOMOTIVE INDUSTRY DEVELOPMENTS

During its first years of operation UNIDO organized in Vienna a series of seminars to promote its services among its constituent member countries both donor and recipient. One of such seminars, namely in October/November 1971, was attended by a delegation of India composed of the Under-Secretary of the then Ministry of Industrial Development and an adviser to the Minister. During that meeting UNIDO exposed its work and plans for the automotive industry as described above.

In those days, India planned, under its fourth five year development plan, *inter alia*, the manufacture of 50,000 low cost vehicles per year rising to 100,000 in 1978/79 (resulting essentially from the Maruti project) and a substantial increase in the production of scooters (500%) and motorized tri-wheelers (80%) during the same period.

Independently from the above and back in 1962, the Association of Indian Automobile Manufacturers and the Council of Scientific and Industrial Research had invited a director of the UK Motor Industry and Research Association (MIRA) to study the Indian automotive industry and

investigate the feasibility of forming in India an organization similar to MIRA. The recommendation of that study was that “cooperative research and test facilities were desirable for the Indian automotive industry”. Thus, in 1966, the Automotive Research Association of India (ARAI) was established as a non-commercial industrial research and testing organization with the assistance of the Government of India and the doyens of the automotive industry at that time: Premier, TELCO, Ashok Leyland, Mahindra & Mahindra, Bajaj, to name a few. However, the Association remained in paper and in intentions until the Indian and UNIDO ideas crossed in that meeting in Vienna of November 1971, as mentioned in the previous paragraph.

THE FIRST TECHNICAL COOPERATION PROJECT

The matter was pursued at both ends and a project, to start only after 1976, to establish an “Automotive Ancillaries Testing Center”, was included in the 2nd UNDP Country Programme for India. After pressure from both UNIDO and the Indian Ministry of Industry, the project was advanced and approved to commence in August 1975. The UNDP office in New Delhi gave a helping hand in this connection. In the meantime, a suitable ground of 105 hectares in the Vetal Hill Forest Park in Pune had been acquired and construction of a covered space of 1,700 sq.m had been completed, divided into a workshop of 1,000 sq.m and three levels of about 230 sq.m each. The first UNDP-financed project was thus approved much earlier than expected and implementation of the international component started still in 1975. As mentioned above, the Government component had started earlier and new laboratories were ready and waiting for the foreign equipment well before the project’s approval. Locally procured equipment was already installed by the same time.

At approval, the project had a UNDP contribution of US\$ 644,300 (around \$3 million at today’s value).

A big and unusual proportion (\$540,000) was devoted to equipment. Expertise was judged to be mostly locally available. The main external needs were for foreign equipment in view of the scarce foreign exchange availability. The training component, too small in our view then and now, was budgeted at only \$24,800. Local inputs exceeded UNDP inputs. They were estimated at \$790,000 and referred to the ground (a 99 year lease from the Forest Department), the Institute staff costs, the buildings and a substantial amount (over \$600,000) for locally available equipment.

This local contribution was to be shared in approximately equal parts by the then Ministry of Industry and Civil Supplies, the Council of Scientific and Industrial Research (CSIR), and the ARAI, the latter through a levy of annual fees amongst its members.

The Center had thus an important private sector participation including financial from inception. In fact the Center was controlled by a Governing Council composed of the senior executives of twenty-two member firms and three nominees of the CSIR. The President of this council came from one of such firms. Furthermore it was envisaged to have a Technical Committee consisting of ten members to advise the Governing Council on technical matters. This setup is today little changed.

The Center, in addition to the office of the director and an administration department, was to have five main technical departments, as follows:

- S Mechanical Workshop
- S Test Shop
- S Materials Testing Laboratory
- S Metrology Laboratory
- S Design Office.

It foresaw a staff totaling 60 persons of which most were engineers and technicians. The Center was equipped to perform the following main functions:

- S Various types of materials (mostly metallic) chemical, mechanical and metallurgical
- S Dimensional control (metrology) and calibration of instruments
- S Determination of viscosity and other characteristics of fuels and lubricants
- S Test engines
- S Component testing (for vibrations, corrosion , durability and noise)
- S Brake testing.

While the above range of services could not cover the variety of the needs of Industry, it was a good start. It should be mentioned that some of the member firms, like TELCO, had already important R&D facilities which were busy developing indigenous vehicles and components.

THE SITUATION AT PROJECT'S COMPLETION

The project was completed at the end of 1982. The project underwent various extensions and budget increases since estimates of needs had been done originally in a conservative manner. At the time of the project's completion, UNDP funding had been used as follows:

Item	US\$
Expertise	112,687
Training	127,690
Equipment	1,805,982
Miscellaneous	10,988
Total	2,057,347

This represents an increase of over three times the original budget, partly justified by the then high inflation of equipment prices.

In those days technical cooperation projects were not subject to in-depth evaluations so the situation at the end is extracted from various papers and from the project terminal report. A letter from the then UNDP Resident Representative in India upon a visit to the Center and meeting some of the main end users, mentioned that he was "very impressed with the facilities of the Center" and that these end users "spoke very highly of the services rendered to them by the Center". Further he termed the project as "one of the most successful UNDP projects".

The production of motor vehicles of all types had grown from 329,000 in 1975 to 790,000 in 1981. During the same period, automotive ancillary production had grown in average by 16% per annum. Exports however remaining relatively static around 10-15% of total production value. The Indian automotive industry was then based on an import substitution model and was strongly protected from imports. Exports related essentially to commercial vehicles and buses to nearby countries and Africa. These developments had a bearing in the Center in two ways: The volume of services increased but the approach of the Center to Industry was essentially of a R&D nature caused by the import substitution direction of the sector.

The project was implemented as planned and, as mentioned above, with a substantial increase in UNDP funding mostly to meet the then prevailing high inflation and to secure additional equipment to face increasing tasks from industry not foreseen at the project's start. Among the latter were: improvements in the performance and life of two-stroke engines, use of alcohol as an additive to gasoline and evaluation and control of automotive emissions. Training abroad was particularly appreciated and still today recalled as an asset by its participants.

The organization setup suffered changes from the original plan to accommodate more and more specialized needs. Thus the following departments were established, whose titles are self explanatory:

- S Vehicles Testing Laboratory
- S Engines Testing Laboratory (Diesel and petrol)
- S Components Testing Laboratory
- S Materials Testing Laboratory (Chemical, Mechanical and Metalography)
- S Instrumentation Laboratory
- S Metrology Laboratory
- S Prototype Building Shop (mechanical workshop).

It is obvious that at its completion the project met its intended objectives. The number of assignments /operations undertaken during the project life, thus demonstrating the meeting of the needs of Industry - despite the seller's market at that time in India where anything produced was sold - was impressive:

Assignments	Quantity
Vehicle evaluation	47
Engine evaluation	225
Component evaluation	350
Materials testing	1240
Metrology operations	630
Instrumentation calibration and measures	310

The bulk of these operations were performed on request of Industry and only a small percentage - less than 2% - was requested by the Government and public institutions.

In what regards standardization, ARAI was involved in various ISI standardization committees and thus participated in the elaboration of 48 new standards and the revision of 14 existing standards.

During the project life, ARAI organized, using its own staff and visiting international and Indian

experts, a series of 44 seminars and discussion meetings in a variety of technical subjects. At the same time, the Center was undertaking a series of special projects either requested and financed by the Government (powered cycle rickshaw, use of radio isotopes in engine wear studies) as well as by industry (use of alcohol in agricultural diesel engines, development of heavy duty brake fluids) and planned a series of other development projects (silencer for two-wheelers, torsional vibration damper, improved mountings for engines, to name just a few).

ARAI was able to raise revenues from Rs.510,000 in 1974-75 to Rs.4,745,000 in 1981-82. In the later figure, half refers to sales of services and the rest to membership fees and other income. Total expenditure is not known but detailed present figures are available further on in this report.

FURTHER TECHNICAL COOPERATION

Success breeds success and thus ARAI was able to convince the Government of India who in turn was successful in obtaining from UNDP as well as UNIDO funding for follow up and more specific projects as follows:

UF/IND/79/038 - Development of Motorized Cycle Rickshaw:

This project was financed with UNIDF inputs of \$129,600 related to international expertise and equipment. A prototype was developed using a square section tubing frame and a 50cc local petrol engine. It seems that the vehicle conceived was too heavy and the engine not powerful enough to propel it. Furthermore, the factory producing such engines closed down and similar engines were not available from other suppliers in India. There were no takers from the manufacturers side for the prototype developed. This project exemplifies the pitfalls of research projects undertaken at the supply side and affecting a market segment heavily influenced by traditions and social considerations. The development of an improved rickshaw either power assisted or not, to lessen the drudgery inflicted to its drivers is still today an actual proposition for which an adequate solution has not been found.

DP/IND/83/017 Fatigue Testing Laboratory for the Automobile Industry

Vehicles plying Indian roads are subject to inordinate and strenuous exertions. Vehicles and components designed for other operating conditions have a shorter life in India. No wonder that the modest facilities for fatigue testing envisaged under the first project quickly proved insufficient. A new project was implemented from March 1984 to December 1988 with a UNDP budget of \$2,382,000 to set up a comprehensive fatigue testing facility able to perform the full range of tests of complete vehicles (trucks, passenger vehicles and motorized two- and three-wheelers) and of a variety of components. 70% of this budget was devoted to equipment, percentage which was justified because of the heavy capital intensity of fatigue testing, particularly the servo-hydraulic equipment. Still a considerable amount of foreign expertise was made available in the fields of Statistical Data Analysis, Instrumentation Hardware, Application Instrumentation, Road Data Acquisition and Analysis, Application of Fatigue Test Equipment and Computer Application for Data acquisition and Analysis. Sixteen researchers/engineers received training under the project in automotive laboratories specialized in fatigue testing in the UK, USA, Germany and Italy and a number of study tours were organized for senior staff. An evaluation of the project conducted in February 1990 confirmed that its intended effectiveness was indeed met. That evaluation made some recommendations such as :

- a) That a standard load spectrum be derived to describe typical Indian road conditions and vehicle overloading. This was undertaken under a \$0.5 million project funded jointly by the Industry and some Academic Institutions. Work in progress in this area still today includes: road profile measurement for typical Indian roads and correlating a generalized axle acceleration as a road

input parameter and the measured road profile on test tracks and by laboratory simulation.

- b) To undertake follow-up research in various fields. The following projects with government of India funding, either completed or ongoing, took or are taking place in the Fatigue Testing Laboratory:
- S Creation of a Data Bank on Fatigue of Indian automotive materials - Phase I (\$0.38 million - completed)
 - S As above - Phase II (\$0.38 million - ongoing)
 - S Establishment of Techniques and Facilities for development of elastomer Components (\$0.25 million - Completed)
 - S Establishment of facilities for Quantification of Ride Comfort of Vehicles (\$30,000-Completed)
 - S Development of Techniques for the Evaluation of Joints (\$60,000 - Completed)
 - S Study on the effect of Residual Stress on Fatigue Life (\$90,000 - Completed)

(Figure 2: Four poster simulation of service load conditions, Equipment provided under DP/IND/83/017 - Fatigue Testing Laboratory for the Automobile Industry - picture)

- c) To update equipment and improvement of staff qualifications. More than \$0.8 million have been invested to update the facilities in terms of equipment. Existing and new staff have been trained by organizing training courses. However, with the ever increasing pace of modernization, particularly in electronics (digital) control, hardware and software, these efforts may not be enough in keeping the fatigue testing laboratory internationally updated.
- d) To expand the quality and quantity of documentation published by the laboratory. More than 30 publications on various fatigue questions have been made and distributed to industry. A number of workshops, seminars, educational and demonstration lectures are regularly held. A biennial seminar, the MTS ARAI Simulation Seminar (MASS) - is being held since 1995.
- e) To diversify the end users of the laboratory. The Automotive Industry keeps the laboratory sufficiently busy. However efforts are being made to extend the activities of the laboratory to agricultural tractors and construction equipment. Additional equipment and facilities would be needed for this expansion.

Summing up, the recommendations of the evaluation of the project to establish the Fatigue Testing Laboratory have been well followed, seen after a decade.

Figure 3 below gives an idea of the increase of income of the laboratory in relation to its manpower.

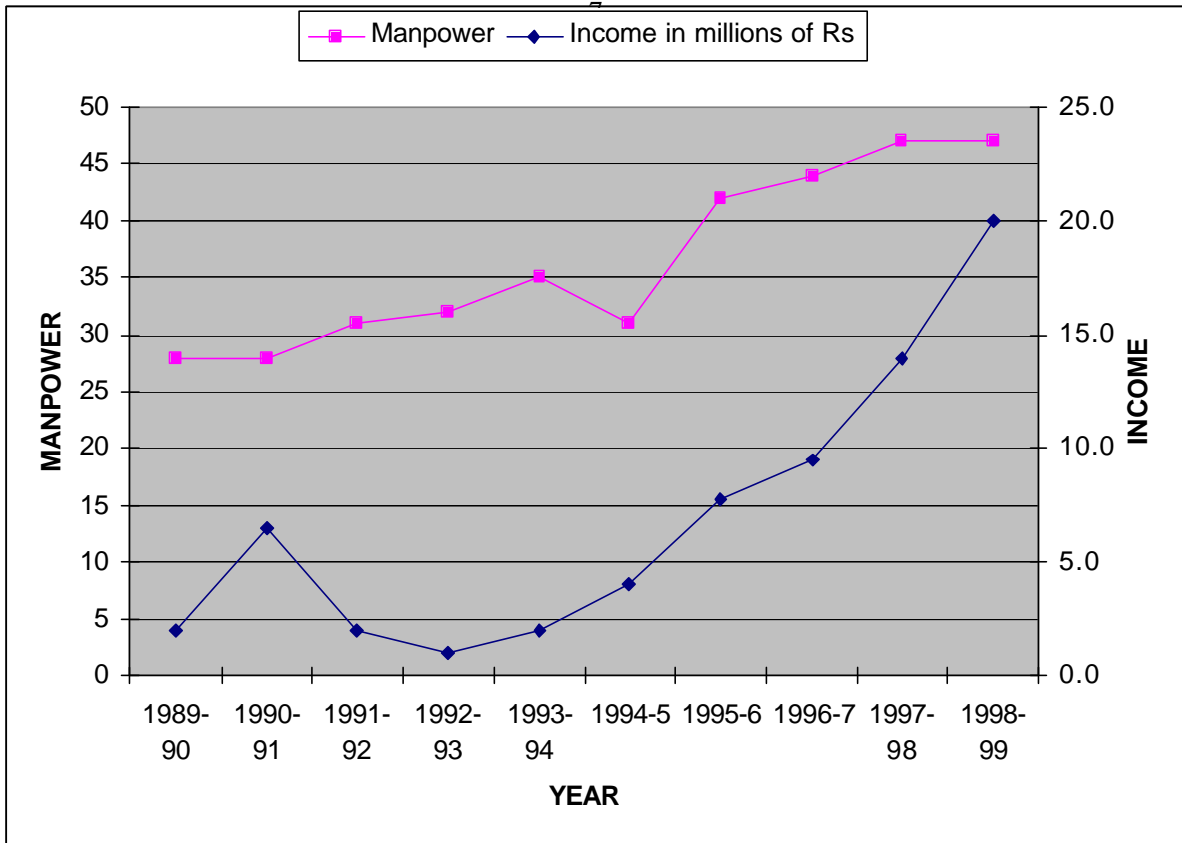


Figure 3

Performance of the Fatigue Testing Laboratory

DP/IND/85/070 Emission Laboratory for the Automotive Industry:

With the increase in vehicle population in India it became necessary to establish legal emissions regulations to reduce such emissions. The purpose of this project was to establish, for the first time in India, including in the vehicle manufacturers premises, the necessary facilities and capabilities for the evaluation of emissions from the array of engines used by automotive means in India, be them two or four-strokes, diesel or combustion engines. This project was implemented from June 1986 to December 1990, under government execution and comprised a total UNDP contribution of \$1,556,000 divided as follows:

Item	US\$
International Personnel	77,200
Training	123,300
Equipment	1,334,000
Miscellaneous	11,500

Results of the project were determined by an in-depth evaluation conducted in February 1990. The facilities for emission testing were established, consisting of four chassis dynamometers equipped with exhaust gas analysis systems and two engine test cells for emission evaluation. Ten engineers were trained abroad. ARAI, on account of its unique know-how in this field in India, became a pioneer in

emission measurement and development work for emission reduction in India. It also enabled the playing of a nodal role in preparing the technical portion of emission legislation in India. The first stage legislation was introduced in 1991-92. The second stage - corresponding to the European standards of 1992 and involving evaporative emissions levels - was introduced in 1 April 1996. The third stage is to be introduced in 2000 and will involve mandatory catalytic converters. Because of the uniqueness of its laboratories, ARAI plays still today a key role in the implementation of legislation both for type approval and conformity of production, besides assisting the manufacturers in having their products meet the legislation requirements. The laboratory has developed type approval procedures for the equipment used by road transport authorities for the implementation of the in-service vehicle norms and also is a major type approval authority for this equipment.

ARAI still keeps contacts with the Austrian expert who was instrumental in the setting up of the laboratory under the project.

(Figure 4: Emission testing of a two wheeler - picture)

THE SITUATION AT PRESENT IN ARAI

Management

Like any "Society" constituted under Indian law, ARAI is governed by a Governing Council with 27 members, 24 nominees of the major Indian automotive firms - selected amongst the present 75 ARAI member companies - and three nominees from the Ministry of Industry. The President and Vice-president of the council are selected among the private sector nominees. The Association of Indian Automotive Manufacturers and the Automotive Component Manufacturers Association of India are invited to participate in the Council's deliberations. In addition to the normal functions expected from a Management Board, the Council takes an active part in ARAI's tasks. Thus, so-called non-sponsored tasks, normally R&D and capacity building work (projects financed by the Development Council for Automobile and Allied Industries/Cess Committee, by the Ministry of Industry and by own funds) have to be approved by the Board while client sponsored work (projects, testing and certification) does not. During fiscal year 1997-1998 the ratio of income between non-sponsored and sponsored tasks was 35/65. Total income was Rs.121 million, up 15% from the previous year.

Financing

Since fiscal year 1995-96 ARAI receives no public grant towards recurring expenditures.

Income to ARAI derives from several sources:

- S Membership fee of companies amounting to 0.01% of their turnover, subject to a maximum of Rs. 500,000 per year per firm.
- S Invoices for work done, which include:
 - C Depreciation of equipment/facilities (which may not be enough to fully depreciate expensive pieces of equipment)
 - C Consumables
 - C Manpower
- S Cess funds in India (levied against the price of each vehicle sold in India) amount to Rs. 200 to 250 million per year out of which Rs. 80 to 90 million are used by ARAI. In addition Rs. 10-20 million originate in an Industry Fund for R+D projects used to create expertise needed by all

industry.

As a conclusion ARAI is today basically funded by sales of services, 60% from the Industry and 40% from a variety of Industry and Public funds.

Operations of ARAI

ARAI's facilities are grouped under the following departments, each one operating as a separate cost center:

- S Engines Laboratory
 - * Diesel Engines Development
 - * Basic Engine Research
 - * Spark Ignition Engine Development
 - * Advanced Engine Development facility
- S Vehicle Engineering Group
- S Vehicle Evaluation Laboratory
- S Fatigue Testing Laboratory
- S Automotive Emissions Laboratory
- S Automotive Safety and Homologation Laboratory
- S Materials Laboratory
- S Metrology Laboratory
- S Technical Information Center, which manages ARAI's website
- S Automotive Electronics and Control Systems Laboratory
- S Administration and Finance

Future plans include the establishment of :

- S Automotive Materials and Processing Laboratory, to deal with non-metallic materials
- S CAD/CAM Center
- S Failure Analysis Group

Interesting projects which ARAI is presently working on include:

- S Pollution control of 2-stroke and stationary engines, including the use of LPG and CNG as fuels. Prototypes for retrofitting kits are being developed. A patent has been granted for a pumpless lubrication system for 2-stroke engines. Incidentally, ARAI has been awarded 11 patents and two trade marks.
- S A system to easily detect the adulteration of fuels, a perennial Indian problem.
- S Study of the problems of emissions in used vehicles.
- S Pollution control of tractors.

Human Resources Development

ARAI is still using Government pay scales which are lower than Industry. This is partly compensated by an incentive scheme, established 1 April 1994, which rewards productivity at personal and department levels .

There are presently 360-370 people working in ARAI of which 200 professional. Out of these 80 have a minimum M.S. level and the rest are technicians. Fifty women are employed out of which twenty are engineers. This is an unusually high ratio for women employment in engineering type of activities in India.

Earnings per employee have steadily grown from 81 thousand Rupees in fiscal year 1993/94 to 254 thousand Rupees in 1997/98.

The bulk of training of the staff was undertaken under the various technical cooperation projects mentioned before. Training of the staff abroad is not systematically undertaken nor foreseen in ARAI's budget. This training, when undertaken - around 6 to 10 persons per year - is usually offered by multinationals or provided under equipment supplies.

There are no regular training courses available at ARAI. One post-graduate course was once undertaken for 15 people but it took too much of ARAI's resources and brought no income. There are about four to six seminars per year of average one-week duration on specific subjects but such courses are not self financing. Because of the need to heavily subsidize any type of training activities these do not constitute at present a priority for ARAI.

Standards. Certification

An important feature of ARAI's operations is its efforts to gain international recognition. Thus ARAI has been certified by the German TÜV and the same is being negotiated with UTAC (France) and IDIADA (Spain). ARAI is already certified under ISO 9001 and is working towards meeting ISO 14000. This certification simplifies considerably the export of Indian-made vehicles to these countries.

Development of standards aim at harmonization with established ECE standards. Only in those cases where Indian conditions, such as for evaporatory emissions, substantially differ, separate standards are adopted.

Institutions enabled to undertake certification work are so mandated by the Ministry of Transport. 80% of certification work in the automotive field in India is undertaken at ARAI. The other Indian institutions involved in this work are:

- S Vehicle Research and Development Establishment - a Ministry of Defense organization
- S Indian Institute of Petroleum
- S Central Forum for Agricultural machinery.

The Auto Parts Institute at Ludhiana is not yet involved in certification work.

Information. International Exposure

One of the mechanisms that ARAI utilizes to keep international exposure is the periodic organization of international symposia in cooperation of SAE, India Branch. The last one, SIAT'99 was organized during 13-16 January 1999. Around 450 delegates of which 100 from 12 countries participated. 64 technical papers were presented at twenty technical sessions. Coinciding with SIAT'99, an exhibition of automotive products and services with 48 stalls was organized.

Departments of ARAI are connected through a LAN so that users can browse information easily for bibliographic searches, accessing the bar code system for stock verification and transactions

and traceability of books and standards.

In addition to a webpage (www.araiindia.com), ARAI publishes the following publications:

- S Monographs on technical subjects - 7 in 1997/98
- S Safety standards - 6 in 1997/98
- S A monthly 12 page newsletter
- S Monthly Abstracts - A survey of automotive and related world with technical literature
- S Promotion booklets on ARAI as a whole and on each of its technical departments

Regional Dimension

Proximity to end users for such a service institution is essential. Thus, branches in Delhi and Chennai are planned. Ground near Delhi has already been purchased. Total investment here is planned at 800-900 million Rupees. This facility will be devoted essentially to mandatory testing especially related to crash worthiness and safety. In Chennai, proving grounds for vehicles are planned. There are no working relations with the Auto Parts Technology Institute, also established with UNDP funding in Ludhiana. There are no justification for this situation, except for the geographical separation of both institutions.

EVALUATION

The above projects, except for UF/IND/79/038, can be evaluated as follows:

Efficiency: These were expensive projects consuming considerable international and national resources. However, they serve an industrial subsector with a large output: 0.85 million four wheelers, 0.17 three wheelers and 3.1 motorized two wheelers were produced in 1997/98 and there is good potential for growth despite the present economic turn down. India is still comparatively under motorized with 1 passenger and commercial vehicles per 1,000 inhabitants. Within this framework and considering the unique role of ARAI in India, the effort was largely efficient.

Effectiveness: All objectives were met, that is the Institution was created as well as the different facilities aimed by the more specific projects. Services provided are used by Industry.

Impact: A multitude of testing, certification and R&D tasks have been performed for the benefit of industry as exemplified in this report. While the totality of the tasks and the quantification of the benefits could not be ascertained by this exercise, sizeable impact at the level of the end users can be observed. Furthermore ARAI has been instrumental in a variety of policy questions, namely the establishment of standards particularly in the field of safety and pollution control.

Sustainability: This type of projects need to be evaluated against the concept of dynamic sustainability, that is, not only the capacity established by the cooperation effort continues after the assistance ceases, but it grows subsequently and keeps pace with technological developments, which are often rapid. Up to now, nine years after all the projects' completion, ARAI has been able to keep up with international developments and to increase its international exposure. However, new and tough challenges for the future of ARAI loom in the horizon. Considerations regarding the future sustainability of ARAI are offered by the author in the next section.

Regarding project UF/IND/79/038, it can be said that it was efficient in the sense that outputs were produced but not effective neither had any impact because the prototype developed had no takers at the manufactures side. Lessons from this experience can be derived and are indicated in the appropriate section.

THE FUTURE

ARAI is presently facing a series of new challenges which are bound to increase in importance in the near future.

- S It serves an industrial sub-sector which uses rapidly developing technologies. While basic and major technological breakthroughs are not expected in this subsector, a number of changes in components are expected and these changes will be continuous. ARAI needs to keep riding the crest of the technological development wave in those areas where it chooses to concentrate. Today's technology of some components will be obsolete in five years. Among such changes we can cite the increasing use of electronics, of non metallic materials and of continuing higher demands on safety, pollution and energy efficiency.
- S Ownership of this industrial subsector will face considerable changes in the near future. While in the recent past ownership was essentially Indian, a process of increased foreign participation or full ownership by multinationals either in the terminal and components sectors has started. These multinationals have considerable R&D facilities at their home base so there is a strong chance that there will be less demand for R&D efforts in India.
- S As mentioned before, for an institution of this type, physical proximity to its end-users is important because it facilitates the process of consultation. In other large countries such service institutions have been obliged to open branches in various parts of the country so that they have a better geographical coverage. The spread of the industry and the size of India point to this direction. ARAI is already planning two branches but we are sure that this process of regional outreach will not stop here. Networking between such branches as well as with institutions not depending from ARAI, like the Auto Parts Technology Institute in Ludhiana will become necessary. Obviously this geographical spread will further strain the financial and human resources of ARAI.
- S The Indian automotive market has changed in recent times from a seller's to a buyer's. There is fierce competition between final producers. Prices of vehicles are being pushed down and the same applies to components. At the same time, requirements in terms of quality for vehicles and their components are going up either because of a more demanding internal market or the need to meet requirements in terms of standards and customers wishes in sophisticated export markets where Indian producers started to venture.
- S Despite the relatively low density of vehicle population in India, because of the bad state of the road infrastructure, traffic is intense, accidents are frequent and vehicle and component life is short. There is therefore a need to devote increased attention to fatigue and safety questions and to the preparation, implementation and certification of the related standards.
- S Pollution, in general and emanating from vehicles in particular, has reached alarming proportions in India. Again here there is a need for considerable development work in order to reach acceptable standards, assist manufacturers in implementing them and then to verify its application.
- S The percentage of sponsored work by Industry will have to go up from the present 60%. This will demonstrate the continuing utility of the Industry to its end users.
- S Finally, Indian automotive industry has reached a mature stage. It will be increasingly difficult to convince multi- and bi-lateral donors to allocate technical cooperation funds to support this Industry. Besides, such donors are realigning their activities towards more social goals such as poverty alleviation and rural development. Further re-equipment and retraining of staff of institutions like ARAI has to be financed from their sale of services to the Indian industry.

None of the above challenges are new to ARAI. Its management is responding to such challenges. However, it is possible that a pause, reflection and a certain break with the past will be needed. The future of ARAI may need to be reconsidered under a different viewpoint than the one followed up to now. Among the needed changes we could cite less emphasis in R&D activities, more on quality control and certification. Advice to industry does not have to exclusively be based on R&D and testing work carried out in house but increasingly using information services, linkages to the world, thus facilitating the offers of technology from abroad either through licensing, joint ventures and other forms of transfer of technology. The existing Technical Information Center in ARAI is a good base for further developments in this area. The soul of such industrial centers in the future will be in their Technical Information Systems.

ARAI will have to take a difficult decision on whether it can keep up with the technology development in all the broad areas it now covers or concentrate on areas where it can keep international comparative advantages. Possibly the latter option will be more reasonable, although its governing council has resisted the narrowing down of the field covered so as to be able to serve as many end users as possible.

FUTURE SUSTAINABILITY

As mentioned before, ARAI has been able to keep up with technology development up to now and ceased receiving government grants since 1995. But one question that ARAI management has to ask itself is how this situation will present itself in the future. Certain equipment in ARAI starts to show its age and re-equipment with updated items, usually more expensive will be required. International exposure either by periodic visits abroad or inviting international expertise will also be required. The holding of the periodic SIAT meeting is a good step in the direction of keeping ARAI's international exposure.

All this is to be financed from ARAI's income. This evaluation due to its limitations cannot offer concrete solutions but only raises the question of future sustainability, not only in terms of current expenditures but also to continuously re-equip itself and maintain desirable levels of international technology.

LESSONS LEARNED FOR TECHNOLOGY CENTERS

- S** For an organization like UNIDO it is of importance to keep a minimum amount of analytical and research work to develop the concepts of intervention. In such a way, value added to technical assistance projects will be enhanced. At the same time, under the concept of the "learning organization", field experience has to be continuously kept under review to determine best practices and avoid errors.
- S** A Technology Center has to be "owned" from its inception by the counterpart. Foreign inputs should be considered only as a help to materialize the local idea. This is fundamental, although not the sole factor, to ensure sustainability of the Institution.
- S** Institution building projects need longer involvement of donors than the typical three year project. Even in this case of a rather sophisticated level of counterparts and end users, a 17 year involvement, which is found adequate, was needed.
- S** The question of sustainability for industrial technology projects has to be envisaged from a dynamic point of view. It is not enough to maintain the level of know-how achieved at the end of the project but ensure that this level increases in line with international technological

developments.

- S R&D projects particularly involving relatively large financial outlays, such as those related to the manufacture of prototypes, should be only envisaged after the commitment and partial financing of a prospective end user of the technology or design pursued.
- S Technology Centers need from its inception a strong direction and participation including financial from industry which is bound to be private. Public subsidies should cease after a while. If the government wishes to support particular goals of social interest, such as environmental questions, it should do so under specific development projects such as those emanating from cess funds. The institutions should be operated like a private concern, including the freedom to have their own working systems and pay scales which will enable the attraction and keeping of suitable staff.
- S Technology Centers do not have to rely exclusively on in-house work but need to maintain an important and proactive information system thus keeping the windows open to what is happening in the world.
- S Staffing of Technology Centers has to be of sufficiently high level so as to be respected by end users that is Industry. Such Centers should not become institutions for recent engineering graduate entry-level but rather use people already with industrial experience, whose know-how should continue to be developed to keep up with technology advances.