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Regional Seminar on Machine Tools
for Countries in Latin America

16 to 25 October 1972
Buenos Aires, Argentina

26 to 27 October 1972
Sao Paulo, Brasil

P R O P O S A L

For the Establishment of a NC Machine Tool Demonstration Centre 1/

presented

by

the Secretariat of UNIDO

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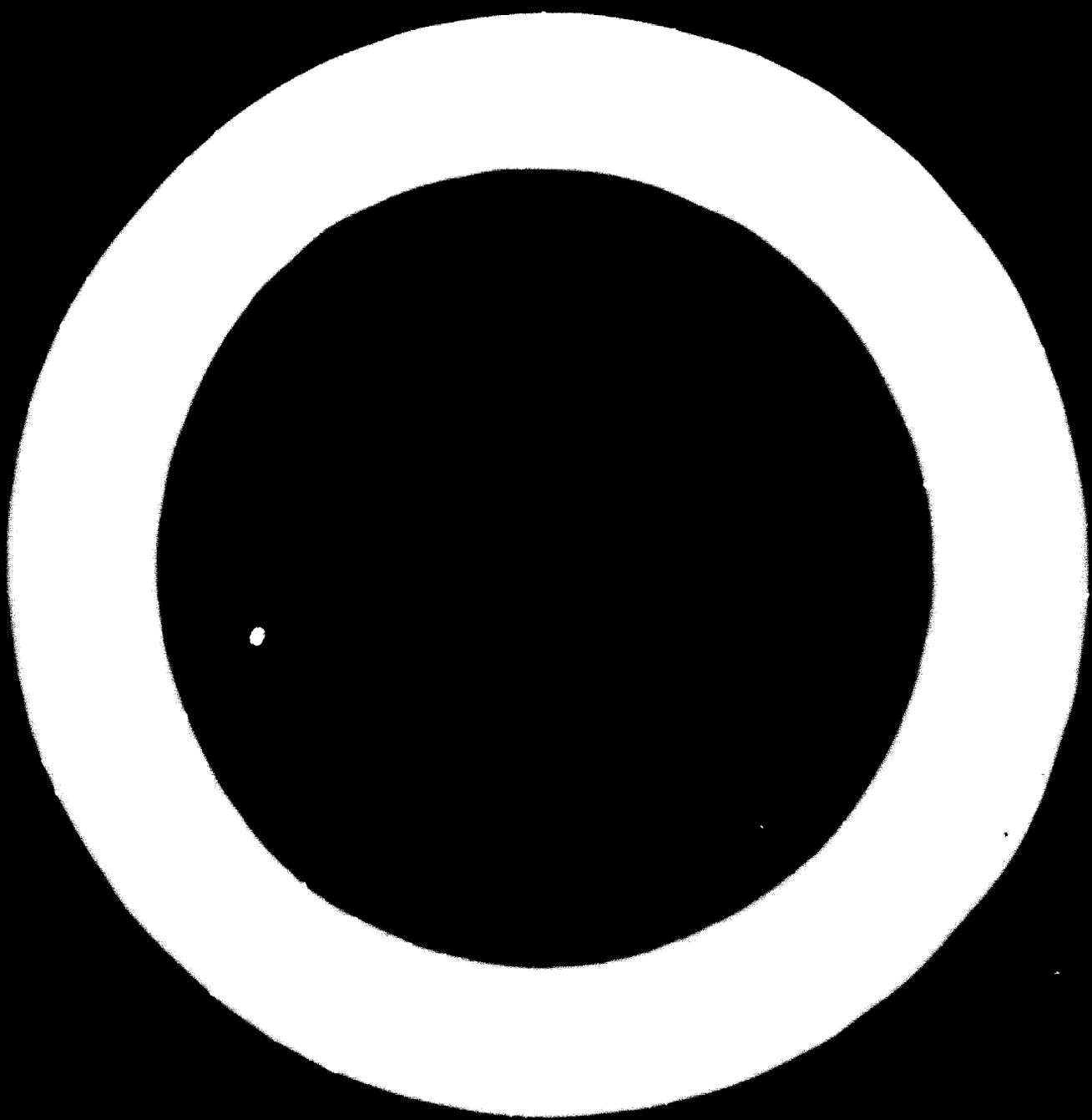


1. Introduction

The poor quality of production of various kinds of engineering products is the main factor which prevents most of the developing countries from expanding their industrial production, import substitution and export promotion.

Some of the developing countries have to buy tools, dies, jigs and fixtures needed for production. Some have to buy the proper steel in order to manufacture their own tooling. All these countries require foreign currency, which is very often not available in developing countries. Measuring instruments are required for the production of replacement and spare parts, and these are not always available in the workshops of developing countries. For the introduction and application of progressive measuring and controlling methods, financing as well as skilled labour is required.

The proper operation of machine tools only becomes possible if there are highly trained personnel available in the country, personnel who are not only able to read but who can also understand and interpret the most complicated blueprints in order to make use of the dimensional and quality control with tolerances expressed in fractions of millimeters. They must also be qualified to adjust at any given moment any deviation from the required tolerances in the operation of machine tools serviced by them.

The success of the development of the engineering industry depends not only on the stock of machine tools but also on the way in which these are used. Some developing countries have sufficient stocks of equipment which are not being fully and properly utilised. This means unnecessary expenditure for buying, servicing, repair and maintenance of machine tools. The effective use of machine tools is a very important factor in increasing productivity. Certain of the most intractable difficulties confronting the developing countries could in large measure, be resolved by the introduction of numerical control machine tools.

The main advantage of NC which may be considered relevant in the case of developing countries are:

- the reduction of setting up time
- the elimination of complex jigs and fixtures
- the improvement of quality
- greater accurancy and better repeatability
- substantial reduction in human errors
- the reduction of inspection and measuring instruments
- the possibility of using less skilled labour to operate the machine

But while it is no longer necessary to employ such highly skilled machine operators, programmers are required for the preparation of the control tape which raises the problem of training in addition to which there is the problem of maintaining a more complex machine with its highly sophisticated control system.

It has been found that the most effective application of NC machine tools has taken place in companies who have ensured that the production management have a clear understanding of the advantages and the limitation of the system and have introduced manufacturing procedures to fully exploit the potential of these machines.

2. Background Information

The numerical control (N. C.) of a machine tool is a device which provides for automation of a machining cycle on the basis of control information which it receives in the form of numerical data. This type of control which represents a particular type of sequence control is concerned mainly with the travel of moving parts like tool holders and work-piece holders. N. C. is a very important improvement in sequence control of machine tools because the travel of parts is no longer limited by stops which have to be adjusted with every change in the size of the work-piece, but by a feed-back system to the numerical control unit itself, which counts the extent of the movements as they are performed and stops them as soon as the desired dimension is reached. When the tape carrying the control instructions has been set up, and the tools set to a predetermined datum, no other adjustments of the machine motions have to be made at the beginning of the manufacturing process.

Numerical control provides automatic operation of machines while eliminating complicated jigs, fixtures and other expensive tooling. It makes it possible to pass rapidly from one manufacturing operation to another by a simple change of the programme tape and thus the useful operating time of the machine improves from some 20 percent or 30 percent to 70 or even 80 percent.

Numerical control increases the flexibility, versatility and performance of the machines to which it is applied. It reduces waitingtime due to passing parts from one machine to another, time spent in loading, setting, inspecting and unloading the work pieces. It is important to note that automation by numerical control is intended mainly for small and medium scale production. Mass production manufacturing processes, on the other hand, have long since been automated thanks to transfer machines and special machines designed in each case for the machining of a specific part.

The point-to-point system and the continuous path control system are the main N. C. systems which are complementary to each other. Continuous path control or contouring control, is a costly and complex system, which for the time being concerns only a small sector of industry even in the industrialised countries. It is designed for the manufacture of complex shaped parts of high accuracy, which are usually required by the aerospace industry. The special case of this type of control, however, involves problems completely different from those relating to the point-to-point system.

The point-to-point system, much simpler and considerably lower in cost, meets 80 percent of the needs of industry. In the initial stage, all efforts should be concentrated on this type of control. Furthermore, the use of the point-to-point system of numerical control does not necessarily require the use of electronic computers for programme preparation. In simple machining operations which are common in most workshops, manual programming is fully justified. Manual programming is quite sufficient for parts that require simple machining operations such as drilling, tapping, straight line or simple arc milling and plain turning, as long as the number of instruction blocks carried by the punched tape do not become excessive.

3. Description of the Project

Objectives

The main objectives of the establishment of a numerical control machine tool demonstration centre are:

- To provide an advisory service on the economic justification and selection of NC machines;
- To provide training for production managers on the problems associated with the use of NC machines, including the application of group technology techniques;
- To allow production engineers to see the practical application of numerical control under production conditions;
- To enable lectures on numerical control application and suitability for particular operations to be given in an appropriate industrial environment;
- To enable company managers to make preliminary decisions on the applicability of numerical control to their production requirements;
- To arrange courses for programmers on data programming and tape preparation, the main emphasis to be towards manual programming techniques but to give a brief introduction of the use of computers as aids to manual programming and for the complete production of control tapes;
- To advise on preventive maintenance, and run training courses which will be aimed at providing a good understanding of the control system and include fault finding procedures;
- To organize conversion courses for operators from conventional to numerically controlled machines;
- To arrange test runs on components supplied by industry to prove that it is both practical and profitable to produce components under numerical control;
- To provide a limited production service to enable companies who have decided to install NC machines to continue production of selected parts pending installation of the machines in the company plants;
- To provide a service on a commercial basis for the preparation of tapes for the smaller user who does not have suitably trained staff.

Note:

If the Centre is located in one of the more highly industrialized developing countries, it may be desirable to include detailed training in computer-aided programming. To do this it would be necessary either to have a small computer at the centre or to have a terminal giving access to a suitable computer. No recommendation on the type of computer or terminal and their cost can be given until it is known what programming

Note (continued)

language is to be used and the type of major computer which is available on a time sharing basis in the country concerned.

Duration

The duration of the project is expected to be three years. During this period United Nations' or other experts will train local personnel in accordance with the above-mentioned objectives.

Outside Contribution

An outside contributor is expected to provide the services of experts, fellowships and equipment:

(a) Experts

	Duration	Cost US$
Project Manager (NC machine tool engineer)	36 mm	90,000
NC machine tool operator	18 mm	45,000
NC Maintenance engineer	18 mm	45,000
NC programme engineer	18 mm	45,000
SUB-TOTAL	90	225,000

(b) Fellowships

NC Manager	6 mm	3,000
NC Maintenance engineers (2)	12 mm	6,000
NC Programmers (2)	12 mm	6,000
NC Machine tool operators (2)	12 mm	6,000
SUB-TOTAL	42 mm	21,000

(c) Equipment 1/

Vero turret NC drilling machine	54,000
Cincinnati 2V-100 vertical NC drilling machine	36,500
Herbert/De Vlieg horisontal spiramatic jigmill with NC control	62,000
D.S. G. 2112 x 60 lathe with Ferranti Acculin digital read out system	19,300
D + D Accuratool plugboard 1" diameter, turret lathe	9,700
Ferranti Conquest digital inspection machine	21,000

1/ This provisional list of equipment is subject to changes; the final version will be prepared by a consulting firm or the project manager on the spot.

Tool Servicing machines:

Brierley ZB 32 drillpoint grinder	1,800 US$
Hunt DG 100 drillpoint grinder	5,650 US$
J + S 310 tool and cutter grinder	4,080 US$
Carbide tapping machine	1,500 US$

Cutting tools, measuring equipment etc.

Drills, milling cutters, boring bars, turning tools, surface plates, clamps, blocks, dial indicators, micrometers, height gauges etc., and tools storage cabinets	26,000 US$
Work storage racks and hand truck	2,000 US$

Tape preparation equipment

Friden Flexowriter tape punching machine	**6,900 US$**
Tektronix tape programme verifier	**12,720 US$**
Tektronix hard copy unit	**4,150 US$**

Services of engineers for special assistance in setting up NC machines	**4,000 US$**

Office and Lecture Room equipment

Desks, chairs, typewriters, photo-copier, cupboards, filing cabinets, cine projector screen	5,000 US$
SUB-TOTAL	276,300 US$
TOTAL	522,300 US$

Government Contribution

(a) Local Staff

NC Centre Director	1
Programming Engineers	2
Electronic Maintenance Engineer	
NC Machine Demonstrators	3
Typist/tape machine operator	
Secretaries	2
Cleaning ladies	2
Total:	10

Government Contribution (continued)

(b) Building 1/

Demonstration hall	210 sq. m.
2 small lecture rooms	70 "
Manager's office	25 "
General office	60 "
Toilets, passage and store	60 "
	425 sq. m.

Based on a cost of US$ 220 per sq. m. including professional fees, excluding site and roads . . . . . US$ 93,500

Detailed description of the equipment

Each of the machines has been carefully selected to comply with the overall objectives of the Centre and to provide facilities for the demonstration of specific aspects of numerical control application in the manufacturing process. Drilling, boring and milling are the most important areas for the general use of NC in the batch production industry.

The Vero turret drill meets the requirement of a versatile drilling machine capable of completing most operations with the six tool positions available. Tool changing or a second machining operation thereby being eliminated. Very light milling operations, such as milling small keyways or cutting small channels can be performed on the machine at the same setting as the drilling operations. Programming and setting up the machine are particularly easy.

The Cincinnati vertical single spindle drill meets the requirements for a machine where only one or two tools are necessary for the operation. It can also be used where more tools are required than can be accommodated in a turret drill, but this requires a high skilled operator to cope with the frequent tool changing, or serious damage may be done to the component or even the machine if an incorrect tool is loaded. The machine spindle is more robust than on a turret drill enabling heavier milling operations to be undertaken, as well

1/ Layout subject to changes; the final version will be prepared by a consulting firm or the project manager on the spot

as light boring operation. [illegible] this machine is easy to programme and select.

The Herbert Le Vil[illegible] boring [illegible] NC Skymill is an extremely accurate horizontal boring machine with an indexing table which is capable of undertaking the complete drilling, boring and milling of box type components. It can therefore complete the work which would be undertaken on a machining centre, but requires manual changing of the tools. The spindle carrier is designed for heavy milling operations so that the machine is also fully capable of being used as an NC milling machine. This machine therefore can perform as a boring machine, or a milling machine or a machining centre with manual tool change.

The DSG lathe is fitted with Ferranti Acculin digital read-out rather than an NC system as numerical control is unlikely to be adopted in the developing countries during the present decade as the principal advantage of NC turning is the faster operation rather than any specific increase in accuracy solely achievable with NC. The accuracy and repeatability can be achieved with the read-out system at much lower cost. It is therefore desirable that management should become familiar with this type of equipment.

The D + D plugboard turret lathe is a good example of how the versatility of a machine can be greatly increased through simple control systems. Turret lathes have not been sufficiently accepted in most developing countries so that this small example of such a machine with the added versatility of plugboard control can be used to show the advantages of this type of machine and also the control system. Plugboard controls are applicable to many types and all sizes of machines. Plugboard control is often regarded a useful halfway stage from manual machines to full numerical control.

The Ferranti Conquest digital inspection machine enables accurate verification of drilling, boring and other machining operations to be undertaken with great rapidity. The machine is also a useful means of demonstrating the use of digital read-out systems for machine measurement.

The Brierly drill point grinder which is only available for drills up to 30 m.m. and the Hunt drill point grinder for drills up to 100 m.m. are essential for the successful application of N. C. drilling. The N. C. drilling machine relies on the accuracy of its spindle for the accuracy of the hole position instead of a drill bush alone to do the work. The drill must therefore be free from deflection caused by bad drill point geometry. This can only be achieved by accurate machine grinding. It is also usual practice when drilling in solid metal to use a spiral point instead of the chisel point, as this further reduces the likelihood of defflection. These machines have the capability to produce this point form.

The J + S 310 Tool and Cutter Grinder, is necessary to ensure that the milling cutters and boring tools used on the drilling and boring machines are ground correctly, and thus capable of efficient operation. The speed and feed rates for NC machines are established by the programmer who will assume that the tools are in suitable condition for use. Therefore if tools in need of regrinding are used, work may be spoiled or even tools may be broken. The tool and cutter grinder can also be used for small surface grinding operations such as minor adjustments to setting blocks.

The carbide lapping machine will be used for the final edge treatment of the carbide cutting tools after grinding.

The Friden Flexowriter is a machine widely used for the preparation of tapes from manually prepared programmes.

The Tektronix tape verifier enables the instructions contained in the tape to be checked without actually running the operation on the NC machine. Most programmes can be improved after a study of the actual errors which must be corrected before the tape can be used to produce a correct component. The verifier is also an excellent low cost item of equipment for training purpsoes as the programme can be seen visually, tape amendments made and the programme viewed again. All this can be done in the classroom without disrupting work progressing on the machine tool. The hard copy unit enables a permanent record to be made of the trace from the CRT.

The tooling to be of the latest design using throw-away tips, micro-bore tools, presetting devices and other modern aids to assist with the rapid manufacture of parts to a high degree of accuracy.

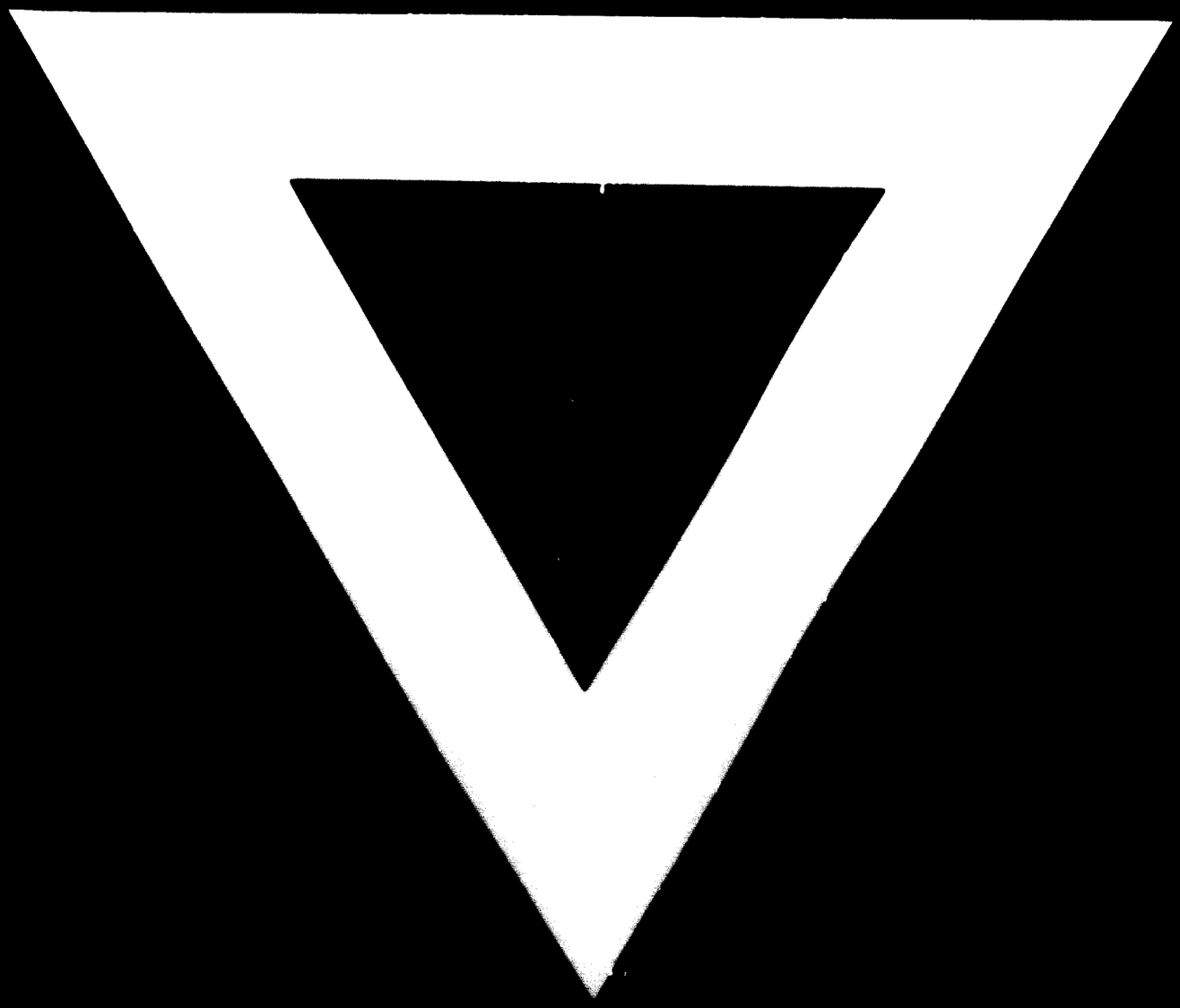
The Building

The building should be designed to create an industrial atmosphere in the demonstration hall with adequate height for the machines, but should also have suitable, wall, floor and roof finishes to permit absolute cleanliness to be maintained. Storage areas separated from the hall will be required.

The two lecture rooms should be provided with facilities for viewing films and slides, so that natural light must be excluded when necessary. The rooms should be adequately sound-proof so that machine noise does not cause disturbance and should have accoustic ceilings to provide good conditions for the speakers.

The manager's and general office require no special features, but should provide good working conditions.

If the centre is located in an extremely hot climate it would be desirable for all areas to be air condit oned.



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