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ELKEM UNIVERSITY
CONTINUING EDUCATION FOR GRADUATE PROFESSIONALS

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ABSTRACT

Elkem University is a framework for postgraduate education and technology transfer within Elkem's core business areas. The target group is process metallurgists and other technical personnel at the production plants, and personnel from the corporate technology departments.

Elkem University arranges courses, typically of 2 by 1 week duration, which offer updating of professional skills and transfer of the most recent "state of the art knowledge" and "best proven technology". The main focus has been on ferroalloy process understanding and furnace operation, but special courses are also being arranged in areas such as Post Taphole / Refining, Maintenance, and Aluminium Technology.

Elkem University courses have been approved as Continuing Engineering Education courses at the Norwegian Institute of Technology.

1. INTRODUCTION

The history of the ferroalloy industry covers periods of different development trends.

One pioneering era was linked to the development of the self-baking, continuous electrode, more than 75 years ago.

After this break-through a new era took off, when the invention of the söderberg electrode was followed by a series of new developments in process technology and equipment design.

From about 1950 and a couple of decades ahead the development was characterised by steadily increasing furnace sizes. Transformer capacities increased from 15 MVA to 100 MVA in the period. This was the golden era of the engineering companies, in Elkem represented by the Engineering Division (now Elkem Technology).

After 1970 this development towards increasing furnace sizes levelled off - as has actually also the rate of new installations. Instead, we have experienced an era of increased competition which requires more emphasis on process understanding, furnace performance, and product development.

The operating power level and production rate of existing furnaces have been increased. Specific power consumption figures have been lowered. For many producers the product range has shifted away from commodity into refined products with a higher degree of built-in knowledge. Computerised process control and utilisation of information technology on large have become necessities.

All this points at the need of *competence*. Without discrediting the old metallurgists and furnace operators by suggesting lack of knowledge and skill, we must clearly admit that the demand for competence is stronger today than it was ever before. And this goes for all levels in the organisation.

Training and education are key words.

Among furnace operators in Elkem's Norwegian ferroalloy plants, the level of education is clearly higher today than it used to be. Quite a few young operators have finished secondary school or vocational school when they are employed. And further education as certified furnace operators is offered through a formalised system jointly agreed upon and developed by the main employee and employer organisations, and linked to the public educational system in Norway.

However, for the graduate professionals (metallurgists and others) there has been no equivalent system for continuing education specially adapted to the needs of the ferroalloy industry, and offered to the industry as a whole. To meet the company's own demand in this area, Elkem has established a framework called *Elkem University*, for postgraduate continuing education and technology transfer within Elkem's core business areas.

2. COMPETENCE, KNOWLEDGE, COMMUNICATION

It was stated in the previous paragraph that the demand for competence is stronger today than it was ever before. So, let us try to define what we actually mean by competence.

Competence is *knowledge*, but not only that. Competence is also *skills* and *attitudes*. And - finally - competence is the *ability to use knowledge and skills*. Actually, competence can be defined as the sum of all these factors.

For the category of personnel which constitutes the target group for Elkem University, one type of knowledge is the "school basics" learned in technical collage or at the university. A part objective of an Elkem University course is to give fresh-up lectures on the most relevant basic topics, such as thermodynamics, heat transfer, statistics, or control theory.

A typical "student" at Elkem University has obtained his or her MSc. degree in metallurgy, metallurgy oriented inorganic chemistry, mechanical or electrical engineering several years ago, and has since then mainly been engaged with the practical problems of day-to-day operation. Such a person may very well benefit from repetition of some theoretical basics, and - with the practical experience acquired in the meantime - the lectures may even prove more fruitful and meaningful than they did some years ago, before graduating.

Another type of knowledge is more specifically related to our business, and to the technology we are using. As compared to the long-lived ("eternal") character of theoretical basics (e.g. mathematical principles), this is often a volatile or short-lived knowledge in the sense that it is more or less continually being developed or improved. It may even happen that new insight turns "recognised knowledge" upside down so it has to be abandoned all together and replaced by "new knowledge".

This volatile knowledge may change by naturally accumulated experience, or because of findings by luck. But more typical, it is the result of systematic efforts in research and development projects. Anyway, it is important that this knowledge of "best proven technology" or "state of the art" is being transferred throughout the organisation with efficiency and the least possible time delay. This is certainly one of the most important missions of Elkem University.

Actually, the experience with Elkem University so far has clearly revealed how difficult it is to communicate and transfer knowledge, and how extremely important it is to be aware of this difficulty and to act properly to overcome it.

It is hardly any exaggeration to claim that communication and transfer of *existing* knowledge in many cases are more important than developing *new* knowledge. It is surprising, and even frightening, to experience that significant knowledge which has been known for years by some, is completely unknown to others who would badly have needed it. Confidentiality or deliberate restriction on the spread of knowledge is rarely the reason, as one can often find that the knowledge in question has been published.

The problem is often to present existing information in a communicative easy-to-understand form, and to make it *available* to those who need it. It sounds simple, but experience shows it is not. Elkem University does not solve the problem completely - but within Elkem it certainly makes a significant contribution.

To finalise this paragraph, let us look at a couple of examples of how expert opinion or "knowledge" may be drastically changed and replaced by new knowledge, and also how difficult it can be to communicate new knowledge so it is efficiently transferred to those who need it.

Less than 40 years ago there was no cavity around the tip of the electrode in a ferrosilicon furnace under normal and correct operating conditions - according to the accepted theory of the time. According to the same accepted theory, cavities could only appear if the furnace was operated at too low voltage.

Today we know better. By excavations and visual probing we have acquired new knowledge: There *is* a cavity, and it plays an important role in the process. Also interesting to note is, that operators who knew from their own experience that the cavity was there, chose to keep silent to avoid critisism for erroneous operation.

The important area of furnace linings offers another example of "expert knowledge" which has been abandoned and replaced by new knowledge. Not so many years ago, the ruling theory was that the thermal insulation should be as good as possible, in order to "lock the heat inside" the furnace and minimise heat losses. A series of burn-throughs in FeSi and Si-metal furnaces in the mid-eighties led to a re-consideration of this principle:

By applying a high thermal conductivity ramming between shell and lining, a better control of the heat loss was obtained, and a "freeze border" could be established at a safe distance inside the shell as an efficient precaution against metal breakthrough. (This principle was already well known in the aluminium industry for protection of the cathode sidewall.) The heat loss with this new type of lining turned out to be at the same level as for the old type of insulating lining after a few months of deterioration.

This (surprisingly?) new acknowledgement and other well-founded recommendations for lining practice have been available for many years, and have even been published at several international conferences. Nevertheless, examples can be found that this existing knowledge was not available to, not digested by, or simply ignored, by persons or organisations responsible for furnace re-lining at a later stage.

3. THE DEVELOPMENT OF ELKEM UNIVERSITY

3.1. The first course in 1991

The first "course for process metallurgists" was arranged in the fall of 1991. At the time, the designation "Elkem University" had not yet been introduced.

The course was arranged over two weeks, with a 3 weeks separation between the two periods. Separate locations were chosen for the two course weeks.

Each time a suitable conference hotel was chosen, where the participants stayed together the full week with board and lodging. This gave the advantage of shaking the group efficiently together, and allowing social as well as professional communication also outside the lecture hours.

In the planning of this first course, an issue for discussion was the differences between the various process areas. Ideas of separatism were brought up, such as: "The melting of stones in a ferrosilicon furnace is something completely different from reducing ferromanganese from ores, and the two processes can not be treated in the same course".

During the later development of Elkem University such arguments of separatism have been strongly weakened. Anyway, the decision was taken to concentrate on FeSi and Si-metal in the first course. It was also decided to run the course in Norwegian, so the participation was limited to the FeSi and Si-metal plants in Norway, and Icelandic Alloys Ltd.

One reason for the latter limitation was a concern whether the language barrier would restrict an efficient communication, on the part of the lecturers as well as the attendants.

The course program was - as a main rule - divided in lessons of 45 minutes with 15 min. breaks in-between. This gave altogether about 65 lessons over the two weeks. During the first week the dominant part was lecture lessons ("one-way teaching"), whereas more time was used for discussions, exercises and case studies during the second week. The main program items were:

- Thermodynamics
- Kinetics
- Process theory (FeSi/Si process chemistry)
- Raw materials (quartzites and reductants)
- Electrode operation
- Electrical Engineering
- Mathematical models / process modelling
- Control theory
- Computer control
- Statistics / SPC
- Economy
- Furnace operation practice / case studies

Lecturers were Elkem-internal personnel, and in addition professors and other professional lecturers from external institutions, mainly The Norwegian Institute of Technology (NTH).

The above described scheme for the first course was judged successful and has been followed in large for three proceeding courses, with the following exceptions:

1. All the main smelting processes have been included in the same course program, i.e. FeSi, Si-metal, FeMn, SiMn and FeCr.
2. The courses have been run in English, with Elkem-global participation.
3. The number of different theoretical subjects during one course has been reduced.

3.1.1. Process Understanding / Furnace Operation

Encouraged by the success of the first course, it was decided to continue developing courses at what was defined as "post-graduate level". As an umbrella designation for such courses the term "Elkem University" was introduced.

The idea was that Elkem University should cover a variety of courses according to the following guiding principles:

- The courses shall focus on the core business areas of Elkem.
- The courses shall be strongly *technology* oriented - and not overlap with courses in general topics and management, organised by the corporate Personnel and Organisation Development (POD) Department.
- The courses shall contribute to fast and efficient spread and transfer of R&D results as well as other new technological achievements in proprietary areas.

The intended spread and variation in course topics did not come true for the three years to follow after the first course in 1991, for the following reason:

The "course for process metallurgists" in 1991 turned out to hit a substantial demand. So, 2x1 week courses over the same main topic were repeated in 1992, in 1993, and in 1994. The title of these three latest courses has been

"PROCESS UNDERSTANDING / FURNACE OPERATION".

Even though all these courses had the same title, there have been changes which we shall briefly comment upon in the following.

3.1.2. Program Variation

One experience from the first course in 1991 was that we tried to cover too many theoretical subjects, only allowing for a superficial treatment of each topic.

This situation had to a certain degree been foreseen. Therefore, well acknowledged textbooks had been purchased and given to each student, in the rather optimistic hope that the "pieces of taste" lectured would encourage to self-studies afterwards.

Probably not too surprising, we had afterwards to admit that this hope was too optimistic. In the next courses we have therefore limited the number of different subjects, and instead varied the selection of subjects from one course to another. However, we have still made a point of including good textbooks and other relevant literature in the course material given out.

In this way we have - under the same course title - obtained sufficient variation to attract the same participants more than one time. Actually, with a total participation of 105 in the four courses, as many as 15 of these have attended twice.

3.1.3. Process Integration rather than Separatism

As previously explained, the first course was limited to the FeSi and Si-metal processes.

It was soon acknowledged, however, that there were many topics of common interest to the different process areas. And even on the points where there were pronounced differences, one could expect synergy effects and useful ideas to emerge when people with different experience and background came together.

"Cross-fertilisation" between e.g. the FeSi and the FeMn area in this manner could also be expected to enhance the flexibility of professional resources within the Elkem group, by stimulating personnel interchange between plants and divisions.

So, for the later courses, we have had the following interesting development:

1992: The course had the first week common for all process areas. The second week was separate for FeSi/Si and for FeMn/FeCr.

1993: The full course was common, except for two days with parallel sessions for the two main process areas.

1994: Same as in 1993.

3.1.4. Global Participation

Except for the first course, which was limited to the FeSi and Si-metal area and Norwegian speaking participants, all the later courses have been in English, with participation also from Elkem's North American plants.

In the 1993 and 1994 courses, participation from BHP / TEMCO was invited in addition, on the basis of the Elkem - BHP co-operation agreement.

The broad participation, with up to 14 different plants from three continents represented, has given an extremely good basis for fruitful discussions and exchange of experiences, and has been beneficial to the total program.

Any worries about problems using English as the course language have proved groundless. Actually, it has been claimed to be an additional benefit to the course that it provided useful practise in an important foreign language, a benefit which the American and Australian participants have been missing!

3.1.5. CEE Course at The Norwegian Institute of Technology (NTH)

Elkem University has established a good co-operation with NTH, and has used professional lecturers from several faculties, especially from the Metallurgical Institute.

For the 1994 course in Process Understanding / Furnace Operation this co-operation was further formalised, as this course was approved as a Continuing Engineering Education (CEE)* course at NTH. One implication of this approval was that the course was ended with an optional examination as for ordinary NTH courses. The two-week course gave two university credits**, and a third credit could be obtained by carrying out an additional exercise or minor project.

Although only a few of the participants were in a career or educational situation where official credits had any real significance, about one third of the group chose to sit the exam, and all of them passed. Actually, one of the participants had the Elkem University course defined as a part of his curriculum for his Dr.ing. (Ph.D.) study.

More important than the examination and the official credits is the fact that the course was approved as a CEE course at NTH, which can be considered as a quality assurance and an acknowledgement of the professional level of Elkem University.

4. THE NEXT STEPS

After four successive courses in Process Understanding / Furnace Operation time was due to shift focus, and to consider Elkem University courses also in other topics.

4.1. Aluminium Technology

In November and December 1994 a one-week course was arranged for two different groups totalling 31 persons from Elkem Aluminium Lista, Elkem Aluminium Mosjøen and Elkem Research.

The course was named Aluminiumteknologi I, and covered subjects such as physical metallurgy, alloying, and melt treatment.

The course Aluminiumteknologi I will be followed by Aluminiumteknologi II in 1995, with the focus on casting technology.

The one-week courses in aluminium technology have also received status as CEE-courses at NTH.

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* In Norwegian: Eksamensrettet Etterutdanning (EEU)

** 20 credits corresponds to a one year full time university study.

4.2. Maintenance and Operation

A major project on maintenance is being carried out by the ferroalloy divisions in Elkem, under the name VDL 2000 (Maintenance year 2000). Major aims are to define a unified concept for future maintenance, to establish standards and guidelines for terminology and key figures for bench-marking, and to develop tools and methods for reliability centred maintenance (RCM).

By the end of 1994 this project had reached the stage when transfer of project results and implementation at the various plants must be given the highest attention. And, based on the success with the Elkem University concept so far, it was decided to use Elkem University actively also in this process.

The first step along this line was to arrange a one-week seminar for technical managers and maintenance managers, in order to present and discuss the results and recommendations from the project VDL 2000. The seminar took place in November / December 1994, with participation from all Elkem's smelting plants in Norway, from Icelandic Alloys, and from Elkem Aluminium.

The next step in introducing "Elkem's future maintenance concept" is being planned as part of a new two-week Elkem University course, to be arranged in March and May 1995 (prior to the scheduled presentation of the present paper at INFACON).

This course will focus on the interaction between operation and maintenance. The results and recommendations from the project VDL 2000 shall be conveyed also to operations personnel. An objective is to achieve a mutual understanding and acceptance of maintenance as one of the main productivity factors.

Another aim is recognition of the interdependency between operations and maintenance personnel in order to optimise total plant productivity. Organisational development shall be treated, with focus on co-operation between operations and maintenance departments, integration between disciplines, and multiskill concepts.

Also, purchasing strategies and principles shall be treated in the context of contracting, specification practice, guaranties, and spare part policies.

An approximately equal participation by operation and maintenance personnel is anticipated.

5. "DATE-STAMPING" OF METALLURGISTS

A two-week course in "REFINING / POST TAPHOLE " is being planned in the fall of 1995.

What the next Elkem University course after that will be, has not yet been decided at the time of writing this paper. What *has* been decided, however, is that Elkem University shall continue in the form that has been established.

This means that successful courses will be repeated at suitable intervals, and new courses will be designed as new needs are revealed. It will always be a main objective to convey the most recent knowledge of state-of-the-art and results from the latest technology developments to the persons who shall use this knowledge and implement the development results in practice.

In order to achieve a lasting effect of this form of continuing education for the persons in question, it has to be repeated at intervals which cover suitable periods of technology developments. A descriptive term suggested for such a repeated educational updating is *date-stamping* of metallurgists and other graduate professionals.