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REPORT 79-24

ASSESSMENT OF THE TECHNOLOGICAL CAPABILITIES OF THE CANADIAN FOUNDRY INDUSTRY

MINERALS RESEARCH PROGRAM
PHYSICAL METALLURGY RESEARCH LABORATORIES

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

JUNE 1979

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Canadian Government Publishing Centre
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Hull, Quebec, Canada K1A 0S9

CANMET
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Ottawa, Canada K1A 0G1

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Catalogue No. M38–13/79–24 Canada: $3.25
ISBN 0-660-10427-X Other countries: $3.90

Price subject to change without notice.

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N° de catalogue M38–13/79–24 Canada: $3.25
ISBN 0-660-10427-X Hors Canada: $3.90

Prix sujet à changement sans avis préalable.

ASSESSMENT OF THE TECHNOLOGICAL CAPABILITIES OF THE CANADIAN FOUNDRY INDUSTRY

by

R.C. Shnay*

Edited and condensed
by
R.K. Buhr**

CANMET REPORT 79-24

MINERALS RESEARCH PROGRAM
PHYSICAL METALLURGY RESEARCH LABORATORIES

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FOREWORD

A healthy, viable foundry industry is important to the Canadian economy, not only as a source of employment and contributor to the gross national product, but also because it is essential to almost all secondary manufacturing operations.

The Canadian objective of energy self-sufficiency is expected to create increased demands for high integrity alloy castings. The principal industries requiring such products will be tar sand mining, oil and gas pipelines and nuclear plants. With the need to conserve energy, there will also be an increased demand for automotive machinery and agricultural castings with higher integrity. The less sophisticated segments of the market face increasing price competition from other countries where high volumes, greater efficiency or lower labour costs allow them to compete effectively in the Canadian market. These challenges must be met by acquiring and utilizing the latest technology.

The Foundry Section of the Physical Metallurgy Research Laboratories carries out research and development projects perceived to be in the national interest in response to the Minerals Research Program of EMR. Technical assistance by the section is also provided on request to individuals, subject to certain restrictions imposed by the federal government. Through the years, the work of the section has been well received by the foundry industry. However, these R & D resources could be better utilized if research programs and services were based on more detailed information of the technological needs of the Canadian foundry industry.

It was therefore decided to obtain more detailed information and a contract was awarded to Robert Shnay & Associates Ltd. to conduct a survey by means of questionnaires and plant visits. A report was duly prepared by the consulting firm, the results of which have been summarized and presented in this report for the benefit of the industry and public at large. Translation into French has been initiated and copies in that language will be made available for the benefit of the large number of foundries in Quebec and elsewhere where French is spoken.

R.K. Buhr

AVANT-PROPOS

Il est important pour l'économie du Canada de maintenir son industrie de la fonderie en bon état, non seulement du point de vue de la main-d'oeuvre et pour sa contribution au produit national brut, mais aussi parce qu'elle est importante au bon fonctionnement de la presque totalité de son industrie secondaire.

On prévoit que l'objectif d'autosuffisance en matière d'énergie du Canada conduira à un accroissement de la demande des coulées d'alliage de haute qualité. Les principales industries qui auront besoin de tels produits seront l'exploitation des sables bitumineux, les pipe-lines de pétrole, les gazoducs et les centrales nucléaires. Vu le besoin de conserver l'énergie, il y aura certainement un accroissement de la demande de pièces coulées de haute qualité pour les véhicules et la machinerie agricole. Les secteurs moins perfectionnés du marché sont menacés de concurrence des prix de la part des autres pays dont le volume de production élevé, une meilleure efficacité ou des coûts de main-d'oeuvre plus bas leur permettent de rivaliser sur les marchés canadiens. Ces défis doivent être relevés par l'acquisition et l'adoption de la plus récente technologie.

La Section de la fonderie des Laboratoires de recherches en métallurgie physique effectue des projets de recherche et de développement d'intérêt national dans le cadre du programme de recherche sur les minéraux du ministère. La section offre aussi une aide technique aux particuliers suivant les restrictions imposées par le gouvernement fédéral. Au cours des années, les travaux effectués par la section ont connu un succès auprès de l'industrie de la fonderie. Par contre, les ressources de R & D pourraient être employés à de meilleures fins si les programmes et les services de recherche étaient basés sur des renseignements plus détaillés des besoins technologiques de l'industrie canadienne de la fonderie.

A cette fin, un contrat a été adjugé à Robert Shnay & Associates Ltd., leur permettant d'étudier cette industrie à l'aide de questionnaire et de visites à l'usine. Cette société a ensuite rédigé un rapport et les résultats abrégés sont présentés dans le présent rapport au profit de l'industrie et du public. La traduction de ce rapport en français est commencée et sera disponible sous peu au grand nombre de fonderies du Québec et autres régions francophones.

R.K. Buhr

ASSESSMENT OF THE TECHNOLOGICAL CAPABILITIES OF THE CANADIAN FOUNDRY INDUSTRY

by

R.C. Shnay*

Edited and condensed by R.K. Buhr**

SUMMARY

A study and assessment of the technological capabilities of the Canadian foundry industry was carried out by Robert Shnay & Associates Ltd., under contract to Energy, Mines and Resources Canada. The results of this survey were intended to be used as a guide for future research and development projects in EMR aimed at improving industry viability.

An up-to-date list of operating foundries was first developed and questionnaires were mailed to the 324 foundries identified. This was followed by telephone contacts and personal visits to 54 of the plants to elicit more detailed information. A total of 152 responses were received.

Technical capability, on a regional basis was found to be highest in southern Ontario and lowest in the Atlantic provinces. Competence was also related to the type of foundry, the market served and size of the foundry. Management attitudes to environmental controls, health and safety, energy conservation and technology appeared to depend more on the market served than on the foundry size, i.e., the technological requirements of a specific market dictated the technological level of the foundry serving that market.

Successful foundries were those that had established a market position and had developed their production equipment, technology and expertise in a measured, balanced manner to support it. The unsuccessful foundries had failed to do so.

Major buyers of castings were generally satisfied with the quality of the castings received from Canadian foundries but were critical of the suppliers inability to handle large orders and, in one case, for failure to provide technical advice on corrosion and abrasion-resistant materials.

Export business was a significant factor at 34 foundries contacted. The devalued Canadian dollar had little effect, however, as most of the supplies and equipment required by the foundries were im-

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ported from the U.S.A. largely cancelling the exchange advantage. In many cases, metal prices were dictated by the U.S. price as well.

A number of research and development projects were identified. However, the most significant requirement for upgrading the technical competence of the industry was indicated to be properly trained engineers and technicians. On the combined basis of the questionnaires and visits, the industry was estimated to require 445 more engineers and technicians over the next five years. In the U.S.A. and Europe, universities and colleges have foundry engineering options or actual foundry colleges. These do not exist in Canada. The hiring of foreign graduates with such training is sometimes difficult because of immigration procedures, inability to adapt to Canadian life, and language problems. Means of overcoming the anticipated shortage of skilled personnel are urgently needed.

EVALUATION DES COMPETENCES TECHNOLOGIQUE DE L'INDUSTRIE CANADIENNE DE LA FONDERIE

par

R.C. Shnay*
Rédigé et abrégé par R.K. Buhr**

SOMMAIRE

Robert Shnay & Associates Ltd., par un contrat accordé par Energie, Mines et Ressources Canada, a effectué une étude et une évaluation des compétences technologiques de l'industrie canadienne de la fonderie. Les résultats serviront de guide pour les projets futurs de recherche et de développement effectués par l'EMR pour améliorer la rentabilité de cette industrie.

On a d'abord rédigé une liste à jour des fonderies en opération et des questionnaires ont été expédiés à ces 324 fonderies. Par la suite, cinquante-quatre de ces usines ont été contactées soit par téléphone ou par des visites afin de recueillir des renseignements plus détaillés. On a reçu 152 réponses.

Du point de vue régional, la compétence technique est plus élevée au sud de l'Ontario et moins poussée dans les provinces de l'Atlantique. La compétence est aussi fonction du genre de fonderie, le marché à desservir et la dimension de la fonderie. L'attitude de la direction vis-à-vis la protection de l'environnement, la santé et la sécurité, la conservation de l'énergie et la technologie semblait dépendre beaucoup plus du genre de marché à desservir que de la dimension de la fonderie, i.e. les exigences technologiques d'un marché quelconque prescrivent la compétence technologique atteinte par la fonderie qui dessert ce marché.

Les fonderies qui remportent du succès sont celles qui se sont triées un place sur les marchés et ont perfectionné leur équipement de production, leur technologie et leur compétence de façon mésurée et équilibrée. Les fonderies qui ont négligé de le faire n'ont pas connu de succès.

Les principaux acheteurs des pièces de coulée étaient généralement satisfaits de la qualité des pièces provenant des fonderies canadiennes. Ils ont par contre critiqué l'inaptitude des fournisseurs lorsqu'il s'agit de commandes volumineuses ou, dans un cas, de conseiller sur les matériaux résistant à la corrosion ou à l'abrasion.

Les exportations sont un facteur important. Trente-quatre des fonderies consultées ont affirmé que les exportations étaient un facteur important. La dévaluation du dollar canadien n'a eu pres-

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que aucun effet car l'importation des Etats-Unis de la majorité des biens d'approvisionnement et d'équipement a vite fait d'annuler tout bénéfice d'échange. Dans plusieurs cas, le prix du métal canadien correspond au prix des Etats-Unis.

Plusieurs projets de recherche et de développement sont identifiés. On a découvert que le facteur le plus important pour hausser la compétence technique de l'industrie est une bonne source d'ingénieurs et de techniciens d'expérience. Selon les réponses aux questionnaires et les visites, l'industrie pourrait avoir besoin de 445 ingénieurs et techniciens de plus dans les prochains cinq ans. Aux Etats-Unis et en Europe, les universités et les collèges offrent soit un programme de technologie de la fonderie ou ont leurs propres collèges de fonderie; non pas au Canada. L'embauche d'étudiants gradués étrangers est quelquefois compliqué à cause de mesures d'immigration, l'inaptitude à s'adopter à la vie canadienne et les problèmes linguistiques. Il faut trouver des solutions à cette pénurie de personnes qualifiées le plus tôt possible.

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TABLES

1. INTRODUCTION

A contract was let through CANMET to Robert Shnay & Associates Ltd. by Energy, Mines and Resources Canada to carry out a study and assessment of the technological capabilities of the Canadian foundry industry. The primary objective of this study was to develop a technological profile of the industry. Energy, Mines and Resources Canada will use this profile as a source document for developing its program to improve the future viability of the industry.

The Department of Industry, Trade and Commerce, as well as various provincial governments, have previously carried out studies of the Canadian foundry industry. However, these were primarily concerned with general business and economic information and were mainly confined to ferrous foundries. The present study is concerned with technology and includes ferrous, non-ferrous and investment casting foundries.

An up-to-date list of all foundries in Canada was developed and a questionnaire was devised and mailed to each foundry. The questionnaire was designed to be comprehensive but easy to fill out. Non-respondents were later contacted by telephone and a number were visited individually. Purchasers of castings were also visited and interviewed to obtain their appraisal of the technical abilities of the foundries. All of these factors are discussed in the present report and the needs of the Canadian foundry industry are described.

2. LIST OF FOUNDRIES

2.1 PROCEDURE

Preliminary lists were obtained from the Department of Industry, Trade and Commerce, provincial departments of industry, trade associations, and trade directories. These were combined to produce a mailing list for the questionnaires. Local lists were then checked in each major centre; first through telephone directories, then by referring to local suppliers and prominent foundrymen. Deletions or additions were made as required, and the final list was developed.

2.2 LIMITATIONS

The final list includes all foundries in operation on December 1, 1978. One question that did arise on occasion was the definition of a foundry. A number of firms originally listed as non-ferrous foundries, and one firm listed as an investment casting foundry, expressed a desire to be excluded since they did not consider themselves as members of the foundry industry. These firms actually melted metal to produce a few components needed for their own final product. Examples were manufacturers of signs and ornaments and one manufacturer of plastics processing equipment. In compliance with their wishes, these companies are not included with the list.

The original intention was to include data on capacity, number of employees and principal products with the listing. This information was requested in the questionnaire since it could not be obtained elsewhere. The response to this section of the questionnaire was low and the auxiliary data required for the list were too incomplete to be included.

2.3 ANALYSIS

A total of 324 foundries were identified, distributed as shown in the table.

It is interesting to note that 161 foundries are located in Ontario, almost 50% of the total. Iron foundries form the major group at about 50% followed by non-ferrous at 40%. As steel foundries tend to be larger than iron and non-ferrous, a ranking by production or by number of employees would be quite different. The largest Canadian foundries are located in Ontario, so that the amount of foundry activity in that province is considerably higher than the 50% indicated numerically.

3. QUESTIONNAIRES

3.1 PROCEDURE

A draft questionnaire was developed in

Foundries operating in Canada

Region	Type of foundry				Total
	Steel	Iron	Non-ferrous	Investment	
Atlantic Region	1	13	4	1	19
Quebec	7	42	32	5	86
Ontario	13	72	71	5	161
Prairie Region	4	17	9	-	30
British Columbia	7	11	10	-	28
Total	32	155	126	11	324

English which covered all the required points plus the auxiliary data requested from foundries. The draft was submitted for approval to the Scientific Authority at PMRL, and for comment to the Canadian Foundry Association and L'Association des Fondeurs du Québec. Comments were also requested from several major suppliers. Additional questions were incorporated at the request of the Canadian Foundry Association and the final version was translated into French.

After a suitable period following initial circulation, a telephone follow-up procedure was initiated. Seventy-five calls were made producing only four additional returns. This method was then abandoned, and instead as many firms as possible were visited. This was somewhat more successful, yielding a 50% response from 30 visits.

The completed questionnaires were reproduced on microfilm, which in turn were mounted on individual cards and submitted to Energy, Mines and Resources Canada. Brochures and other material submitted with the questionnaires by the foundries were also included. All material generated by the survey was given to EMR for safekeeping to ensure confidentiality.

As can be expected with any questionnaire procedure, a number of responses were ambiguous and some questions were not answered. In all cases, these points were clarified by either telephone calls or direct visits.

3.2 RESPONSE

The total number of replies was only 152 or 46.9% of the foundries listed. It is worth while analyzing the percentage response by region and type of foundry as the conclusions and recommendations of this study were influenced by the source of the information received.

Atlantic Region	-	52.6%
Quebec	-	40.7%
Ontario	-	46.0%
Prairies	-	63.3%
British Columbia	-	53.6%
Steel foundries	-	68.8%
Iron foundries	-	53.5%
Non-ferrous foundries	-	32.5%
Investment casters	-	63.6%

The low response rate is not surprising in the case of non-ferrous foundries. Most of the operations are small, the owner-manager frequently simultaneously supervises production, sells castings, and runs the office. However, it was discouraging that a number of large and important foundries did not respond despite telephone calls and requests for visits.

4. SUMMARY OF DATA FROM QUESTIONNAIRES

The data from the questionnaires are summarized in Tables 1-4. As might be anticipated, more process and quality control methods are used by ferrous than by non-ferrous foundries. Investment casting foundries are the most technologically advanced because of the relative sophistication of this process.

The anticipated future requirements for engineers and technicians are also reflected by the process and quality control criteria. Table 5 highlights some of these data.

Obviously the large number of small non-ferrous foundries influences these results. However, it is obvious that more technical control is urgently required in the non-ferrous sector, and that this has not been fully acknowledged in staffing plans.

Table 1 - Technological profile of the Canadian steel foundry industry

Steel foundries	Number of employees		
	Less than 100	100 - 350	More than 350
Number of respondents	8	10	4
Engineers and technicians as percent of total employees (1)	2.6	2.3	2.3
Engineers and technicians to be added in next 5 years	8	36	18
On-the-job training offered	8	10	4
Adequate process control (2)	5	9	4
Adequate quality control (3)	5	10	4
Quality control inspection or metallurgy departments	4	10	4
Research and development activity (4)	1	3	4

Notes: (1) Engineers and technicians serving in technical functions or line supervision.
(2) Equipment and methods required to maintain a low scrap rate.
(3) Equipment and methods to ensure customer's specifications are met.
(4) Includes corporate R & D and R & D on proprietary products.

Table 2 - Technological profile of the Canadian iron foundry industry

Iron foundries	Number of employees		
	Less than 50	50 - 250	More than 250
Number of respondents	36	37	11
Engineers and technicians as per cent of total employees (1)*	5.0	2.5	1.8
Engineers and technicians to be added in next 5 years	26	63	51
On-the-job training offered	32	36	11
Adequate process control (2)	11	26	11
Adequate quality control (3)	12	30	11
Quality control, inspection or metallurgy departments	21	21	11
Research and development activity (4)	6	12	6

*See notes Table 1

Table 3 - Technological profile of the Canadian non-ferrous foundry industry

Non-ferrous foundries	Number of employees		
	Less than 25	25 - 50	More than 50
Number of respondents	20	14	5
Engineers and technicians as per cent of total employees (1)**	5.7*	4.9*	2.0
Engineers and technicians to be added in next 5 years	0	8	9
On-the-job training offered	8	10	5
Adequate process control (2)	5	7	3
Adequate quality control (3)	7	8	3
Quality control, inspection or metallurgy departments	8	7	5
Research and development activity (4)	0	6	3

*All technical institute graduates

**See notes Table 1

Table 4 - Technological profile of the Canadian investment casting foundry industry

Investment casters	Number of employees		
	Less than 25	25 - 50	More than 50
Number of respondents	6		
Engineers and technicians as per cent of total employees (1)*	5.4		
Engineers and technicians to be added in next 5 years	17		
On-the-job training offered	6		
Adequate process control (2)	6		
Adequate quality control (3)	4		
Quality control, inspection or metallurgy departments	6		
Research and development activity (4)	3		

*See notes Table 1

Table 5 - Technical capability summary

Foundry type	No. of respondents	Foundries having adequate		Engineers & technicians to be hired in next 5 yr	No. of technicians and professionals per foundry
		Process control (%)	Quality control (%)		
Steel	22	18 (82)	19 (86)	62	2.8
Iron	84	48 (57)	53 (63)	140	1.67
Non-ferrous	39	15 (39)	18 (46)	17	0.44
Investment	6	6 (100)	4 (67)	17	2.8

5. VISITS TO FOUNDRIES

5.1 PROCEDURE

Visits were made to the major foundries as well as to typical small and medium size foundries. The objectives of the visits were to assess the level of technology and to examine company capabilities, management attitudes about improving technology and environmental control, and about conserving energy.

Two problems were encountered in developing the sample. First of all, there is difficulty in defining small, medium and large foundries. If size is considered without regard to the type of foundry, almost all steel foundries would be in the large category and almost all non-ferrous foundries would be small. The second problem is geographic as most of the foundry industry is located in southern Ontario. This is also the region where one would expect technology to be furthest advanced. A sample based on purely numerical considerations would therefore be biassed in favour of higher technology, and would under-represent certain regions in Canada where much of the new technology is required.

Separate size definitions were thus developed according to the number of employees for each type of foundry. The basis was to define a medium size range that would include at least 35% and no more than 60% of the foundries of a given type. A size definition was not made for investment casters because of the small number.

Foundry classification by size

Type	Size		
	Small	Medium	Large
Steel foundries	less than 100	100 to 350	more than 350
Iron foundries	less than 50	50 to 250	more than 250
Non-ferrous	less than 25	25 to 50	more than 50
Investment castings	- no size distinctions -		

It must be noted that foundry size could also be defined in terms of tons produced or sales volume in dollars. Using a tonnage criterion, a pipe or ingot mould foundry with a high output per man hour per ton would be larger than a foundry producing short-run intricate castings with high labour and technical contents. A sales volume criterion would be affected by the type of metal cast and the type of product sold. As the main concern of the visits was management attitude, it was considered that these would be most accurately represented by a sample based on the number of employees. If the concern were oriented towards economic rather than technological factors, other criteria might have been more appropriate.

The geographic problem was resolved by drawing a disproportionate number of the sample's small and medium foundries from the Atlantic Region and Western Canada where there were no large foundries. In this way, geographic variations could be included although at the expense of small and medium foundries in Quebec and Ontario.

Initially, all large major foundries were to be contacted personally, but this proved impossible as some refused to allow visits.

Also, foundries known to use a unique process to produce a single product, when either process or product was proprietary, were not included to keep the data applicable to the general foundry industry. Plant visits were made as shown in the table.

Plant visits by type of foundry

Region	Type of foundry			
	Steel	Iron	Non-ferrous	Investment
Atlantic Region	-	3	1	-
Quebec	4	2	2	1
Ontario	3	19	5	-
Prairies	1	4	4	-
British Columbia	2	2	1	-
Totals	10	30	13	1

Visits were also made to a number of other firms where plant tours could not be arranged but discussions were held with the management. These have been included in the observations presented in the sections which follow.

The general pattern of the plant visits was a tour of the facilities first, followed by a detailed discussion of the equipment, processes and products and, finally, a general discussion with senior management.

5.2 GENERAL OBSERVATIONS

In general the technological capabilities of the foundry itself were highest with the large firms. However, management attitudes towards technology, the environment and energy conservation were not so much related to size as to the markets served.

The Canadian foundry industry can be divided into four groups. The first is essentially a carry-over from the past. These foundries are local in nature and provide local service. They manufacture castings for their municipality and replacement parts for local industry. Specifications, if not completely absent, are not treated very seriously by either the customer or the foundry. Such foundries are usually primitive with little or no technology other than that gained by experience limited to their type of operation. They will continue to exist until they are driven out of business as their customers become more demanding or by competition from better organized foundries. The need for environmental controls and the difficulty of attracting skilled labour willing to work under substandard and primitive conditions are already causing great difficulty.

The second group of foundries are independent and highly entrepreneurial in nature. In most cases they have developed a market position and have the technology, organization and facilities to support it. These firms are highly oriented towards growth and will not be readily put out of business by environmental or safety and health regulations.

The third group can be termed special purpose foundries. These produce a single product line using processes specifically designed for that product. Examples of this type are foundries producing soil or pressure pipe, railway wheels, ingot moulds and permanent mould aluminum castings for automobiles. Their technology is highly specialized and their attitudes towards environmental and safety and health regulations are generally progressive.

The fourth group of foundries are the large captive organizations which are primarily devoted to producing castings for the products of their parent company. These foundries often specialize in a few large-volume items used in their products and purchase small-volume or other castings from independent firms when the economics are favourable. These captive foundries generally have the largest plants and most advanced technology - although this is somewhat conditioned by the success of the parent company.

Several companies operate a number of foundries. Some of these have centralized technological facilities on a corporate level. In such cases the corporate structure was not included in the questionnaire data, but is reflected in the discussion on management attitudes.

The investment casting industry, with one possible exception, falls into the group of independent, highly entrepreneurial foundries. However, they have generally developed their own proprietary technology and have little in common with the rest of the foundry industry. There is some question as to whether this segment of the industry should have been included in the study. It would probably be worthwhile to consider investment casting foundries separately, as each is based on its own technology. Their concerns are more involved with matters such as exchange rates, duties, export assistance, defence contract sharing and customs and other restrictions involved in bringing in customers' samples, dies or drawings.

5.3 ENVIRONMENTAL CONTROLS

Most foundries comply with pertinent regulations. Some smaller foundries still have to do something about cupola emissions or dust and noise from shake-outs or arc furnaces. The necessary technology exists. The major inhibiting factor is the capital involved to make the necessary improvements. One encouraging approach taken by a number of the more progressive foundries is to combine the environmental improvement with equipment or process changes which will also decrease costs and improve quality. Examples of this are:

- small iron foundries switching from cupolas to induction furnaces using preheaters with excellent dust and fume collection systems;
- installing automatic pouring or fixed pouring stations so that fumes can be more readily collected;
- installing close-capture exhaust systems which are effective and also reduce make-up air requirements.

In general, management attitudes varied from avoiding the expense as long as possible to doing more than current regulations demanded to avoid more stringent regulations in the future.

One serious problem for older foundries, particularly in Ontario, was that residential areas have grown up around them. The residents complain about odours and noise that may not exceed government allowable limits. Management has responded by:

building new foundries in industrial parks, thereby solving the problem and also gaining the advantages of a new plant;

regulating their hours of work and eliminating noisy or dirty operations during the night;

installing equipment to decrease noise and odours;

ignoring the complaints and pointing out the firm's economic importance to the community.

Management, particularly of the larger firms, want to be good citizens and generally adopt a cooperative approach. One firm in Ontario has donated a significant part of their property to the city as a future park and playground. Not only does this result in good will, but the trees and shrubs will help to absorb noise.

Non-ferrous foundries appear to have the most cavalier approach towards environmental control. This is based on the notion that as their operations tend to be cleaner than iron and steel foundries and little public attention has been focussed on them, they do not need to be concerned. As non-ferrous foundries can emit various noxious fumes and wastes, this attitude cannot be condoned.

One point that came up repeatedly with management was that the onslaught of environmental, safety and health regulations began with a protagonistic type of relationship. On one side were the regulatory agencies and on the other, in direct opposition, the industrialists. This led to a poor relationship aggravated by industry's belief that government inspectors had little knowledge of, or experience in, the industries they were attempting to regulate. N.N. Sacks of Deere and Co. presented this point very effectively in the 1978 Hoyt Lecture to the International Congress of the American Foundrymen's Society.

5.4 SAFETY AND HEALTH

The managers at most of the foundries visited were anxious to provide optimum working conditions for their employees. Generally they wanted conditions in their plant which would enable them to recruit and retain a stable work force, reduce absenteeism and improve efficiency. In addition, as many large customers insist on visiting foundries prior to accepting them as suppliers, clean and efficient-looking premises are helpful in attracting new business.

As in the case of environmental controls, the more progressive managers are taking steps which not only improve working conditions, but also provide economic benefits. Typical examples are:

providing overhead sand systems for moulding stations thereby removing sand from the floor and silica dust from the atmosphere while increasing efficiency;

- installing high-pressure sodium lighting, which increases illumination, reduces power costs, and is claimed to reduce scrap, absenteeism and fatigue;
- installing individual indoor dust collection systems for grinders, eliminating a health hazard and also reducing make-up air heating requirements.

One major problem facing many foundries is the control of fumes and odours from chemical binders used in moulds and cores. Equipment is available to control this problem but is sometimes ineffective because of plant lay-out. Close-capture mobile hoods are often mounted on pouring cranes to capture fumes - particularly in non-ferrous foundries. These are generally effective, but side draughts or a poor pouring layout can decrease their efficiency.

The more primitive foundries are not particularly concerned with safety and health. Not surprisingly these are the same foundries who complain about not being able to get competent help. However, in general, foundry management is convinced that good working conditions is simply good business. Although there may be disagreements on some particular provisions of the official regulations, the general attitude can be described as more than cooperative.

5.5 ENERGY CONSERVATION

Foundry managers have realized that, like safety and health, energy conservation is just good business. The cost of energy has increased sharply over the last few years making major savings possible. Measures such as heat recapture which were not considered economical a few years ago can now make a significant contribution to the profitability of a foundry.

The same foundries that consider environmental regulations do not apply to them also disregard safety and health and show little concern for energy conservation. Fortunately, these firms form a small minority.

Almost all the foundries visited have some form of energy conservation program. In most plants this is under the direction of senior management; in other plants an engineer or supervisor is given the full responsibility. In several foundries such individuals have no other responsibilities and devote themselves exclusively to energy conservation projects. Many Ontario foundries have used the Ontario Energy Bus to survey their plants in this connection and to make recommendations.

The Measures for energy conservation which appear to receive the most attention are:

- general monitoring of the utilities - lighting, heating, power and ventilation;
- reducing power or fuel used in melting, holding or heat treatment;
- recycling or recapturing heat from cooling water, cooling air or exhaust;
- better heat distribution to reduce make-up air heating;
- close-capture hoods to reduce exhaust and thus reduce make-up air requirements;
- improved scheduling of heats or melt campaigns;
- reduction of excess melting, i.e., reduction of pigged metal by better planning or by using automatic pouring;
- changing from oil sand, hot-box or shell core processes to chemically bonded cold box processes;
- improving the plant lay-out to reduce space heating and ventilation requirements as well as reducing the distance molten metal has to be transported;
- improving ladle heating, using ladle covers and changing ladle design;
- replacing refractory brick with insulating fibre-type refractories where possible;
- replacing after-burners with baghouse or other collectors;
- high-pressure halide lighting.

One of the major sources of energy loss in a foundry is the remelting of scrap, sprue and pigged iron. An improvement in yield as little as 5% could have a significant effect on energy consumption. In addition to the energy saving, there would also be savings in handling, moulding, coremaking and cleaning. Surprisingly, only 2 of the 54 foundry managers on the plant visits mentioned scrap reduction as an energy conservation measure.

Monitoring of utilities involves a policing action to ensure that lights are turned off when not needed, make-up air is not heated more than needed, automatic controls are installed for heaters placed over truck doors, idle machines are turned off and area heating turned down where not required. One foundry obtained a major saving by turning off cupola emission controls when the cupola was not in use. Another realized a major saving by reducing the pre-heat time for automatic pouring equipment. This required some study to ensure that the scrap rate did not increase.

Power and fuel used in melting is reduced by using hot blast or twin blast arrangements in cupolas. Other measures taken are to install demand control on electric furnaces and regulate production scheduling. Annealing furnaces are operated more economically by ensuring that a full load is charged, by using insulating refractories, by optimum burner adjustment, and by using heat from the exhaust air to preheat the combustion air.

A number of methods are used to recapture heat from compressor or furnace cooling water or air. These involve heat exchangers. The heat is used for showers or space heating. Exhaust air presents more of a problem as usually it either has to be cleaned or passed through an air-to-air or air-to-water heat exchanger. Some foundries have ingenious arrangements where make-up air either enters the foundry at an area of heat concentration or passes through such an area. There are also arrangements where the make-up air sweeps across the ceiling, forcing hot air down to the working area. One foundry directs the air used to cool their electric furnace coils into the foundry in the winter time and outside the foundry in the summer. This is done simply by removing appropriate wall panels from the air cooler enclosure.

Large ceiling fans are used in some foundries to obtain better distribution of heat and thus reduce heating requirements.

If exhaust can be reduced by close-capture hoods or better plant lay-out, power used for exhaust fans can also be reduced as would both power and fuel used for make-up air. This has become a major project in some foundries.

Other measures listed above are self-explanatory. Almost every foundry is involved in some form of energy conservation, the number of such methods probably being larger than the number of foundries involved. This may be the best example of the fabled ingenuity of the foundryman. However, much still remains to be done and many managers or engineers are not familiar with all the available devices and techniques. This would be a fruitful subject for a workshop or seminar where ideas and information could be exchanged.

5.6 TECHNOLOGY

There has always been a trade-off in the foundry industry between technology and material and energy costs. In the past, foundry managers preferred to spend money on materials and energy rather than on improving the technology. For example, high-grade scrap and pig iron would be used rather than a chemical laboratory or a spectrograph. The sharp increases in the costs of quality materials and energy during the last few years have changed the emphasis so that most foundry managers are now much more willing to pay for technology. The increasingly stringent quality demands of their customers, and the growing pressure to mechanize and automate have also stimulated the growth of technology in the industry.

Basically, the level of technology in a foundry is determined by the market it serves. Data obtained from questionnaire and visits confirmed this fact. It has always been obvious that a foundry serving a quality-oriented or more sophisticated market would have to have technical competence in proportion. A foundry serving a low-cost, high-volume market is forced to install highly automated equipment for moulding and core making and this also calls for a high level of technology. Simply squeezing a handful of sand is not an adequate form of quality control for sand for an automatic moulding system. The use of sophisticated chemical binder systems and the need for skilled personnel to maintain complex equipment have also helped to raise the general level of technology in the industry.

With very few exceptions, the foundry managers interviewed were concerned about developing greater technological competence. Although many had indicated in their questionnaires they had no difficulty recruiting engineers or technicians, in the interviews almost all expressed concern that many of those hired were graduates of foreign institutions. This very often created problems as the individual had to cope with the difficulties presented by a new culture and often a new language. Graduates of Canadian institutions seldom had any knowledge of foundry technology and usually required extensive training before they could justify their salaries. The need for appropriate education and training was not restricted to the technical staff but extended to line supervisors.

A further indication of management's concern about technology was the very high proportion of firms providing assistance for on-the-job training. Another indication was that in almost all the foundries visited, management and supervisors were active in the American Foundrymen's Society, either on behalf of a company or as individual members. The short courses offered by the Cast Metals Institute (CMI), the educational arm of the American Foundrymen's Society, were by far the most popular form of training. It can cost the foundry several hundred dollars for a two- or three-day course.

In section 5.2, under "General Observations", a group of foundries was described which was local in nature and could best be termed as primitive. Management in these foundries does not show appreciable interest in technology, nor does it exhibit any intention of change. Fortunately, they are the exceptions.

6. SUCCESS AND FAILURE IN THE FOUNDRY INDUSTRY

6.1 GENERAL COMMENTS

The question of what constitutes success or failure in the foundry industry proved to be considerably more complex than expected. The success of a company can best be judged on the basis of its profitability. It is doubtful if the financial statements of over 300 foundries would provide meaningful data on which to base a comparison. Few foundry companies are public, and the ones that are, consolidate the financial data of their foundry operations with other operations.

The criteria used in the study to select successful foundries were all qualitative. These were - history of consistent growth, continuous pattern of modernization, and reputation as a reliable supplier.

In addition, suggestions were requested from suppliers, appropriate government officials and trade associations.

The success or failure of a captive foundry depends primarily on the success or failure of its parent company, although there were examples of failures among captive foundries that had little to do with the performance of the parent.

Considering the general objectives of this study, it seems appropriate to concentrate on the success or failure of independent foundries. However, some failures in captive foundries have been included in the discussion, as they have general significance.

It would be inappropriate to list unsuccessful foundries by name; however, naming the following successful foundries chosen for study should cause no embarrassment. This is not complete but is simply representative of the successful foundries visited.

Canadian Steel Foundries Division of Hawker Siddeley Canada Ltd. - Montreal, Quebec.

Benn Iron Foundry Ltd. - Wallaceburg, Ontario

Crowe Foundry Ltd. - Cambridge, Ontario.

Standard Induction Castings Ltd. - Windsor, Ontario.

Western Foundry Co. Ltd. - Wingham, Ontario.

Burnstein Castings Ltd. - St. Catharines, Ontario.

Cambridge Brass Division of Waltec Industries Ltd. - Cambridge, Ontario.

A.H. Tallman Bronze Co. Ltd. - Burlington, Ontario.

Ancast Industries Ltd. - Winnipeg, Manitoba.

ABM Light Metals Ltd. - Calgary, Alberta.

A-1 Steel and Iron Foundry Ltd. - Vancouver, B.C.

This selection includes steel, iron and non-ferrous foundries from Montreal to Vancouver. No selections were made from the investment casting foundries as there was not adequate information available.

6.2 THE PATH TO SUCCESS

The most striking characteristic of the successful foundries was that they had an established market position. The days are over when a jobbing factory made anything for anybody and a difficult casting was regarded as a personal challenge to the foundryman's skills. Either through design or a seemingly natural process of evolution, the successful foundries have invariably established themselves as suppliers to a specific industry, or of a specific type of casting. Some examples of this are:

Canadian Steel Foundries - steel railway castings;

Benn Iron Foundry Ltd. - light-sectioned intricately cored grey iron castings;

Burnstein Casting Ltd. - high-integrity copper castings for power transmission applications;

A.H. Tallman Bronze Co. Ltd. - Intricate, high-integrity pure copper castings for the steel industry.

Success does not rest solely on market position, but also demands that the foundry have the technology, production facilities and sales support.

If the market position is based on providing high volume and good service, the production facilities have to be appropriate. An example of this type is Western Foundry Co. Ltd. If on the other hand, the market demands quality or integrity, the foundry may allocate more of its investment capital to quality control equipment than to mechanization. An example of this type is Burnstein Castings.

A second common characteristic of the successful foundries is coordinated growth. As their market positions became established and their sales volume grew, their production facilities, technological resources and all other phases of the operation were developed proportionately. It is not uncommon to see both manual and automated moulding lines in the same foundry, simply because the firm is growing in steps to enhance or at least defend a growing market.

A third common characteristic is management's attitude towards developing personnel. Several of the most successful foundries gave this point their first priority.

One interesting observation concerned captive foundries. Small captive foundries that have been established with the idea of using excess capacity for outside business seem to be successful only when outside business is a major component - 40% or more - of their volume, and more importantly when they have used their captive business to define their market position. A good example of this is Benn Iron Foundry Ltd. in which the captive products are very intricate light-sectioned castings for air brakes. This has led to concentrating on other markets for similar work. A-1 Steel and Iron Foundry Ltd., like several other foundries in Western Canada, has a proprietary product line, in this case logging and marine hooks and chains. This not only provides a means to smooth out fluctuations in demand by making proprietary products for inventory, but also provides the base for a market position and the facilities to support it.

An interesting but not altogether surprising observation was that the successful foundries were those which almost invariably had technical problems to report on their questionnaires. Another observation that should be mentioned is that the management or staff of successful foundries take active roles in trade and technical associations. In fact, these foundries, including some that were not selected for study, could be said to almost dominate the trade and technical associations.

Most of Canada's special purpose foundries can be considered successful. Their performance is usually highly dependent on a very narrow, specialized market, so that they have, in fact, defined a market position, albeit in very narrow terms and have developed the resources to exploit it.

One characteristic noted in some but not in all of the successful foundries was a compact lay-out with a very high degree of space utilization. These foundries also operated on at least two, and often three shifts. Their reasons for this approach besides the obvious financial advantages, were that process control, quality control and supervision were all better in a compact, highly utilized plant. Standard Induction Castings Ltd. is an excellent example.

In summary, the successful independent Canadian foundries have established market positions and, in a well-balanced manner, have developed the management, personnel, technology, production facilities and other business functions to support and exploit that position.

6.3 THE ROAD TO FAILURE

Obviously the road to failure is defined as being opposite to that of success and results from failing to follow the right signposts. However, this answer is overly simplistic and one must examine the problem in more detail.

During the last 15 years there has been a marked decline in the number of foundries in North America. The reason most often given is the need to install environmental controls and to provide safe and hygienic working conditions. Markets have not declined and, except for the last few recessionary years, there has been a steady growth. When the failures are examined in more detail, the vast majority were the primitive local foundries which simply did not have the resources to provide for environmental controls and improved working conditions. The lack of financial resources was due to their dependence on low-priced, low-volume business that did not require quality control or even a moderate level of technology. This particular segment of the market has declined and will continue to decline. The portions that remain will be increasingly subject to intense competition from high-volume, mechanized and automated foundries. As Canadian markets for castings such as manhole frames and covers are relatively small and widely dispersed, major capital machinery investments by the individual foundries cannot be justified unless substantial integration of the domestic foundries can be achieved or substantial export markets are developed.

Even more serious than the lack of capital is the lack of technology. The management and supervision of these foundries have simply been unable to cope with the challenge presented by more lucrative markets or by high-volume production. Not all such foundries have disappeared, but more than a handful cannot be expected to survive.

The inability to establish a market position has been another major reason for failure. Foundries which will not specialize or at least concentrate their efforts on one type of casting or on one market, become unable to compete in the present specialized markets.

A common source of failure has been a reluctance to buy new equipment and, instead, to patch up and make do with someone else's discarded and out-dated machinery. Failure also occurs in foundries that do not use qualified independent engineers or other sources of expert advice when they lay out a new foundry, or upgrade or expand facilities. Eventually they are hamstrung by inefficient, congested plants and are faced with major capital expenditures.

Inordinate and badly-planned expansion or automation has been a common route to failure. Increasing production capacity without due regard to the market and without adequate technology or skilled people leads to difficulty in meeting the capital investment costs. Foundries have also invested in equipment which has proved to be unsuitable for their market. They have then tried to develop a market, lacking the technology and the people required to serve it.

Another common source of failure is when the captive foundry is designed to produce a particular product line for the parent company, but requires outside work. As discussed previously, such an operation can be successful only if the proportion of outside work is substantial and if the proprietary work is used to define the market position. Under these conditions, buyers can assume that the foundry is interested in their business on a permanent basis and not simply as a fill-in; also the foundry will have the equipment, technology and people required to supply the outside market successfully. It should also be pointed out that the management of a semi-captive foundry can be placed in a position which is almost untenable. They must serve two masters, the demands of the parent company and the demands of the outside customer. This is particularly true when there is a question of priority in delivery and service.

Failures due to purely technological factors are rare, as the basic fault must always lie with management. The technology is available; it is management's responsibility to define their needs and procure the technology they require.

6.4 BUYERS' COMMENTS

A list of 15 major casting buyers was developed in consultation with several foundry sales managers. A letter was written to each asking about import purchases (discussed in the next section) and soliciting comments on their Canadian suppliers. They were asked whether they were satisfied with the quality and technical services of their Canadian suppliers and also for any general comments.

Replies were received from twelve buyers. In all cases they expressed satisfaction with the product quality. The only negative note regarding technical service was from a tar sands company which complained that their Canadian suppliers were not able to provide the same degree of expertise in selecting alloys for abrasion and corrosion resistance as did U.S. suppliers.

Negative comments were also directed at sales and marketing activities. Buyers did not have enough information about prospective suppliers. A common complaint was that buyers had to be extremely careful in selecting Canadian foundries to be assured of quality and delivery.

The most common complaint was that Canadian foundries did not have the high-production facilities to supply large runs with suitable lead times.

Reviewing these comments in relation to the previous discussions about success and failure only serves to reinforce the need for defining a specific market position and developing the physical, technological and human resources to support it.

7. CASTING IMPORTS AND EXPORTS

7.1 STATISTICAL DATA

The publications by Statistics Canada do not provide sufficient data for a thorough quantitative analysis of casting imports and exports. There are two reasons for this. First, castings entering or leaving Canada are only counted if they are rough castings. If they are finished or replacement parts, they are listed as the actual component (e.g., fittings). One might go through the lists of articles or components and pick out the castings except that in some cases they are not distinguished from forgings. The other problem is that exports of non-ferrous castings are not listed separately. Copper alloy castings are combined with forgings, and aluminum alloy castings are combined with fabrications.

Statistics Canada data were used to calculate the trade balance for ferrous castings for the five years from 1973 to 1977. This is shown in the following table:

Trade balance - ferrous castings

Year	Tonnes	Tons	Dollars (1000's)
1973	+ 42 590	+ 46 958	+ 34,514
1974	+ 18 874	+ 20 810	+ 32,220
1975	+ 35 511	+ 39 152	+ 20,931
1976	+ 59 426	+ 65 519	+ 50,593
1977	+ 63 733	+ 70 268	+ 52,782

It is interesting to note here, that Canada has a trade surplus in ferrous castings. It is also interesting to point out that this surplus seems to be growing in both tonnage and dollar value. The major components on the import side are ingot moulds and stools which range from about 54 420 to 81 630 t (60,000 to 90,000 tons) a year at values that ranged from $149.35/t ($135.53/ short ton) in 1973 to $335.34/t ($304.30/short ton) in 1977. This particular import is a reflection of the fact there is only one independent Canadian manufacturer of ingot moulds and stools (Canron, Inc.) and the steel mills will always want to have at least one alternative source of supply. It should be emphasized that the positive balance of trade does not take into account the import of finished castings, and applies only to rough ferrous castings.

The average value of Canadian imports in the years 1973 to 1977 was $556/t ($505/short ton). The average value of Canadian exports for the same period was $952.14/t ($865.57/short ton). Unfortunately, exports of ingot moulds and stools are not listed as such, so that a comparison without that relatively low-priced item is not possible.

It should be noted that the United States is by far the major trading partner.

7.2 VISITS TO FOUNDRIES

Fifty-four visits were made to foundries and six additional companies were visited where the contact was limited to a discussion with management. Thirty-four of these 60 foundries reported that a significant part of their sales, in some cases amounting to over 90%, were made to export markets. These markets were forest products, railways, agricultural machinery, automotive, truck, primary steel, and U.S.A. defence industries.

The devaluation of the Canadian dollar may have contributed to the large export figures but judging from the most recent statistical data at the time of writing it does not seem to have had a major effect. One of the reasons was that most of the foundry supplies and equipment had to be brought in from the U.S.A., and even Canadian metals were priced on the international market so that foundry costs had risen sharply due to devaluation.

7.3 INFORMATION FROM CASTING BUYERS

Letters sent to the 15 major casting buyers referred to in the previous section also requested information on import purchases. Of the 12 companies that responded 5 obtained all of their casting requirements in Canada. Examining the replies of the other seven respondents, one finds that the major reasons for importing are:

(1) The lot size required is too large for a domestic foundry, that is, lead time would be too great. This is most frequently the case for automotive castings.

(2) The size of the casting is too large, that is, it exceeds the maximum pour size. This is often a factor for manufacturers of hydroelectric or other turbines.

(3) A Canadian foundry which may have the facilities to supply the volume and size, may not be competitive with the U.S.A. suppliers. This is often due to transportation costs. One buyer reported that volume steel castings cost 15-20% more from Canadian suppliers even after adjusting for exchange rates.

(4) Many buyers import finished assemblies with a large casting component.

(5) Many castings are brought in as replacement parts or spares for equipment originally purchased in another country.

(6) The U.S.A. parent of a Canadian subsidiary owns the patterns which are placed in U.S.A. foundries; Canadian volume is not large enough to warrant a separate set of patterns.

(7) A special alloy or specification is required and the Canadian volume is too small to warrant developing a supplier.

The only imports that were reported solely on technological grounds were:

(1) Type 4 Ni-Hard;

(2) Low-temperature, low-carbon alloy steels requiring A.O.D. processing.

It was apparent from the replies that buyers in the newer markets in Western Canada are making an effort to buy Canadian. This was also evident during the plant visits, where foundries had considerable orders for castings destined for tar sand, coal mine and pipeline projects.

8. CONCLUSIONS - NEEDS OF THE CANADIAN FOUNDRY INDUSTRY

8.1 GENERAL COMMENTS

The Canadian foundry industry ranges from primitive establishments which have not changed for fifty years or more, to some of the most advanced and sophisticated in North America. The range in quality of their products can be illustrated by the fact that a purchaser in the Atlantic Region would have difficulty in finding a local foundry that could meet engineering specifications, whereas on the other hand, some U.S.A. buyers look to Canadian sources for high-quality stainless steel castings and Canadian investment casters export 90% of their production to the U.S.A. and Western Europe. For these and similar reasons, a set of general conclusions drawn from this survey would be of limited value. As the purpose of the survey was essentially to provide a basis for developing a program of technological assistance, it seems more appropriate to state conclusions in terms of needs.

As discussed previously, the local service foundries are a carry-over from the past. Their primary problems are of a management and financial nature and these must be resolved before any technological needs can be considered. Such foundries are thus not given direct consideration in the ensuing paragraphs of this section.

8.2 EDUCATION AND TRAINING

As one would expect, the level of education and training varies with the size and type of foundry, and with the nature of its market. The percentage of qualified technical personnel in the total plant payroll tends to diminish with the size of the foundry, but a certain minimum amount of technology is required regardless of size. Training programs, either internal or external, are offered by 87% of the responding foundries. This ranged from 100% in the steel foundries and investment casters to 93% in the iron foundries and 44% in the non-ferrous foundries. The foundries responding to the questionnaire - 152 or 46.9% - plan to hire a total of 236 engineers and technicians during the next five years. A rough extrapolation based on the responses by type of foundry would place the estimated total at 445.

The above facts should certainly indicate not only an interest in education and training, but also the fact that the need for technically trained people is expected to grow very sharply. In the questionnaires and also during the plant visits, by far the most critical need expressed by management was for engineers and technicians with some knowledge of foundry-oriented science and technology. Foreign graduates with such training were sometimes hard to find and present problems with immigration procedures, adapting to Canadian life and often language difficulties. Canadian graduates, unless they had a previous working background in the industry, had to be given specific training in such subjects as sand technology, moulding, coremaking, melting, etc., because Canadian institutions do not offer foundry options.

The major problem facing Canadian foundries in filling their professional staffing objectives, is the lack of foundry courses in the metallurgical departments at Canadian universities and technological institutions. Unless major changes in course content are made quickly, the demand for 445 professionals and technicians by the foundry industry over the next five years will not be met.

8.3 PROCESS CONTROL

In the questionnaire and during the plant visits, process control was essentially defined as the steps taken during processing to measure and control critical parameters so that maximum production could be attained with the scrap rate held to the minimum practical level. As one would expect, the level of process control improves with the size of the foundry. It is lowest in non-ferrous foundries, increasing through iron foundries to steel foundries and is highest with investment casters. This is partly a reflection of the size of the foundries and partly due to the type of products produced and processes employed.

Considering that a major energy waste is that used to remelt scrap, process control should have a high priority. Excessive scrap also costs money in wasted labour, moulding and core materials, refractories, inoculants and, in addition, is a prime cause of extended lead times and late deliveries.

Most of the foundries with inadequate process control could attain a minimal acceptable level by an investment of no more than $20,000. This would be for simple sand-testing equipment, a eutectometer for iron foundries or at least an immersion pyrometer.

One may well ask whether the failure to make this investment is due to lack of funds, lack of knowledge on the part of management, or simply a reflection of the lack of technically trained people. In any case there is an urgent need for all such foundries to test their moulding sands and metal temperature during processing if they are to operate successfully.

8.4 QUALITY CONTROL

The questionnaire data revealed that 40% of the Canadian foundries did not have the equipment or procedures to ensure that their products complied with the purchaser's specifications. This statistic may be misleading as in many cases only occasional testing is done because formal specifications were not required on a regular basis. It may also be misleading as customers often use a specification simply as a matter of description and do not insist on verification. As with process control, inadequacies were mainly in the non-ferrous and small foundries. In most cases, but not in all, the foundry that had inadequate process control was also inadequate in quality control.

There were exceptions where a foundry's customers provided no formal specifications.

It would be unreasonable to expect small foundries to install complete chemical laboratories or tensile testing equipment. However, outside testing laboratories do exist in most large centres and could be engaged to provide such services. The need in this case is to determine the availability of outside testing facilities and to provide local facilities where none exist.

8.5 TECHNOLOGY

The degree of technical organization, as one might expect, is a function of foundry size. The first step appears to be the formation of an inspection, metallurgical or quality control department. The ultimate step appears to be the introduction of research and development. As with process control and quality control, the degree of sophistication increases from non-ferrous to iron and then to steel foundries and investment casters. About 25% of the respondents reported some research and development activity. It appears that most of this activity exists on a corporate level in multi-plant companies or deals with final products in companies with captive foundries. In the case of the automotive foundries and other Canadian subsidiaries of large U.S.A. firms, most of the R & D is carried out in their U.S.A. laboratories.

Judging from the technical problems returned with the questionnaires, the Canadian foundry industry does not have a major need for new scientific knowledge or its development into usable technology. A few specific research and development needs were revealed and these are listed in Section 10.

Most of the problems reported were not technological in nature, and technical only in a very broad sense (e.g., scarcity of suitably trained personnel). The majority of actual technological problems raised can be resolved by applying knowledge that had already been published and should be common knowledge.

The need in this case is to develop better ways to supply the industry with available technology. One obvious answer is to provide them with engineers and technicians who have had a foundry-oriented education or training.

One point raised in several questionnaires and meetings was the need to find ways to improve productivity of the Canadian foundry industry. This need can also be met with more specifically trained engineers.

8.6 SALES AND MARKETING

A substantial number of foundries reported exclusion from domestic and export markets for technological reasons. Invariably this was due to the lack of adequate process or quality control equipment. The only exception was one foundry excluded from a market because it did not have A.O.D. processing equipment. The problems appear to be primarily financial, as the foundries concerned did not have confidence that the market in question was adequate to justify the cost of the equipment. On closer examination it was also evident that many of these foundries also lacked the necessary trained personnel or the organization was simply inadequate to deal with the challenge.

The foundries that do have technically trained or shop-experienced salesmen are not always adequate or equal to the customer assistance available from U.S.A. suppliers. This was particularly true in the case of abrasion and corrosion resistant castings. Thus, the needs are for both financial assistance and better-trained personnel for quality control and sales.

8.7 ENVIRONMENTAL CONTROL, SAFETY AND HEALTH

Almost all of the foundries visited comply with environmental, safety and health regulations. The exceptions were generally small or old foundries which presented more difficult problems due to their physical layout or outdated equipment. Two major problems still exist. The first is the foundry which now finds itself surrounded by a new residential area. The other problem which is purely technical in nature is to control the fumes and odours resulting from the increased use of chemical binders. This particular problem requires research and development to find better methods of fume and odour control and to develop a less bothersome binder system.

8.8 ENERGY CONSERVATION

Generally speaking, foundry managers consider that energy conservation, like environmental control, safety and hygiene, is just good business. Almost all the foundries visited had active energy conservation programs. The exceptions were the small foundries of all types.

Many of the measures taken are common to all - such as utilities monitoring, but many others are unique and ingenious methods which have been developed in individual foundries. A broad dissemination of available technology and an interchange of ideas between the foundrymen themselves is needed.

8.9 SUCCESS AND FAILURE IN THE FOUNDRY INDUSTRY

The major ingredient for success in the foundry industry is the development of a market position. This must be followed up by a balanced development of facilities, personnel and technology capable of supporting that market position. A thoroughly detailed case-history type of educational program could be helpful in this respect.

The difficulty reported by several buyers of obtaining large volumes is understandable when one considers the size of the Canadian market and also the fact that such large orders are often quite sporadic. One answer to this for the Canadian context would be the development of cheaper, more flexible automated moulding systems that could operate efficiently on short-run as well as long-run work.

9. GENERAL RECOMMENDATIONS

9.1 EDUCATION AND TRAINING

9.1.1 Formal Education

The projected requirements of the foundry industry for engineers and technicians far exceed the anticipated supply from Canadian universities and colleges. In any case, these institutions do not provide sufficient background in foundry-related sciences and technologies. Because demand for all types of engineers and technicians is reported to exceed the supply of graduates, some additional facility would be indicated. With the present restriction on educational budgets it is doubtful if Canadian universities could be encouraged to expand by adding foundry options to their engineering curricula. Such foundry options are found in many U.S.A. universities. Most, if not all, receive financial and other support from the Foundry Educational Foundation which is made up of companies involved with the foundry industry. This organization exists for the sole purpose of encouraging and assisting universities and colleges in developing courses for engineers and technicians wishing to pursue a career in the foundry industry. Their efforts have been extremely successful.

In Europe, the policy has been to set up foundry colleges with either state or industry support, or a combination of the two. This approach has also been successful.

Graduates of both the American and European programs have been recruited by Canadian firms with good results.

It is doubtful if either of these two approaches would be successful in Canada. First of all, education is a provincial matter, and secondly the scale of the foundry industry and its geographical dispersion would make either approach difficult.

What is recommended is really a combination of the two methods.

(a) A foundry college should be set up in affiliation with a major university. The affiliated university would grant degrees and provide the necessary training in the basic sciences and humanities. The college would provide instruction in the sciences and technologies specific to the foundry industry. Such a college should be jointly financed by the foundry industry and foundry suppliers as well as by provincial and federal governments. One obvious possibility would be to take advantage of the existing foundry research facilities and staff at Energy, Mines and Resources Canada (EMR).

(b) Foundry technicians could best be trained at the community college level. Financial and other support could be provided by the same association of foundries and their major suppliers. Instructors could be drawn at least in part from local foundries.

Obviously, the above recommendations are presented as points of departure for further discussion. However, one must not lose sight of the fact that the Canadian foundry industry must make a concerted effort and organize to ensure that they can resolve what most claim to be their most pressing problem - properly trained personnel. It is also obvious that such a program requires some form of governmental participation or assistance.

9.1.2 Continuing and On-the-Job Training

Despite their heavy commitment to training programs, foundry managers require still more help in this regard. Some of the suggestions advanced were:

(a) Video cassette training programs on certain basic and specific subjects;

(b) intensive examination and review of a specific foundry's technology;

(c) comprehensive technology review of specific subjects;

(d) up-dated reviews of recent advances in technology;

(e) a technology testing program. This would be a series of short written examinations to assess the level of knowledge a foundry technician or supervisor has in a specific subject (e.g., sand technology, gating, etc.). National certification standards could be established for foundry personnel.

9.1.3 Recruitment

The educational programs will not be effective if young men and women do not feel that the foundry industry is a good place to work. The foundry industry itself must tackle this aspect of the problem by upgrading their operations and establishing close relationships with students from the high school level on.

9.2 PROCESS CONTROL

A program should be developed by EMR with the collaboration of the Canadian Foundry Association to publicize the value of process control, establish optimal methods for each type of foundry, and determine the costs of such a program. This information should be distributed to all foundries and could be in the form of a check list.

Expenditures to improve process control to increase yield and thus conserve energy should be considered the same as any other energy conservation measure; and should receive the same attention and the same assistance.

9.3 QUALITY CONTROL

Grants and other forms of financial assistance have been available for improving foundry productivity and for foundry expansion or new facilities. Similar assistance should be made available for quality control equipment which would enable a foundry to expand its markets.

A survey should be made of the availability of private testing laboratories for small foundries that cannot justify their own equipment. Where convenient facilities are not available, foundries and other potential clients should investigate setting up a cooperative facility. EMR staff could provide advice and training.

9.4 TECHNOLOGY

Several foundries expressed a need for studies and assistance to increase productivity. There is also a need for automated equipment better adapted to the realities of the Canadian market.

The British Cast Iron Research Association includes industrial engineering in its activities. There is no reason why EMR should not also include this subject in its responsibilities.

9.5 ENERGY CONSERVATION

A workshop or seminar devoted to energy conservation in the foundry industry would provide a useful forum for the introduction of new technology and the interchange of ideas. Canadian conditions offer more severe challenges and greater opportunities than most other industrialized countries. This kind of program could probably be organized and planned by EMR better than any other organization.

9.6 MARKETING

The importance of establishing a market position and the rather negative comments of some buyers indicate the need for assistance. This topic is more appropriate to the Department of Industry, Trade and Commerce which is already involved and perhaps even more effective programs could evolve based on the findings reported in this study.

10. SPECIFIC RECOMMENDATIONS FOR RESEARCH AND DEVELOPMENT PROGRAMS

As mentioned previously, the Canadian foundry industry has needs more pressing than acquiring new basic knowledge or developing new technology. However, research and development activity must be maintained, not only to build for the future, but also to handle uniquely Canadian problems. In addition, foundry research activity would be a necessary adjunct to any higher educational program.

The following subjects are recommended for research and development programs:

(1) Abrasion-resistant alloys. This study should encompass the mechanics of various types of abrasion processes as well as the alloys themselves.

Grinding, crushing and similar equipment available in the EMR mineral processing laboratories could be used to study abrasion processes as well as to test the alloys. Investigation combining abrasion and corrosion should also be undertaken.

(2) Fume and odour abatement. Methods of controlling fumes and odours from chemical binders should be compared and evaluated. New methods should be developed if needed.

(3) Fume- and odour-free binders. This work should be continued.

(4) Development of domestic moulding sands. This has been an interest at EMR for many years. Efforts should be extended perhaps in collaboration with other laboratories for ultimate commercial exploitation.

(5) Development of low-cost flexible automation for the small jobbing foundry.

(6) Low-temperature alloys. Work should be continued and, if possible, expanded.

(7) Casting defects. This should be a continuing program of collating and reviewing existing literature and doing further research where required.

(8) Production of thin-sectioned intricate castings. This is becoming increasingly important with the weight reduction programs of the automotive and other industries. The work should cover all commercial casting alloys and include the effects of sand and other mould variables as well as liquid metal properties and solidification.

(9) The effects of large volumes of chemically-bonded cores on moulding sand control.

(10) Collapsibility of chemically-bonded moulds and cores.

(11) Energy conservation. A detailed examination of opportunities for heat recapture is required that will illustrate potential savings. This should be followed by a critical review of existing methods and equipment. Finally, development work should be done on promising concepts such as heat pipes.

(12) Factors affecting the shelf-life of chemically-bonded cores. Many foundries report problems in this area.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the support and cooperation received from Energy, Mines and Resources Canada and the scientific authority on the contract who provided the stimulus for this work.

The author also wishes to express his sincere gratitude to the many busy foundrymen who took the time to fill in the questionnaire. In addition, many foundry managers and executives took great pains to ensure that visits to their plants were not only a pleasant but also a productive experience. Their concern for the welfare of our industry is noteworthy and their cordial hospitality is sincerely appreciated.

This study was facilitated in great measure by the support and cooperation of the Canadian Foundry Association, L'Association des Fondeurs du Québec, the Non-Ferrous Founders Association, and the Copper and Brass Development Association.

Finally, the author wishes to express his appreciation to the officials of the Federal Department of Industry, Trade and Commerce and all the trade, commerce and economic development ministries of the provinces. These officials were extremely helpful in providing lists of foundries and other valuable background information.

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