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TRAINING FOR NUMERICAL CONTROL^{1/}

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One of the major problems in the introduction of numerical control (NC) has been in the mistakes made in the application of industrial training. There is a constant misconception that training in NC should be relegated to the role of preparing machine operators, part programmers and maintenance personnel. It is true that these important operating personnel must be trained eventually, but it is impossible to be specific in determining the training needs until some decision has been made as to the final machine tool/control system combination. Thus, the first order of business for training for NC must be in the preparation of those people who will be selecting and implementing the NC machine tools.

The cardinal problem in the introduction of NC into any geographic region has been either the lack of some formal training programme or the presentation of training which is very subjective in content. The initial step in NC training must be to cause as many people as possible in the engineering industries to recognize that numerical control is not just another, new machine tool. NC is a new manufacturing concept. Secondly, it is important that they understand that NC is a new manufacturing concept which is NOT primarily suited to mass production. As NC appears as a form of automation, it is most often considered to be a mass producing method. But experience has taught that NC has its greatest application in short run or small batch production. Getting these two important points across to the managers, supervisors and workers in the engineering industries, is of prime importance and represents a sizeable training task.

Virtually every method of industrial training known might be applied to completing these two major training tasks. There are several avenues of approach to this problem's solution through training, but there is no universal, solitary approach which is guaranteed to be most successful. Thus, the explanation which follows, is a result of time and effort in one geographic area and it may not be the method for every other area. The point is that we are dealing primarily with the philosophy of the training and secondarily with the method. The methods outlined are those we believe to be most effective, but they should be tempered by the actual conditions and situations in any area.

In North America, the various training activities have taken the form of seminars/workshops/symposia, correspondence or home study

courses, day and night classes, magazine articles, books, video tapes, etc. Though all of these methods have provided a definite training service, the single, most successful method has been the seminar/workshop/symposium approach.

The initial training activity in NC was preparing the sales engineers throughout the metalworking cities of the USA and Canada. These men had been instructed to sell the machines, but had not been told how the concept worked and what advantages and disadvantages are generally associated with it. These are the men who, over a period of time, will be in contact with every potential NC user and they must carry the ideas of NC to the men in the plants.

This training activity soon branched out to preparing potential users to understand the concept and its implications. Logically, the people from the engineering industries had to apply the general principles which were taught to their own, personal operations to understand NC's true implications for them. Thus sixty men in a seminar might possibly find sixty different possible situations where NC could work. Or thirty might learn that NC had very little potential in their plants at this stage of development.

The mass education of the engineering industries was approached through one and two-day seminars and workshops. These seminars were scheduled as often as deemed necessary to meet the demand and in geographic locations which were most suited to the students. Most often, the seminars were held in hotels or other public buildings so that representatives from several companies in the region could attend together. An important ground-rule was adhered to throughout the 500 seminars:

Proprietary information would be presented in the classes. The course of instruction remained strictly objective. Briefly, the syllabus for the seminar and workshops was:

- I. Introduction and Process Flow
- II. Fundamental Concepts of NC
 - A. Rectangular Coordinates
 - B. Machine Axis Designations
 - C. Dimensioning Requirements
 - D. Tool Design Considerations
 - E. Engineering Drawings

III. Part Programming

- A. Point-to-point
- B. Continuous Path

IV. Numbering Systems

- A. Decimal
- B. Binary

V. Tape Codes and Formats

- A. Character Codes
- B. Word Address
- C. Tab Sequential
- D. Variable Block
- E. Feed/Speed Codes

VI. Control Systems

- A. Servo Mechanism
- B. Basic Logic

VII. Advantages and Disadvantages

This syllabus was tailored by the instructor to best meet the needs of the personnel in attendance. By continually presenting this seminar, some 22,000 metalworking men became familiar with the concept and its potential (or lack of potential) in their respective plants.

By reviewing the materials continually and remaining open for questions, the misunderstandings and misrepresentations of NC (how and why it works) were generally cleared up.

One of the most important advantages to this training approach was that the seminars were not "selling" NC per se, but were answering questions and clearly stating the facts of the concept. It should be noted that many in attendance found that NC was not the "cure-all" for all manufacturing ills. They also found out that it was not generally applicable to mass production problems. This initial phase of training was aimed at providing the basic knowledge of the principles of the concept, so that the participants could judge what their next step should be.

The second phase of the training for NC was to get away from the generalities of the concept and to bring the training closer to "home" for those in industry. This has and is being accomplished by two special courses of instruction: the Numerical Control Coordinator Course and the Numerical Control Sales Engineers Course.

The NC Coordinator Course was so entitled as it is the most common job title for the individual(s) assigned the task of determining what the company should do in the field of numerical control. In the early stages of NC growth in North America, the initial decisions were the result partly of study, partly of thought and partly a hunch. (It was very common to hear manufacturing engineers refer to their first NC machine as an installation "to learn on". And, one of the first things they learned in many cases was that they had selected the wrong NC machine tool for their work.)

The training of NC Coordinators, who may well have another, official job title within their plant, is accomplished in one week of classroom work. This week is preceded by considerable preparation and data collection by the students and is followed by a 90-day period of free consultancy by phone or mail.

The objective of this arrangement was to minimize the amount of time the student has to be away from his plant and to maximize the resultant work within the plant without additional, outside assistance.

A brief syllabus for the course is:

- I. The NC Professional
- II. The NC Coordinator
- III. The NC Concept
- IV. General NC Application
- V. Parts Analysis
- VI. Selection of the Correct Machine Tool
- VII. Selection of Operating Personnel
- VIII. Training of Operating Personnel
- IX. Machine Foundations, Installations and Check-outs
- X. Tooling Considerations
- XI. Management Responsibilities
- XII. Implementing NC
- XIII. Future Considerations
- XIV. Plus Factor "A" - Retrofitting

The goal of the course is to assist the student in making his own decisions; not to make his decisions for him. Secondly, the course was designed and developed so that anyone familiar with conventional machining arts could apply the principles when he returned to his plant.

At one stage of the growth of NC in North America, sales engineers were requested by users to make final decisions as to which NC machine tool would be best for a particular company's operations. Their recommendations were relatively sound; if you consider the lack of knowledge on the salesman's part about the total company operation and the fact that they were most often based on "floor-to-floor" times.

The design and development of the NC Coordinator Course is based on the theory that NC would be greatly accelerated if each party involved (buyer, seller and builder) would be in a position to do their own "homework".

To accelerate this "homework" approach, the NC Sales Engineers Course was designed and developed. This is a companion course to the NC Coordinator Course and both courses should be presented at approximately the same time period.

Rather than teach the sales engineers to become consultants, the course is designed to augment the NC Coordinator Course so as to accelerate the purchase decision based on facts.

Briefly, the NC Sales Engineers Course syllabus is:

- I. Introduction and Administrative Details
- II. The Professional NC Sales Engineer
- III. The NC Concept
- IV. The Anatomy of an NC Purchase
- V. YOU, the Pro NC Sales Engineer
- VI. The Development of the NC Market

This is a two day course which has been presented regionally to reduce the travel costs for the sales engineers. It provides a background so that new sales engineers as well as those experienced in NC, may improve their respective markets.

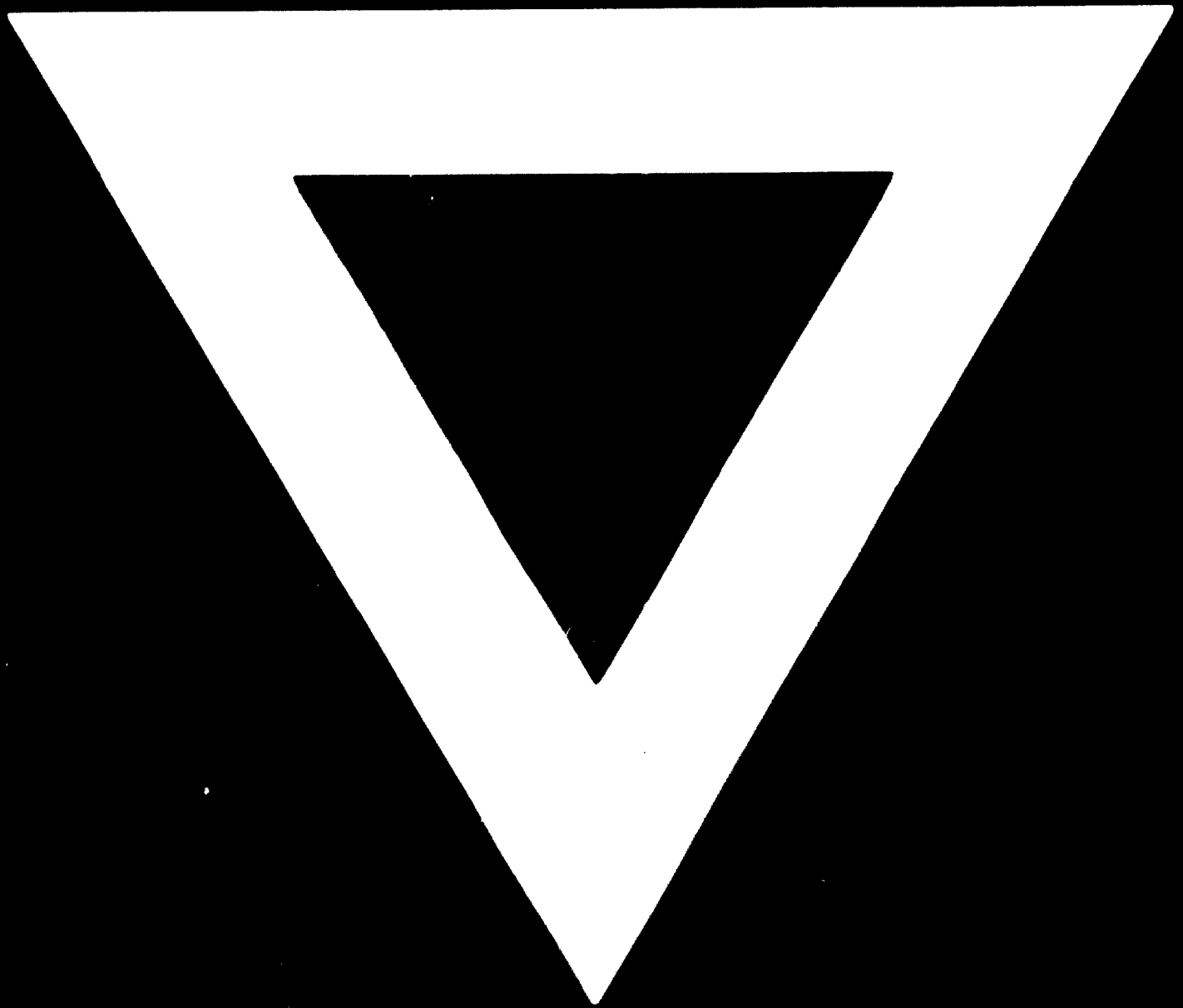
After the broad-brush approach of the basic seminar or workshop we follow with these two essential elements to NC growth: the NC Coordinator and NC Sales Engineers Courses. It is now possible to arrive at sensible, workable decisions concerning NC at a much more accelerated rate. When these purchase decisions are made, they automatically define the training requirements of operating personnel - part programmers, machine operators and maintenance personnel. This specialized training is normally conducted by the machine tool builders and/or the control system manufacturers. The course lengths vary based on the sophistication of the equipment being purchased.

Training can be the key as to whether NC, or any other new technology will be accepted or not. The magnitude of this training task can best be understood by repeating two basic considerations:

1. numerical control is primarily advantageous to short-run or small-batch production;
2. it has been estimated that 80 percent of the world's metalworking is accomplished today in short-runs or small-batches.

These two points dictate the immediacy with the initiation of NC training. Secondly, it points out the need for a sensible, practical method of initiating this training. The key word in any NC activity has always been "START".

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