EXECUTIVE SUMMARY

0.1 A bearing is a simple looking product. It is manufactured from appropriate materials, closely specified, to ensure long life, machined to meet high precision standards, and finished to give minimal friction. Depending on its applications, a bearing may have to withstand prolonged use, high speed rotation, varied temperatures or even a corrosive environment.

For bearings within the normal popular range, the choice of materials is determined by the operating environment and the size, weight or strength required. Sometimes, bearings can be manufactured from a wide range of metals, plastics, ceramics and composite materials.

The machine element - bearing - to which such an importance is attributed, both technically and economically, is mostly found concealed in housings of machines and equipment. As a matter of fact this invisible component can be found in almost any equipment that rotates. Therefore, the bearing as an inter dependent machine element, has a far reaching implication on the efficiency of the machine.

Generally, bearings have been standardised internationally i.e. the boundary dimensions of the product have been laid down. However, with moderate modifications in the standardised designs, bearings have been manufactured and used for various applications the world over.

0.2 The manufacturing activity in the country started in the late 40's, with the production of small and standard bearings. The Indian industry today manufactures small and medium bearings mainly in five categories, i.e. ball bearings, cylindrical roller bearings, taper roller bearings, spherical roller bearings and needle roller bearings. The popular size range is generally restricted to 140 mm OD, though larger sizes are also manufactured by some units. The industry generally does not manufacture special bearings/high precision bearings. Some small scale units also manufacture bearings, but these generally cannot compare in quality or volume with those from the organised sector though a

few do make some special designs. The organised sector manufacturers have generally imported the technology from internationally renowned manufacturers. The rolling bearing manufacturers in India mostly manufacture bearings based on the original design and specifications obtained from their collaborators. Generally there is a limited facility available with the bearing manufacturers for research or development of new bearings of indigenous designs. However, commendable efforts have been made by some units to design and develop bearings, particularly larger diameter ball and roller bearings, to suit specific customer requirements. There are also small scale units producing bearings in small quantities from imported components by assembling them. The following are the major manufacturers of bearings in India:

1. Associated Bearing Company Ltd., Pune (Maharashtra)
2. Asian Bearings Company Ltd., Hosur (Tamil Nadu)
3. Karnataka Ball Bearing Corporation Ltd., Mysore (Karnataka)
4. HMT Ltd., Hyderabad (Andhra Pradesh)
5. Tata Iron and Steel Company Ltd., (Bearings Division) Kharagpur (West Bengal)
6. Shriram Bearings Ltd., Ranchi (Bihar)
7. National Engineering Industries Ltd., Jaipur (Rajasthan)
8. FAG Precision Bearings Ltd., Vadodara (Gujarat)
9. Antifriction Bearing Company Ltd. Bharuch (Gujarat) Lonavala (Maharashtra)
10. Union Bearings Manufacturing Co., Porbunder (Gujarat)
11. Needle Roller Bearing Co. Ltd., Thana/Jalna (Maharashtra)
12. Shriram Needle Industries Ltd., Ranchi (Bihar)
13. Deepak Insulated Cables Ltd., Mysore (Karnataka) (Needle Bearings Division)
14. Austin Engg Co., Gujarat
15. Karnataka Ball Bearing Co Ltd., Mysore
16. Mysore Kirloskar Ltd, Harihar (Karnataka)
17. Needle Roller Bearings Ltd, Thane
18. Needle Roller Bearings Ltd., Waluj
19. Ruby Bearings Pvt Ltd., Rajkot

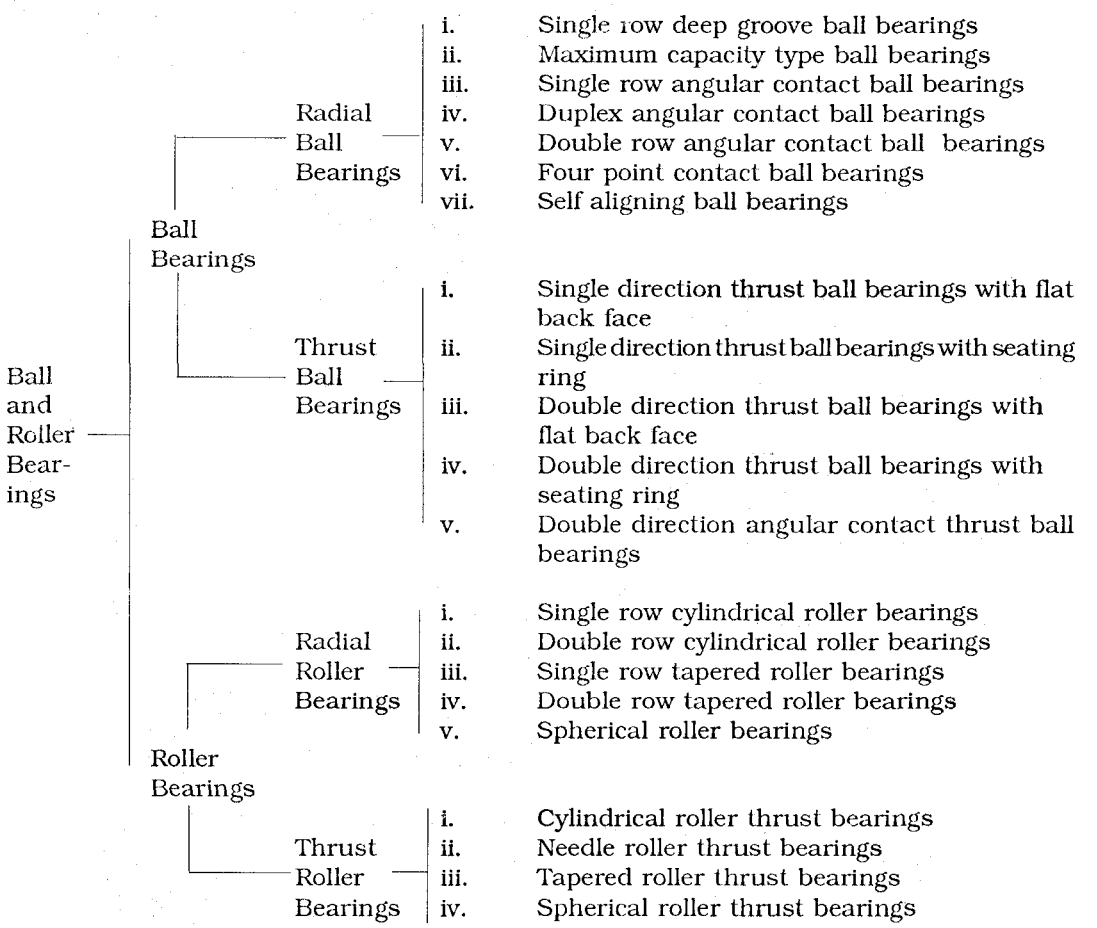
The approved capacity of the industry during 1989 was 82.62 millions nos. The total installed capacity is estimated at 77

million nos per annum in 1989. Of the 19 units, three are engaged in the manufacture of needle roller bearings including their variants like bushes, cages as well as components. Apart from manufacturers of bearings, there are few independent units manufacturing steel balls also.

0.3 The following are the major types of bearing.

a. Ball bearing
b. Cylindrical roller bearing
c. Taper roller bearing
d. Needle roller bearing

Further classification of these major categories is given below :



Depending upon the magnitude and direction of load envisaged in an application, a specific bearing type is selected. The standardisation of bearings universally has facilitated interchangeability, and employment of mass production techniques, thereby achieving economies in scale of operations.

0.4 Bearings of various types and sizes are used for different applications. The major applications are as follows :

- Automobiles
- Railways
- Electrical Motors
- Electric Fans
- Diesel Engines
- Pumps
- Machine Tools
- Textile machinery, etc.
- Other heavy industries

The demand for bearings comprises of Original Equipment demand (OE) and Replacement demand. In July 1986 Government constituted a Development Panel under the DGTD, Ministry of Industry to look into the various problems affecting the roller bearings industry. The Panel has assessed the demand for rolling bearings by 1990, 1995 and 2000 as under.

1990	-	110 millions
1995	-	150 millions
2000	-	190 millions

Considering the new capacity, mostly by way of expansion of existing units that is likely to materialise in the future, the demand and supply situation for ball as well as roller bearings has been estimated as follows.

Year	Total Demand (Million nos.)	Total Supply (Million Nos.)
1991-92	122.90	100.00
1996-97	163.05	100.00

0.5 From the inception of the industry, bearing manufacturing in the country is dependent on foreign technology. The organised sector of the industry has imported know-how from various internationally leading manufacturers of bearings. The import of technology is generally restricted to small and standard bearings. Technology borrowing specifically for special bearings has not taken place so far.

There could be about 40000 different types and sizes of bearings in demand in the market. The Indian industry at present is catering to only about 1000 types and sizes. Total investment in fixed assets in the rolling bearing industry by the end of 1988 has been estimated as over Rs.300 crores.

0.6 The bearing technology transfer within the industry is discouraging and whatever transfer does take place, is incidental to changing of jobs by personnel within the industry. The manufacturers have generally either re-entered into agreement with the same collaborator or have obtained extensions. At times, collaborators have also been changed by a few organisations. Presumably, this has been done with a view to having access to the latest development at the international level and achieving upgradation of technology though it appears doubtful if such of an option or choice was really available

The heavy dependence on borrowed technology indicates that continuous efforts towards development have not yielded the desired results. Moreover, in spite of collaborations the Indian industry generally has not achieved standards of quality close to international levels. Research and Development appears conspicuous more by its absence, in this industry. The industry undertakes routine development programmes from time to time, in terms of additional bearing sizes or increased production.

0.7 The various reasons that have been put forward for selection of a foreign collaborator are as follows :

— The advantages associated with an internationally renowned name.

— Favourable terms and conditions of collaboration.

— Quality of product.

— Assured access to latest developments at the international level.

Almost all the companies have collaboration of a technical nature and financial participation is rare. It is necessary, to mention, that none of the manufacturers had much of a choice while selecting a particular collaborator.

Generally the restrictive clauses pertain to the export of product, transfer of technology to other manufacturers, and use of the brand name.

As regards exports, most of the collaborators have prohibited Indian manufacturers from exporting to such countries where they have licencees operating.

0.8 Support for carrying out 'Research' as such, is generally not available. However, help for solving routine problems, and typical technical problems has been extended by the collaborator.

Training facilities are offered to Indian personnel abroad, i.e. at the collaborator's plant. Similarly, experts from the collaborator are deputed to train people in the Indian company. The period of training generally varies between 3 to 6 months.

Research and Development activity either original or applied, appears to be very limited. The reasons for this are as follows.

The need for R & D is not felt seriously as the market for bearings is not large enough and also is restricted to small and standard bearings only.

— The investment involved in R & D is very high, but the returns on this, in the Indian environment, are very low.

— The rare needs that may arise are fulfilled by the collaborator at a price.

— Lack of complete knowledge about the latest international developments.

The efforts made are of a very general nature in areas of product range expansion, process modification and other routine problems.

0.9 Since the activity is not undertaken on an exclusive basis, expenditure for R & D cannot be earmarked and estimated separately, either for the industry or for individual organisations.

0.10 **LATEST DEVELOPMENTS AT INTERNATIONAL LEVEL**

The international manufacturers have directed the thrust to higher precision, coupled with high productivity. Their efforts are concentrated on improving the quality of the bearings to the highest levels possible. Thus, the life of bearings would be improved, they would carry higher loads and the noise levels would be reduced to the minimum.

Though bearing sizes and nomenclature have been standardised, design modifications do take place continually in order to improve the overall performance of the product. New products as such, may not be a significant area of concentration. With the onslaught of excellent quality volume production by the Japanese manufacturers, some bearing manufacturers have moved towards bearings with special applications, including ready assmeblies that carry rolling bearings integrated into them. Newer materials such as plastics and even ceramics have been experimented with and developed for special applications. Other manufacutrers have reorganised to bring in economy of large volumes, experimented and developed, such as use of plastics and even ceramics.

The pace and achievement of the above mentioned goals in bearing manufacture can directly be linked to innovations in machine tools, process technology and material properties. In machine tools, the stress is constantly on improving the precision levels and productivity. Automation at every stage is most common. This is done within the machine and in transfer from machine to machine into line manufacture, to achieve close control on operations and monitor the pre-process corrections.

0.11 TECHNOLOGY ABSORPTION AND UPGRADATION EFFORTS

The research laboratories and institutions at the national level have not made any significant contribution to the bearing industry by way of R & D.

Most of the existing manufacturers of rolling bearings in India are manufacturing bearings based upon the designs obtained from their collaborators. Some of the bearing manufacturers have been upgrading the designs on the basis of improvements carried out by their collaborators, one of the limiting factor being the equipment technology available with the indigenous manufacturers. Some of the bearing manufacturers have also evolved their own design capabilities and have designed bearings successfully, particularly, of large diameters for applicaion in strategic industries.

The most common material used in the manufacture of bearing rings, balls and rollers is Alloy steel conforming to specifications SAE 52100. This material has become standard material for the industry all over the world. While the basic meterial remains the same, the steel manufacturers all over the world have been improving this material in order to improve the life span and quality of the bearing. The Indian steel manufacturers although manufacturing steel to specifications SAE 52100, are not able to meet the requirement of the bearing manufacturers in so far as purity and oxygen content is concerned. Therefore, the industry has to make do with the material available indigenously which is not of the required quality resulting in poor quality bearing with high scrap percentage.

The bearing manufacturers have been adopting the equipment technology suitable for low volume production. This was essentially due to the demand pattern of rolling bearings in the country being made up of a large diversified range of bearings in small quantities. In view of the very high cost of bearing equipment, most of the bearing manufacturers did not venture to change their equipment technology in favour of large batch production or line production. That apart, there has been considerable upgradation in the production technology itself generated by the requirements of the user sector of higher accuracy bearings. This is evident from the fact that a normal level of accuracy for the standard ball bearing in the world today is P-5 or P-6, whereas in India the Bearing Units are still to equip themselves for manufacturing bearings of such accuracies.

0.12 INTERACTION WITH THE USER INDUSTRY

It is not as if efforts are not made to improve quality but even when the desired quality is not produced, it is still taken by the market.

Of late the situation has started changing rapidly with the entry of the Japanese in the Indian engineering industry. The demand for quality has started growing in the bearing manufacturing industry. Customer support service is assuming importance. On a routine basis, seminars, dealers conferences, and trouble shooting sessions, are undertaken by the manufacturers.

0.13 SMALL SCALE INDUSTRY

The small scale industry in bearing manufacture is operating on the basis of its own experience, and services from technical experts, whenever required.

The industry makes standard bearings, odd-size bearings, and to some extent, large-size bearings. In some cases the manufacturing activity is merely restricted to assembly operations of components generally imported.

Small scale units that cannot afford the high investment machinery and therefore, cannot produce quality or volume, generally cater to the replacement market or low quality demand section.

The small scale units operate more in the realm of trading culture than in manufacturing.

0.14 ANCILLARY LINKAGES

Ancillary development for major components of bearings has not been significant. For the rolling element viz. spherical balls, only one supplier is in existence. Cage-making is generally in-house, rolling elements such as spherical, cylindrical and taper rollers are also produced in-house. Forged rings, which are being increasingly used for making medium and large size bearings, have now become a critical component for ancillary development. The industry is making all round efforts to develop consistent suppliers. However, the quantity and quality of forged rings are not available, though some of the bearing manufacturers have themselves put up facilities to produce formed rings. Vendors for supplying seals and shields have been developed.

0.15 COMPARISON OF TECHNICAL SPECIFICATIONS

Since the product is standardised internationally, the designs followed by the industry are more or less, the same. Technical specifications are restricted to basic parameters. Quality specifications adopted from the collaborator's specifications, vary usually.

0.16 MODERNISATION

With increasing international quality demand, modernisation is naturally a need of the bearig industry today. This is becoming increasingly costlier with the needed imported machines. As it is, the bearing industry is highly capital intensive as the investment required in machines is very high. The industry has been making continuous efforts to improve upon the quality parameters either with the help of collaborators or by installing the latest machines. If the pace of modernisation is not what it should be, it is bacause it is not easily viable due to factors such as :

— Scale of investment
— Market constraints
— Limited scope for automation.

Some of the plants visited have carried out planned modernisation. These are SKF Bearings India Ltd., Tata Iron and Steel Co. Ltd. (Bearing Division).

0.17 TECHNOLOGY GAPS

The reflections of technological achievement are seen in the quality of the product. The bearings manufactured by the Indian industry have to improve considerably to meet international standards.

If the roots of the problem are to be identified, one comes to the following conclusions:

- Machine Tools - precision, productivity
- Materials - quality, consistency
- Operations - process mastery, assembly, quality control
- Skill

These broad areas can be indentified as "Technology Gaps" in bearing manufacture. Although considerable efforts have been made in these directions, the gaps have not yet been bridged.

0.18 THRUST AREAS FOR TECHNOLOGY

The thrust areas for indigenous technology would include :

- Development of indigenous machine tools and equipment for testing, equivalent to international standards of precision. The suitability of these machines in the Indian working environment would be the critical factor.

- Materials are available indigenously. However, the quality of tubes in particular, is not to the satisfaction of the industry. Moreover, consistency in supplies is also not experienced. Cleanliness of material needs to be improved to a great extent to enable the industry to take basic advantage of quality raw material. As regards forged rings, suppliers meeting sufficient quality standards need to be encouraged.

Operational expertise of a very high calibre has to be achieved. Maximum precision in the process, minimum handling damages, and maximum cleanliness should be observed to get the desired quality of bearings.

0.19 CONCLUSIONS

i. The Indian bearing industry commonly manufactures bearings upto 140 mm OD. The product range manufactured by individual units is by and large, common.

ii. The industry has been dependent on borrowed technology and has laid emphasis on high volume of production for which the technology is more suited. The industry does not manufacture bearings for special applications mainly owing to smaller market requirements, resulting into uneconomic batch quantites for production.

iii. Work of an original nature towards development of new products and improvement in machine tools, process technology, etc., is generally not carried out. In the event of major problems, the tendency seems to be to refer to the collaborator reflecting the heavy dependence on the latter. This also relfects on the level of support offered and technology parted with by the collaborator.

The national institutions have not been associated with any such developmental or research work.

iv. The bearing industry is capital intensive. The evolution in machine tool technology - precision and productivity - has pushed the cost of investment to a very high level.

The dependence on imported machines, the costs of which are continually increasing due to high inflation rates in the oveseas countries, the rapidly changing exchange rates and import duties, have all aggravated the situation, reducing the pace of modernisation and making it prohibitive even for new ventures to be competitive.

v. Moreover, the cost of raw materials, particularly tubes available indigenously, is very high, as also the cost of

imported tubes due to heavy import duties. Besides, the quality of basic steel available indigenously is not to the satisfaction of the industry. The high cost of tubes has affected the industry quite adversely. The cost structure has been upset on account of the high proportion of raw material costs and this affects the profitabiliy of at least some units.

vi. Further, the market, even if growing, cannot support such fragmentation as results from the same range/category of manufacture by so many units, many of which cannot achieve the economies of scale that are necessary to sustain the nature of technology and high investments.

vii. As regards the absorption of technology, this is reflected in the quality of the end product attained by the industry. As the situation stands today, the quality of bearings manufactured by the industry is not comparable with international standards. Nevertheless the user industry is by and large using the bearings as are supplied by the manufacturers.

viii. Automation has its own advantages - precision, productivity, and consistent quality. It may not be feasible for individual units in the industry to go for automation owing to a number of constraints. However, partial automation has been attempted by the industry. The importance of controls on operations such as on assembly operations, not always obvious but necessary, do not appear to be fully appreciated.

ix. Apart from the problems associated with costs and in spite of the import of technology and machinery, the obvious difference in quality and productivity is reflective of the lag in technology absorption.

x. The spurt in prices of the important raw material-steel tubes, has compelled the industry to look for an alternative form of material, which has been seen in forged/formed rings. But even here, supplies of these in adequate quantities and to the desired specifications have not been made. Outside the bearing industry itself only one manufacturer

of balls is able to supply balls that meet bearing quality which itself needs upgrading. With only four/five major components in a bearing, ancillary industry generally has no major role to play in the manufacure of bearings.

xi. Application engineering or customer support service, not much in evidence earlier, has started receiving serious attention from the bearing industry. Recently, increasing Japanese association with the user industry may have induced this change and could be expected to influence it in future. The same can be said of quality awareness.

xii. Some small scale units are operating. Some of these units make bearings to special designs or categories not covered by the organised sector. None, however, could be expected to produce quality bearings and generally cater to the replacement market. Units that assemble bearings from imported components are also reported.

xiii. Exports of bearings are negligible for obvious reasons i.e. quality and price competitiveness. There is considerable import, mostly in special types and sizes not covered by the Indian industry. But even in this range, import is reported to be adversely affecting Indian manufacturers.

xiv. Internationally, the accent is on achieving higher and higher quality levels of bearings. Higher precision, minimum handling damages and maximum cleanliness are the thrust areas for development. Individual units have their own grading of quality. SKF, for example, designates it, as Q77, Q66, Q55, where Q66 is reported as the prevalent level and Q55 as the level aimed at.

International manufacturers are moving towards special bearings, and sub assemblies involving bearings, where production of small batch quantities becomes more attractive.

xv. High rates and consistency of productivity have been achieved by the manufacturers abroad by line manufac-

ture. The market demands there, permit mass production techniques and thereby bring in economies in production.

xvi. Machine tool technology for the SPMs involved, is continuously upgraded to achieve precision coupled with productivity, at the international level. This is not only in increasing the output rates of critical machines but also through incorporation of sophistication for precision in performance.

xvii. As regards materials, closer grade and specification ratings are emphasised.

xviii. Upgrading of technology has generally come not from within or from market forces but usually from the collaborator's insistence, if the latter has stakes, either financial or through its name.

0.20 RECOMMENDATIONS

i The technology available with the industry is more suited to high volume production. It is essential to study the market for such bearing types as are essentially required, but in small volumes, maintaining good quality. Therefore, technology specifically suitable for small batch production, while maintaining manufacturing economy and producing good quality needs to be explored to supplement the present situation where a major share of the large volume types is taken by 2 or 3 established units and the balance market is fragmented among the remaining manufacturers which has impact on economies of their operations.

A scrutiny in terms of selection of product mix to suit the overall Indian market demand and selection of appropriate technology to suit that kind of mix appears advisable. Where special bearings are required in a market, these too need to be looked into for development.

ii. It is imperative to encourage the local steel manufacturers to produce basic 'ball bearing grade' steel which would

match the increasingly stringent international standards. In particular the cleanliness of the steel needs to be improved.

iii. The availability, quality and econmies related to indigenously manufactured tubes must receive serious attention. In the absence of availability of good quality tube locally import duties levied on import of tubes may need to be reviewed.

iv At the same time, serious efforts should be made to develop indigenous manufacturers having the potential to manufacture quality seamless tubes for bearings, and make commercial supplies. While it is essential to encourage and support any existing suppliers to improve the delivery to desired quality, it is necessary that, in the process, imports of tubes should not be banned prematurely, which has been one disturbing factor in the industry.

v As the tube prices have soared the turning of races from formed blanks has started to be a more economic alternative. Inspite of the apparent glut of capacity on paper for making formed rings, the recent spurt in demand has not been met by the makers of formed rings for one or the other reason. Also too much material is required to be turned off from whatever is offered. It is necesary to explore and encourage supply of formed rings, through local know-how not involving the high investment machinery, customarily used.

vi There are no suppliers specialising in the manufacture of rolling elements outside the bearing industry, except one for balls who has begun to deliver balls of a quality acceptable to many bearing manufacturers. Balls contribute to a great extent to the quality of bearings and continuous efforts towards upgrading of their quality are called for. Units could be encouraged to specialise in ball manufacturing.

vii. Cage or retainer manufacturing has been an in-house activity. It involves press work and can be off loaded to

press shops, encouraged to specialise in the work. If it were possible to rationalise cage designs, this would facilitate reduced tooling costs and economy of higher volumes. This of course has to be done without sacrificing quality or specialities of individual designs.

viii. Alternative economical methods of making some operations on simple but special purpose machines need to be re-explored and these machines developed, even if such machines were manufactured and tried by the industry, but could not satisfy the performance needs of the industry earlier.

The industry is on the look-out for machines for turning formed rings/blanks that could chuck ring blanks with large dimensional variations, requiring cosiderable stock removal all around. The material economy today has tilted heavily in favour of formed rings, creating the need to develop simple but special purpose machines. Such machines can probably also serve the purpose of converting the end pieces of bars/tubes into usable rings.

ix. Multispindle automats are highly expensive machines and high utilisation levels are essential. While the industry has been moving towards shortening cycle times and turning more rings per cycle, the availability of fast, simple second operation machines for turning corner radii, undercuts, small grooves, etc. would help better utilisation of multispindles. Development of such fast but simple second operation machines specifically for the purpose, needs to be explored.

x. More understanding of the specific features required in designing equipment for heat treatment seems necessary by the users and the manufacturers.

xi. Grinding is the most critical operation involved in bearing manufacture. Most machines used are special purpose machines and have to be imported. The international manufacturers make continuous and specific efforts to

develop grinding machines incorporating a high degree of sophistication.

It may not be realistic to seek indigenisation of all these machines incorporating these features. However, an effort to develop machines that would satisfy the demands of quality of the bearing industry for one or two specific operations, needs to be initiated and supported. Such a development may also be undertaken with the help of a renowned international manufacturer established in manufacturng these machines for the bearing industry.

xii. A programme for full development of grinding machines for industry cannot be advocated. However such manufacturers, as HMT who had a tie-up with M/s. WMW (E.Ger) and PMT Machine Tools, Pune who have a tie-up with Voumard (W.Germany) may be encouraged to acquire the necessary technology for selected operations, progressively.

An alternative to multispindle machines, suitable for plung cutting in turning bearing races for turning formed rings is needed and certainly is within the capability of Indian Machine Tool Industry. Selected inspection and quality control equipment, feeding and material transfer from machine to machine, in process gauging and controls are areas where development could be indigenised.

xiii. Grinding wheels of satisfactory quality have not yet been developed indigenously. Continuous efforts by grinding wheel manufacturers in concurrence with the bearing industry need to be pursued.

xiv. It is felt that the importance and relevance of certain assembly operations in controlling surface damages and equipment such as washing machines for controlling cleanliness, is not fully appreciated. Selective automation could be gainfully employed in handling and transfer. Utmost care needs to be taken while selecting the level of automation, which would suit the relevant volumes and batch sizes. Automation should be introduced initially in such areas where conspicuous gains in quality (e.g. : some

reference surface/dimension through operations) and high machine productivity can be attained rather than mere saving in manpower. Development and manufacture of standardised transfer equipment specifically developed for bearing manufacturing operations should be encouraged.

It would not be realistic to develop sophisticated inspection equipment used in checking certain quality parameters. However, uniformity in the method of measurements and specified limits of various parameters can be introduced.

xv. If indeed serious efforts towards upgrading quality are to be made, it would seem necessary to monitor the quality of bearings produced by Indian manufacturers and compare the same with that of the international manufacturers. It would be desirable if an impartial central authority were to be established to carry out quality audit, assigning targets of achievement within feasible time spans.

xvi. Research and development activity has had little attention. Some of the manufacturers within the industry have the potential to undertake useful work in the area. These units could jointly take up R & D activities suitable to Indian needs.

xvii. Technical services and application engineering have also not been given the deserved priority. The situation is changing demanding careful understanding of user's requirements. An approach similar to R & D should be adopted for imparting technical services and dealing with application engineering.

xviii. The upgradation has come from the force of compulsion by outside agencies and normally, the collaborator. Therefore, evolving a basic policy on the nature of collaboration that would ensure continuous and open support from the collaborator and close scrutiny by the government becomes a highly imperative factor in upgrading the technology.

xix. Tractor manufacturers in India require special bearings, many of them are being imported. Import substitution can be achieved by bearing manufacturers if they can get assured consumption from Indian tractor industry. Total annual requirement of tractor industry can be found out by Ball and Roller Bearing Manufacturers Association of India from Tractor Manufacturers Association of India.