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9. ABSTRACT
A team of Soong Jun University and Georgia Institute of Technology staff members conduc productivity improvement research on the operations of the Yong Jak Fishing Pole Factor in Yong In, Korea. This rurally located labor-intensive industry employs 50 persons in the production of 120,000 bamboo fishing poles per year.

Identified problems include large raw material inventories, dependence on a few customers, peaks and valleys in business volume, bottlenecks in the production process, lack of product diversification, and lack of strong financial resources. Production bottlenecks include inefficient space utilization, back flow of materials and people in the plant, excessive paint drying times and goods in process storage, inordinate employee time consumed in hand matching bamboo sections.

Recommendations for improvement are made in the areas of marketing, facilities, and production. Marketing recommendations focused on pole standardization, diversification of products, development of promotional literature, new customer development, and utilization of available technical assistance. In the facilities area, a new layout and a revised work flow were designed to reduce materials handling. In the production process, changes were recommended in selection of bamboo sections, sizing by gauging, and in the reaming, boring, winding, plugging and painting operations.

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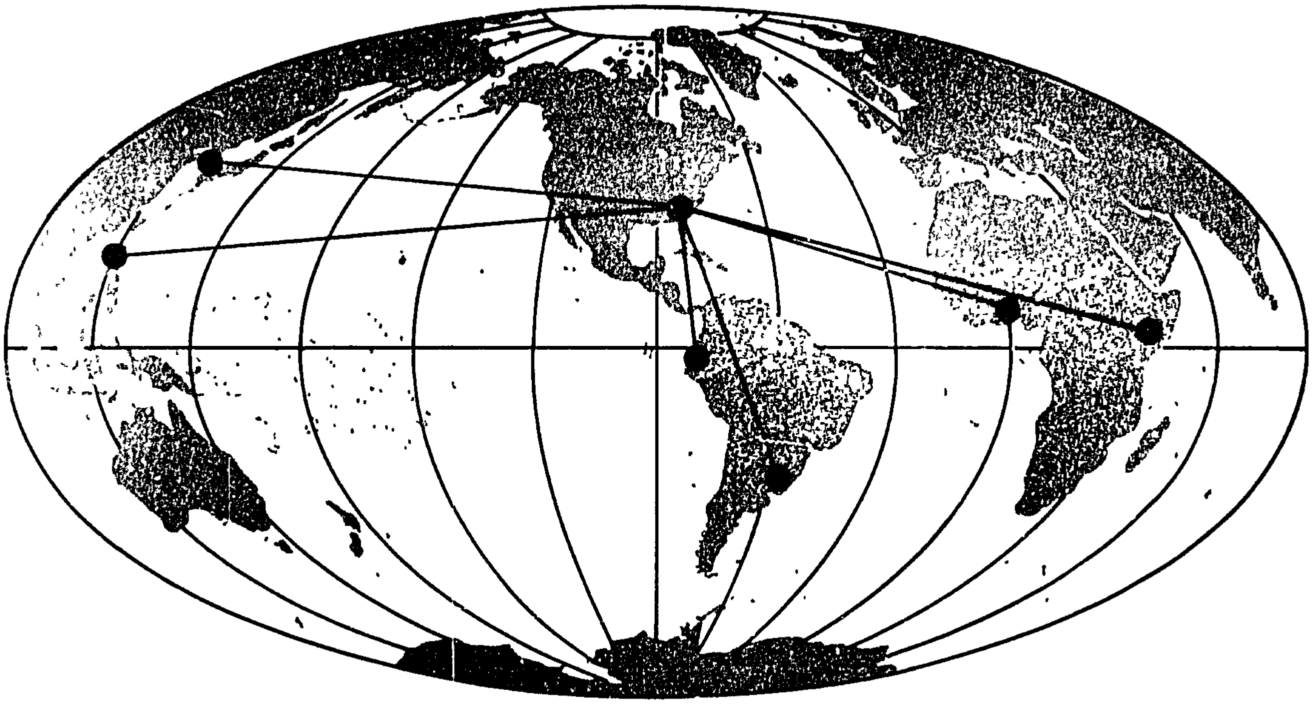

IMPROVING THE PRODUCTIVITY OF A SMALL INDUSTRY IN RURAL KOREA

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

IMPROVING THE PRODUCTIVITY OF A SMALL INDUSTRY IN RURAL KOREA

A Team Research Project of
Soong Jun University, Seoul, Korea
and the
Georgia Institute of Technology

Report by

Herbert Eller
Ross W. Hammond
Ben E. James, Jr.

Funded by the Agency for International Development

Georgia Institute of Technology
Atlanta, Georgia
December 1974

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Foreword

As part of Georgia Tech's five-year program (US/AID-funded) to expand its existing capabilities in employment generation through small-scale industry development, a cooperative relationship was established with Soong Jun University in Korea. This is an innovative private institution interested in developing an educational curriculum and research thrust which is highly relevant to the fast developing Korean economy. Under President Hahn Been Lee, a gifted and progressive Korean, such a program has been organized and implemented, and identifiable results are now being obtained.

One of the first projects to be initiated by the two institutions was a joint staff research study of a small labor-intensive industry to determine how its productivity could be increased without displacing employment. Because of Soong Jun University's interest in starting an industrial engineering curriculum in its engineering school, it was decided the project team would take an industrial engineering approach in conducting this research effort. (See Appendix A for methodology employed in the analysis.)

An initial visit to the Yong Jak Factory in Yong In, Korea, in December 1973 was made by faculty members of Soong Jun University and Georgia Institute of Technology. This plant produces bamboo fishing poles, primarily for export.

Subsequently the factory was visited in March and on a number of occasions in June 1974, when considerable data were collected and analysis was done. Another series of visits occurred in October and November 1974. The intermittent nature of these visits coincided with the visits of Georgia Tech personnel to Korea, when team interaction became possible.

This report results from the joint efforts of the Soong Jun/Georgia Tech team, although it has been written by the Georgia Tech staff. The team hopes that it will serve as a demonstration of some techniques that can be useful in small industry problem-solving in Korea. Those members of the Soong Jun faculty who were not involved may benefit from reading it, and it may be of assistance to anyone in education, government, or industry who is concerned with small industry problem-solving.

The members of the team who were involved at various times during the study included the following:

Soong Jun University	Georgia Tech
In Suk Choi	Herbert Eller
Yong Ho Lim	David E. Fyffe
Yoon Bae Ouh	Ross W. Hammond
Clarence Prince	Ben E. James, Jr.
Gyang Gap Yang	William T. Studstill
Jae Bok Yoon	Nelson C. Wall

As of this writing, some preliminary recommendations have been made to the Yong Jak Factory management by Soong Jun faculty members, and a number of interactions with Soong Jun University personnel are occurring. With this report in hand, it is anticipated that the factory management, with the continuing assistance of Soong Jun University, will be able to effect changes which will substantially increase production.

As always, comments and suggestions from the reader will be appreciated.

Ross W. Hammond, Chief
Industrial Development Division
Engineering Experiment Station

Summary

The Yong Jak Fishing Pole Factory produces various styles of bamboo fishing and ski poles for overseas markets in Japan, Canada, and France. The management wishes to expand its markets and production volume.

A team of Soong Jun University and Georgia Institute of Technology staff members has worked closely with the factory management in a research project on ways to improve productivity.

The company has a number of barriers to developing a larger volume of activity, including large inventories of raw materials, relatively few customers, peaks and valleys in receipt of orders and production for orders, bottlenecks in the production process, lack of product diversification, and lack of strong financial resources.

The present factory capacity is about 120,000 bamboo fishing poles of various types per year, produced on firm orders from abroad. Orders to date from Japan, France, and Canada have kept a factory staff of 50 people employed in a facility of approximately 6,200 square feet or 576 square meters.

Major production processes include storage and drying of green bamboo; cutting heating, and straightening of bamboo sections; reaming, boring, and grinding of section ends; winding ends of sections with thread; and painting of windings.

As these processes were observed by the university team, it was apparent that major bottlenecks existed in four areas:

1. Space utilization was not maximized, and work flow included much backtracking of materials and people in the plant.

2. The painting operation required one third of the production space and had excessive drying times and goods-in-process storage requirements.

3. Too much employee time was consumed in making a preliminary selection of bamboo sections for the fishing poles and in individual sizing of section ends to permit joining the sections.

4. The need for dimensional sizing and interchangeable sections was apparent to facilitate mass production of the fishing poles.

Based on various analyses of the factory over a period of time by the university team members, a number of recommendations evolved in the areas of marketing, facilities, and production.

In marketing, recommendations were developed on pole standardization, diversification of product, development of promotional literature and new customers, and the full utilization of technical assistance from Soong Jun University and other sources.

In the facilities area, a suggested new layout and work flow were designed to reduce materials handling.

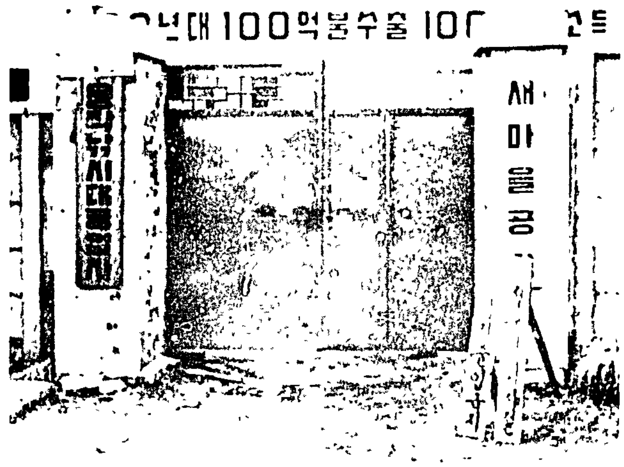
In the production process, a number of changes were recommended concerning selection of bamboo sections, sizing by gauging, and improving the reaming, boring, winding, plugging, and painting activities.

The intent of all of the recommendations is to suggest low cost methods for increasing productivity, which would permit the company to increase production and create new jobs and to more effectively utilize existing building and facilities.

BACKGROUND

Business History

The Yong Jak Factory at Yong In, Korea, was started by an entrepreneur in order to take advantage of the Korean Government's incentives to promote development and growth of Sae Maul (New Village) industries. The owner has many other business interests and participates very little in the day-to-day management of this company, which produces various types of bamboo fishing poles. These poles vary considerably in length and price and were originally designed for Asian markets.



Initially, the Korean Government identified a specific purchaser in Japan for the company's product and offered various incentives to potential manufacturers in order to attract an entrepreneur to create the fishing pole factory. Once the Yong Jak Factory started, however, and the initial order of fishing poles was produced, the original intended Japanese purchaser would not accept the order. The owner then, with the assistance of the Korean Government, located another Japanese buyer. The alternate buyer, however, was only interested in the lowest priced line of fishing poles. It was apparent to the owner that his company could not be sustained solely by sales in the low end of the product line.

Subsequent to the initial team visits, orders for bamboo ski poles were received from Canada, and a fishing pole order was received from France. According to the owner and plant manager, if the company could locate new customers in Europe and North America who would be interested in purchasing higher quality fishing poles, they could achieve a better balance between the low end of the line and the more profitable higher quality end of the product line.

Initial General Observations

This plant purchases large volumes of bamboo during the harvesting season and produces fishing poles during the year to specific order. Many intermediate steps and processes occur between the receipt of the green bamboo and the shipping of the ultimate product.

Readily identified problem areas include the following:

1. Large inventories of raw materials and finished goods.

2. Initially, there was only one major purchaser of products -- Japan (customers in Canada and France were later added).

3. There was no regular flow of orders and production scheduling consequently fluctuated. Orders sometimes had production deadlines which could not be met.

4. Little promotion or advertising of its product is done by the company.

5. Orders placed were for the low-cost line of poles. Profit margins in the higher quality lines are better, but there were few orders.

6. Product diversification was needed. A ski pole order helped in this regard.

7. The plant, with a production output of about 10,000 poles per month, needed to increase its production per month to meet new orders.

8. Every operation was manual. Much hand-fitting and custom work were involved.

9. Most production was achieved by workers who sat on the floor. This slowed down the flow of in-process goods in the plant.

10. Materials handling was entirely manual.

11. The financial structure of the company, like most small enterprises, was not strong. Hence, recommendations for change and production improvement had to involve a minimum of capital investment.

EXISTING CONDITIONS

Product Lines

The products manufactured by the Yong Jak Factory consist of various styles of bamboo fishing poles and some ski poles. The major differences between the styles of fishing poles are the length of the winding of the joint for reinforcement and external appearance, painting, length, and hand finishing. The wholesale price varies from $0.30 to $4.00 per unit. Materials used in the plant include bamboo, cotton yarn, balsa, paper, mineral spirits, varnish, and lacquer. (See Appendix B for sketch of fishing pole assembly.)

Production Plan

At present, fishing poles are produced only on firm orders. There is no uncommitted in-process or finished goods inventory. A large stock of uncommitted raw material (untrimmed bamboo) is maintained in anticipation of firm orders.

Marketing

Up to the end of 1974, the company has produced fishing poles primarily for export to Japan. The maximum annual sales thus far have been around 120,000 units. However, the owner has estimated that the sales volume could be increased considerably if proper efforts were devoted to developing new foreign and domestic markets. As previously noted, the owner's immediate objectives are to develop European and North American customers for his "top-of-the-line" products so that he can ultimately phase out his unprofitable "low-end-of-the-line" items.

It was observed during this study that potential customers are becoming aware of the company and its products by indirect means and are making inquiries about prices and delivery dates. One French firm placed a trial order for 13,000 units, and this order has been produced. A firm in Canada sent a sample bamboo ski pole along with a request for a quotation, and this resulted in an order which has been filled. While this product does not have the profit potential of fishing poles, additional orders could be used as a good fill-in product to level out production variances.

Personnel

The Yong Jak Factory employed approximately 50 people during the analysis period. The management staff includes the owner, a general manager, an assistant general manager, and a part-time clerk. The general manager is responsible for production, product design, personnel, accounting, purchasing, and shipping. He is engaged in every phase of the firm's operations.

It was disclosed that, because of a shortage of housing in Yong In, labor is in short supply in the area. This was of concern to the general manager since, if sales volume were to increase according to the owner's desires, the semiskilled labor required to produce the incremental units would be difficult to acquire. Hence, increased productivity on the part of the present labor force would be extremely significant.

Manufacturing Facilities

Site and building. The building is a single story, concrete block structure of approximately 6,200 square feet (576 square meters), situated on approximately four acres (1.6 hectares) of land. The outside area immediately surrounding the building is used for incoming raw material storage and raw material drying. The building has masonry interior load-bearing walls and narrow doors, which tend to restrict the smooth flow of materials through the production process. There are no provisions for central heating or ventilation.

Process equipment. Major pieces of equipment include small charcoal heaters for the initial straightening, electrically operated circular saws, electrically operated multi-spindle spade drills, manually and foot-pedal operated joint winding lathes, and wooden bins for painted in-process storage. Hand tools include small knives, straightening jigs, and paint brushes. Maintenance tools are very crude.

Production Processes

Incoming material. Bamboo is delivered by truck and stored in the outside yard area.

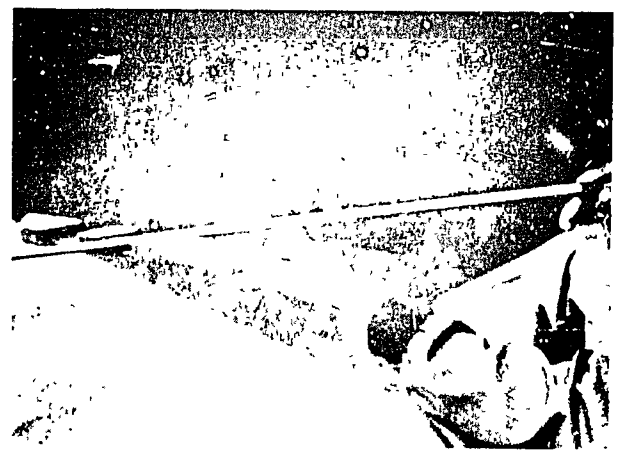
Drying. Bundles of bamboo are opened and arrayed in loose conical stacks to facilitate air drying. During the rainy season, the drying operation is conducted inside the large south wing of the building. Drying time ranges from one month to six months depending upon the weather.

Selection. By means of visual inspection and intuitive decisions, an operator will select and cut the necessary number of bamboo sections to complete a fishing pole assembly. This fishing pole assembly may consist of from three to eight sections, with each section being slightly smaller than the next as you progress from the handle of the fishing pole toward its tip. These sections, which comprise an assembly, are maintained as a unit by means of rubber bands as they are moved through successive operations.

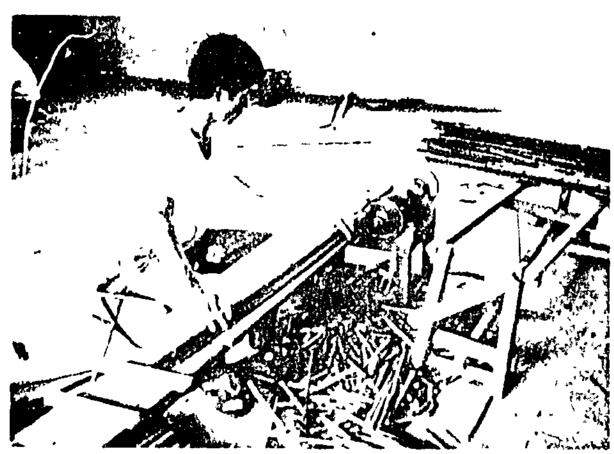
Reaming. Each section of the assembly is hollowed out along its entire length by a reaming operation before heating and straightening. This operation consists of manually forcing the bamboo section down over one spindle of an inverted multi-spindle spade drill. Different diameter sections are reamed by the various sizes of spade drills driven by the electrically operated multi-spindle drill. This permits air to escape during heating, which reduces internal pressure and splitting of the bamboo.

Initial straightening. An operator sights each bamboo section along its length to determine how much straightening is required. The bamboo section is then made temporarily plastic by inserting it into a small charcoal heater. It is then withdrawn and, while still in a semi-plastic state, it is straightened by applying hand force opposite to the curvature with a wooden jig. Upon cooling, the bamboo achieves a permanent set in the corrected configuration.

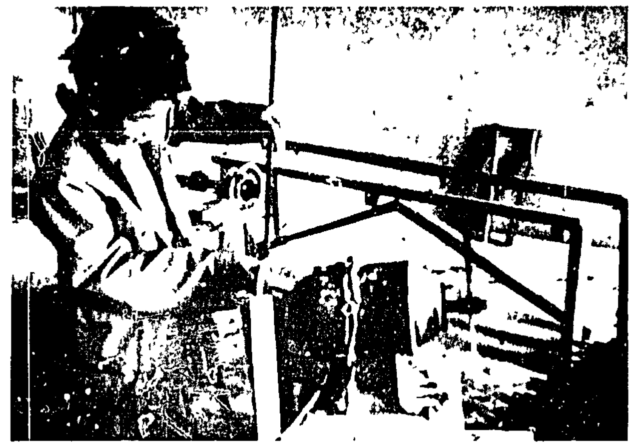
This process is repeated as many times as is necessary to convince the operator that the piece is "straight." Each bamboo section of the complete assembly is straightened in this manner.



Cut-to-length. An operator cuts each section of the assembly to the proper length by using a small electrically operated table circular saw. The butt end of each section is cut off immediately below a joint. This end is then placed against a predetermined stop on the saw table, and the smaller end is sawed off to produce the desired length.



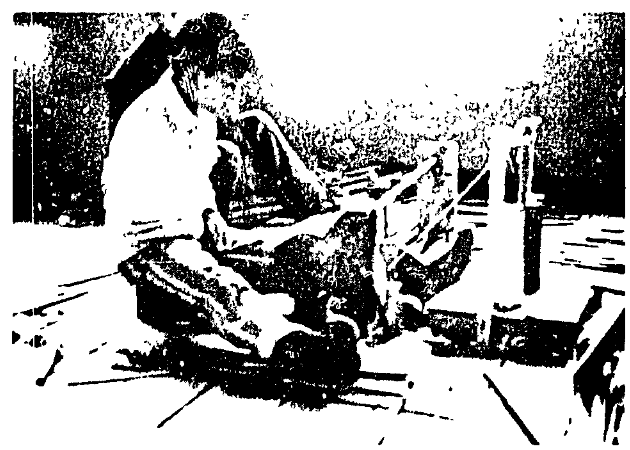
Grind. Each section of the assembly has every joint externally hand ground so that it is flush with the adjacent surface of the bamboo section. This is a manual operation using a small electrically operated bench grinder.



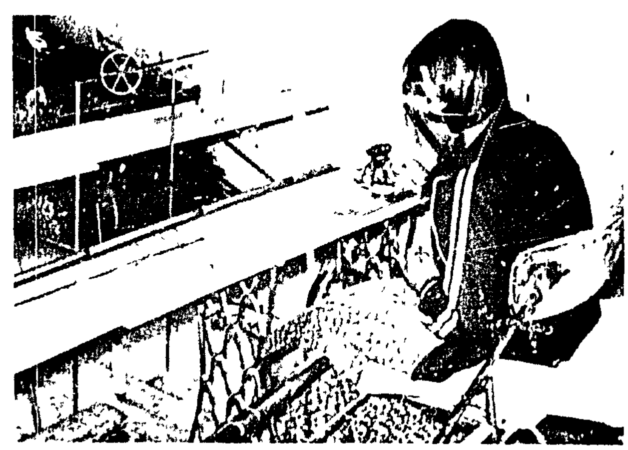
Mark. Each joint of each section of the assembly is hand marked for the proper location and length for winding.

Buff. Each joint of each section is then buffed in the areas where the cotton windings will be located. This is done by using a small electrically operated bench-type rotating wire brush.

Wind. Each joint of each section is then wound with cotton yarn. (See Appendix C for sketch of typical wrapped joint.) This winding covers approximately eight inches with the joint at the center. This operation is performed with a simple hand-powered winding lathe. The bamboo section is secured in the lathe. The operator then feeds the cotton yarn with his left hand while powering the lathe by means of an eccentric and a stick held in his right hand. After all joints of all sections in the assembly are wound, the assembly is then rebanded.

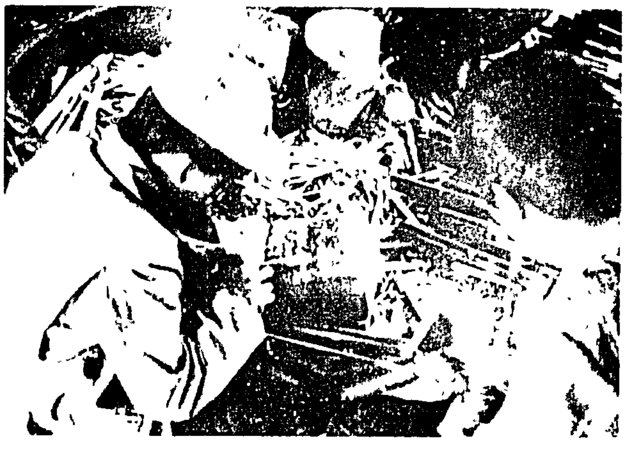


The research team initially observed that most factory employees worked seated on the floor. The team felt that certain operations could be more efficiently performed while the operator was seated on a chair or stool in front of a work surface at table height.



In particular, it was suggested that the thread-winding operation be performed off the floor. Management accepted this recommendation and placed two winding lathes on table tops. Utilizing the foot-pedal mechanism from sewing machines to operate the lathe mechanism, both hands of the operator were then free to feed the thread onto the bamboo sections (see picture on preceding page). This new method considerably accelerated the winding process and provided a more uniform winding on the sections, thereby improving productivity and quality.

Cut and assemble plugs. This operation is performed by an operator whittling down a small piece of wood approximately two inches long until it fits snugly into the hollow butt end of the section. It is then removed, glue applied, reinserted, and then cut off flush with the end of the section. The sections are then reassembled into a bunch and rebanded.

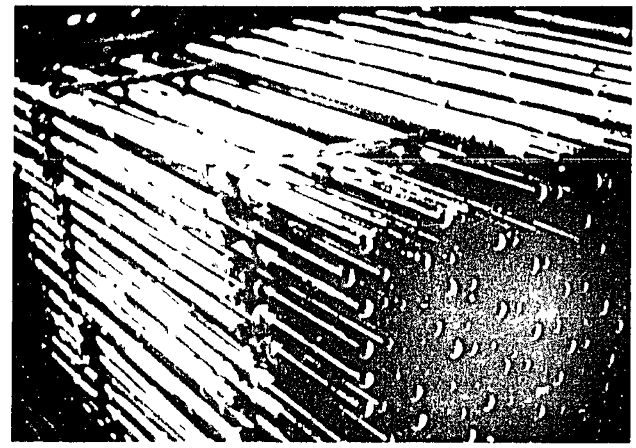


Grind. Each section is ground smooth on the butt end where the wood plug has been previously inserted and glued. This operation is performed manually with a small electrically operated bench grinder.

Paint windings. Each cotton wound joint of each section is hand painted with black paint. This paint serves to hold the cotton windings in place and acts as a primer for subsequent coats of paint.

Bore sockets. Each section is counter-bored in its open end to a depth of approximately four inches. By using various size diameters of boring tools (similar to reaming tools used in the ream operation), the section is counter-bored so that the butt end of the next smallest section in the assembly will fit snugly into the counter-bored length.

Paint. Each cotton wound joint of each section is hand painted with black lacquer. It is cross-stacked and then allowed to dry. After drying, it is hand sanded with very fine sandpaper. This has the appearance of a smooth plastic sleeve. During these operations, the assemblies are disassociated. Butt sections are accumulated in a bin, number two sections are accumulated in another bin, and so on.



Final assembly. Sections are taken from each storage bin and are selectively fit until a complete assembly is accumulated.

Final inspection and straighten. Each section is held briefly over a small flame and hand straightened.

Package. After final inspection, the disassembled sections are placed in either a cloth or plastic bag and secured on the end with a rubber band. Two of the sections of each fishing pole are inserted into two of the larger sections before packaging.

IDENTIFICATION OF BOTTLENECKS

During the period of the study, a number of changes were instituted by the company management as the result of on-the-spot recommendations. A number of continuing bottlenecks which appeared to hamper productivity increases were identified. These became the main areas of study and most of the recommendations contained in this report are related to the major bottlenecks. It was felt that if the bottlenecks in the operations could be reduced or removed, major breakthroughs in productivity might be achieved. These bottlenecks were identified as the following:

1. Space utilization and work flow. An analysis was made of the existing layout, production processes, and the movement of raw materials, goods in process, and finished goods. A number of space-related work flow problems were identified. Then, after considering production alternatives, a proposed layout to eliminate backtracking of goods in process was developed. This layout is discussed in detail in the section on "Recommendations."

2. Painting. The painting operation required about one third of the space allocated to the production of fishing poles. This was due to the number of employees involved in the operation and the relatively large amounts of space allocated to drying and storage of the fishing pole sections. It became obvious that a major revision of this process would be needed before substantial layout changes could be made.

3. Selection of fishing pole sections. A large amount of employee time was spent in a preliminary selection of graduated size bamboo sections, which were fastened together and went through processing into fishing poles as a bundle. However, in the painting step the bundles were broken up and, after painting, were placed in storage bins by size of section. When final assembly of the fishing poles was made for shipment, the individual sections again had to be selected and fitted by hand.

The need for the first selection and combination into sets and bundles was questioned since the sets were later broken up in the painting process and still later reassembled in different combinations.

4. Dimensional sizing. The above problem appeared to be related to the selection of each fishing pole section so that it would fit into the next larger section snugly, permitting the assembly of three- to six-unit fishing poles. In any two adjoining sections, one had to be reamed and the other ground so that the sections would fit together properly; thus the matter of sizing the bore and grinding the inserted end became critical. A great variety of reaming tools were used, and it was obvious some standardization in sizing was needed to permit interchangeable parts and reduce the time consumed in fitting sections.

RECOMMENDATIONS

The following recommendations for increasing plant productivity are grouped under three major headings -- marketing, facilities, and production -- and suggestions for implementing the recommendations are included at the end.

Marketing

Standardization of Relatively Few Types of Fishing Poles. It is recommended that efforts be made to promote customer acceptance of relatively few standard style fishing poles. The most obvious beneficial results of this will be reduced custom styling and processing. It will also permit greater utilization of mass production techniques and will permit production leveling by the ability to produce for inventory when advantageous.

Diversification of Products. It is recommended that increased efforts be made to diversify products by generating sales of other product lines, such as the bamboo ski poles that are simple in design, mass producible, and easily packaged and shipped. The advantages of this would be to increase revenue without placing too many demands on available labor or specialized production equipment.

The Need for Company Promotional Literature. Company promotional materials (descriptive brochures containing pictures and data on the products) should be developed (in Korean, Japanese, English, and perhaps French) for use in mailouts to sporting goods wholesalers in various countries. Soong Jun University can provide assistance in preparing the brochure, translation, and in obtaining customer mailing lists.

The Need to Develop New Customers. The company management must continue to seek new customers and find additional manufacturers' representatives in order to expand volume and increase exposure of its product to potential buyers. It is imperative to develop a broader base of repeat customers to relieve the company of dependence on a few customers and to smooth out the flow of orders for products.

Utilization of Technical Assistance. The technical extension services and information available from any and all available reputable sources should be fully utilized and recommendations implemented wherever feasible and possible.

Facilities

Plant Site and Building. It appears that the present space, both outdoors and indoors, is adequate for present production levels. With substantial changes in production layout, it is believed that an expansion in production of up to 50% with the present site and building could be achieved. It was observed that the building was constructed with little consideration of the manufacturing process. Many of the doors are offset from a work place in one room to the next process work place in the adjoining room. This makes work flow awkward and materials handling distances excessive.

Present Work Flow and Plant Layout. The present work flow is shown in Figure 1 in the form of a flow process chart. This describes, in order of occurrence, the various operations, material physical moves, inspections, delays, and storage of goods in process and finished goods. Its use permits one to analyze the steps in the manufacturing process, the movement in the plant of the materials and the operations which require long periods of time for completion. For example the flow process chart indicates a total of 72 hours of drying time after various coats of lacquer are applied to the sections of bamboo. It also indicates that the bamboo sections move 244 feet (74.37 meters) in the plant in the course of being processed into fishing poles.

The present plant layout and actual flow of the material in the plant is shown in Figure 2. The location of the various operations in the plant is shown in accordance with major operations listed in the preceding flow process chart (Figure 1). There is considerable movement of goods in process back and forth between various rooms in the plant. Ideally, the work should flow continuously throughout the plant, progressing from work station to work station without backtracking of material to previous operations locations. This cannot always be achieved in practice, but backtracking of material should be minimized wherever possible.

Suggested Intermediate Layout and Work Flow. In order to eliminate the back and forth flow of goods in process, some modification of the existing work layout and flow is needed.

Figure 3 shows a suggested layout and work flow which would provide a continuous flow of work in process throughout the factory and eliminate the counterflow of materials from one area to another. The suggested layout also appreciably

Figure 1

FLOW PROCESS CHART

PRESENT OPERATION

SUMMARY

	PRESENT NO	PRESENT TIME	PROPOSED NO	PROPOSED TIME	DIFFERENCE NO	DIFFERENCE TIME
○ OPERATIONS	20					
⇨ TRANSPORTATIONS	18					
□ INSPECTIONS	4					
D DELAYS	-					
▽ STORAGES	5					
DISTANCE TRAVELED	244 ft.					

NO ____

PAGE 1 OF 3

JOB Manufacture and Assembly of Bamboo Fishing Poles

☐ MAN OR ☒ MATERIAL

CHART BEGINS Unload Raw Material

CHART ENDS Move to Storage

CHARTERED BY Herb Eller DATE 5/20/74

Chartered

STEP NO	DETAILS OF METHOD ☒ PRESENT ☐ PROPOSED	OPERATION / TRANSPORTATION / INSPECTION / DELAY / STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ANALYSIS	NOTES
1	Unload	●⇨□D▽					
2	Stack to Dry	●⇨□D▽					
3	Drying	○⇨□D▼			24 Hrs.		
4	To Selective Assembly Cutting	○➡□D▽	30'				
5	Cutting and Inspection	●⇨■D▽					
6	To Straightening Dept.	○➡□D▽	12'				
7	Straighten and Inspect	●⇨■D▽					
8	To Grinding Disc	○➡□D▽	12'				
9	Cut to Length	●⇨□D▽					
10	Move to Reamer	○➡□D▽	8'				
11	Ream	●⇨□D▽					
12	Move to Grinder	○➡□D▽	6'				
13	Grind Ends and Joints	●⇨□D▽					
14	Move to Winding Area	○➡□D▽	18'				
15	Mark For Winding	●⇨□D▽					
16	Move to Buffer	○➡□D▽	8'				
17	Buff For winding	●⇨□D▽					
18	Move To Winder	○➡□D▽	8'				
19	Wind	●⇨□D▽					
20	Move to Plug Fitting Area	○➡□D▽	10'				
21	Cut and Fit Plugs	●⇨□D▽					

Figure 1 (continued)

FLOW PROCESS CHART

SUMMARY

	PRESENT NO	PRESENT TIME	PROPOSED NO	PROPOSED TIME	DIFFERENCE NO	DIFFERENCE TIME
○ OPERATIONS						
⇨ TRANSPORTATIONS						
□ INSPECTIONS						
D DELAYS						
▽ STORAGES						
DISTANCE TRAVELED						

JOB ____

☐ MAN OR ☐ MATERIAL ____

CHART BEGINS ____

CHART ENDS ____

CHARTED BY ____ DATE ____

STEP NO	DETAILS OF METHOD ☐ PRESENT ☐ PROPOSED	OPERATION / TRANSPORTATION / INSPECTION / DELAY / STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ANALYSIS WHY? WHAT	WHERE	WHEN	WHO	HOW	NOTES	ACTION
22	Move to Grinder	○ ➡ □ D ▽	11									
23	Grind Plugs Smooth	● ⇨ □ D ▽										
24	Move to Paint Area	○ ➡ □ D ▽	15									
25	Paint Windings	● ⇨ □ D ▽										
26	Move to Boring Area	○ ➡ □ D ▽	30									
27	Bore Holes	● ⇨ □ D ▽										
28	Move to Painting Area	○ ➡ □ D ▽	30									
29	Paint	● ⇨ □ D ▽										
30	Move to Drying Area	○ ➡ □ D ▽	6									
31	Dry	○ ⇨ □ D ▼			24 Hrs							
32	Paint	● ⇨ □ D ▽										
33	Move to Drying Area	○ ➡ □ D ▽	6									
34	Dry	○ ⇨ □ D ▼			24 Hrs							
35	Paint	● ⇨ □ D ▽										
36	Move to Drying Area	○ ➡ □ D ▽	6									
37	Dry	○ ⇨ □ D ▼			24 Hrs							
38	Move to Smooth Paint	○ ➡ □ D ▽	10									
39	Smooth Paint	● ⇨ □ D ▽										
40	Move to Assembly Area	○ ➡ □ D ▽	18									
41	Assemble and Inspect	● ⇨ ■ D ▽										
42	Inspect Final Assembly	○ ⇨ ■ D ▽										

Figure 1 (continued)

FLOW PROCESS CHART

NO ______
PAGE 3 OF 3

SUMMARY

	PRESENT NO	PRESENT TIME	PROPOSED NO	PROPOSED TIME	DIFFERENCE NO	DIFFERENCE TIME
○ OPERATIONS						
⇨ TRANSPORTATIONS						
□ INSPECTIONS						
D DELAYS						
▽ STORAGES						
DISTANCE TRAVELED						

JOB ______

□ MAN OR □ MATERIAL ______

CHART BEGINS ______

CHART ENDS ______

CHARTERED BY ______ DATE ______

STEP NO	DETAILS OF METHOD □ PRESENT □ PROPOSED	OPERATION / TRANSPORTATION / INSPECTION / DELAY / STORAGE	DISTANCE	QUANTITY	TIME	ANALYSIS WHY: WHAT	WHERE	WHEN	WHO	HOW	NOTES						
43	Disassemble and Package	●⇨□D▽															
44	Storage	○⇨□D▼															
		○⇨□D▽															
		○⇨□D▽															
		○⇨□D▽															
		○⇨□D▽															
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		○⇨□D▽															

Figure 2

PRESENT LAYOUT AND FLOW DIAGRAM

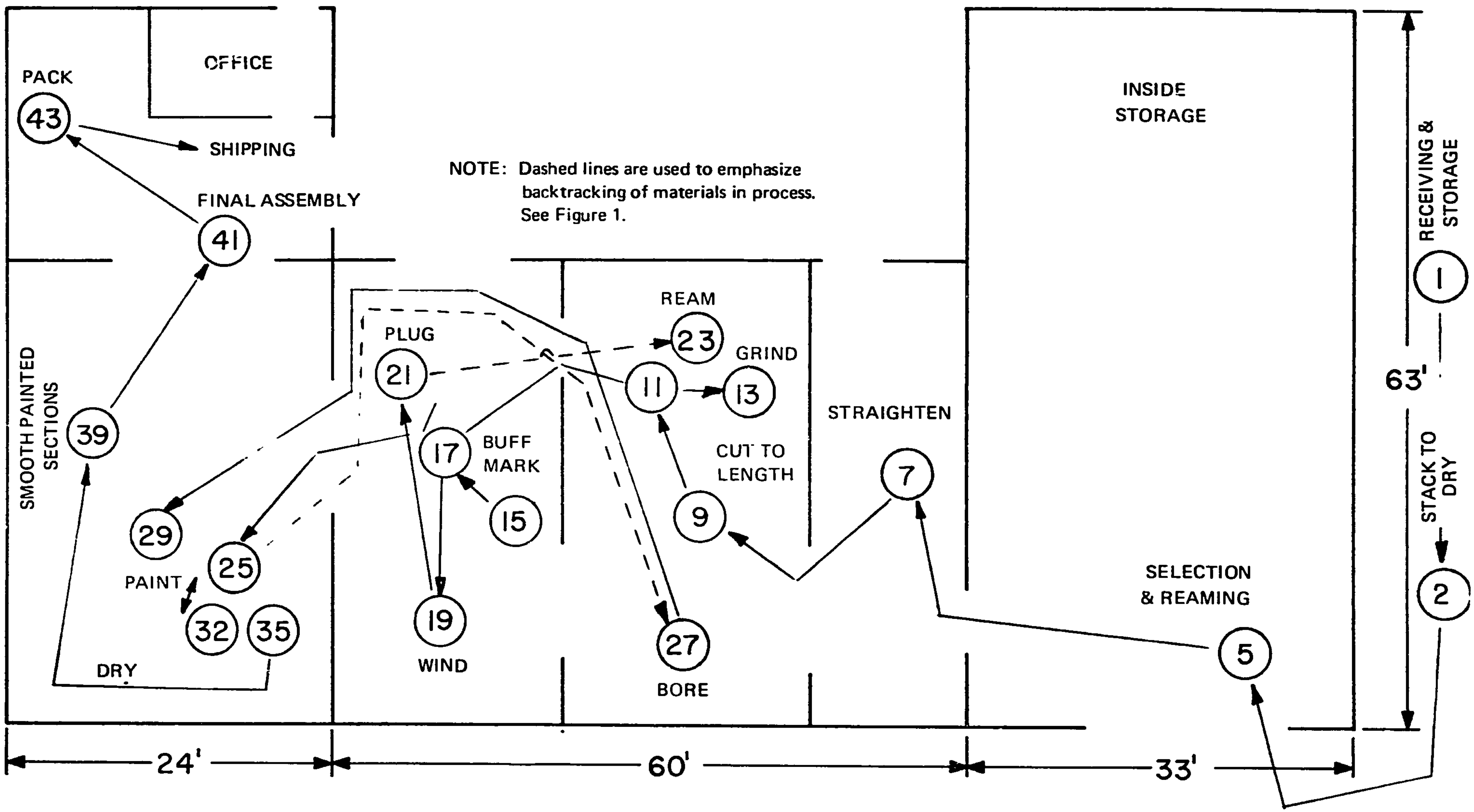
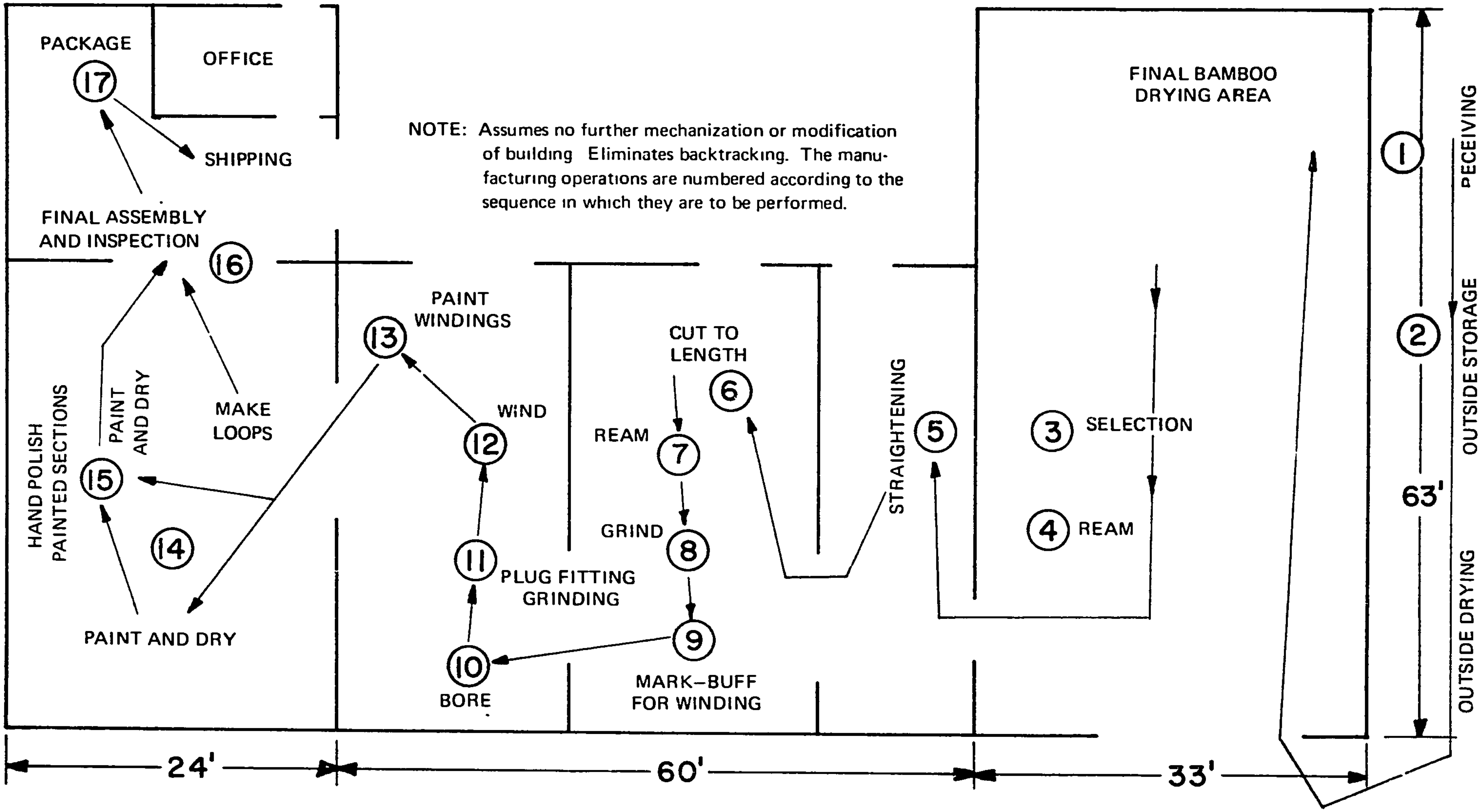


Figure 3

PROPOSED LAYOUT AND FLOW DIAGRAM
INTERMEDIATE STAGE



reduces the transport distance that the goods in process must travel in the plant during the production of fishing poles. The implementation of this layout could materially improve materials handling frequency, time, and distance and could be easily done with a minimum modification of processing equipment.

When orders necessitate larger production capacity, further refinement of layout and work flow may be required as work stations for additional employees are located in bottleneck activity areas.

Production

Materials Handling. It is recommended that materials handling techniques be improved by rearranging the layout and through use of work benches, gravity-fed chutes and/or bins, and tote boxes, making material readily accessible to operators.

Selection. This was observed to be one of the major contributions to low productivity. This operation requires a major intuitive decision on the part of the operator. Without measurements, he must select the sections of a complete fishing pole assembly so that, when properly reamed and bored, the butt of each section nearer the tip of the fishing pole assembly will fit snugly into the open end of its adjacent section toward the handle of the fishing pole assembly. After observing this operation, it was felt that by using simple gauges and fixtures, the selection process could be speeded up considerably as well as made more accurate. By basing the selection of the bamboo sections on precise dimensions, a series of standard male/female joint dimensions could be utilized. In order to verify this concept, however, a simple dimensional analysis of the bamboo joints was undertaken (see Appendices D and E). The analysis indicated that this was feasible. By utilizing this concept, fishing poles would no longer go through the production process as a coherent assembly. Instead, they would be produced as standard components to be accumulated into a complete assembly only as the final step in the production process.

There appears to be an obvious need for a simple gauging fixture as an aid in the selection operation. Based on the graphic analysis of the data taken, it was shown that a nominal diameter of 9.0 mm can be used on all section 1 to section 2 joints and a nominal diameter of 6.0 mm can be used on all section 2 to section 3 joints.

It is recommended that the firm obtain and install these tools in order to eliminate the tedious and time-consuming fitting by hand. This is an important step in moving toward standardization of sections which would allow a much larger level of production with the present plant size. This would permit use of standard size machine tools for sizing male/female bamboo dimensions.

Initial Straightening. This process could be improved by preheating the bamboo sections. This should shorten the time that is required for the section to be in the small charcoal heater and will allow more operators to use each heater. It is not likely that special mechanized straightening devices could be justified from an economic standpoint; therefore, they should continue with the notched stick straighteners.

Advantage should be taken of standard size holes, as recommended in the section on "Selection," to mass produce plugs. This will reduce cutting and fitting time for plugging.

Ream. This operation is generally adequate. A small pilot attached to the reamer shaft, directly behind the cutter end, with a set screw would eliminate much tool chatter and give a smoother cut.

Bore Sockets. This operation is generally inadequate, due to crude tools and a lack of quality control which requires repeated inspections by the operator to determine if the bored section is properly sized. However, marked improvements in the cutting tools can be designed (see Appendices F and G) which would provide standardized boring and grinding operations.

Wind. In observing this operation, it appeared to the analysts that the equipment was operated in a way that was counter to the natural tendencies of an operator. The nonprecise action of the right hand was to provide motive power for the lathe while the precise action of guiding the cotton string onto the winding was provided by the left hand. A redesign of the lathe, whereby motive power was provided by a foot pedal leaving both hands free for work, was recommended. This suggestion was implemented by management.

Dipping bamboo into varnish after winding should be considered. The varnish would hold windings in place, improve finish and durability, and reduce the number of coats of paint required.

Paint Windings. If the winding operation could be delayed until after the bore socket operation, this operation could be incorporated in the regular finish paint operation. This would eliminate a move into the paint area and a move out of the paint area.

Paint. New types of faster drying lacquer should be investigated. Drying time is presently 12 to 24 hours. By using a faster drying lacquer, work in process time can be greatly reduced.

If an electrically driven buffer were used for smoothing painted areas, this would result in increased productivity of this operation.

Final Assembly. If recommended improvements in the selection operation are effected, this operation would require much less time. Presently, a lot of rework is required at this point.

Final Inspection and Straighten. This operation should be combined with final assembly when redesigning the present system.

Implementation of Recommendations

The recommendations in this section are intended to suggest ways of improving plant productivity with little or no capital investment and utilizing the existing land, building, and equipment. If additional capacity can be achieved in the plant, this will result in additional jobs created because of the labor-intensive nature of the plant operations.

The Soong Jun University faculty and staff can provide continuing assistance in the implementation of the recommended improvements.

APPENDICES

Appendix A

METHODOLOGY EMPLOYED IN ANALYSIS

The analysis consisted of investigating each major component of the existing conditions in the company being investigated. These included the following broad categories:

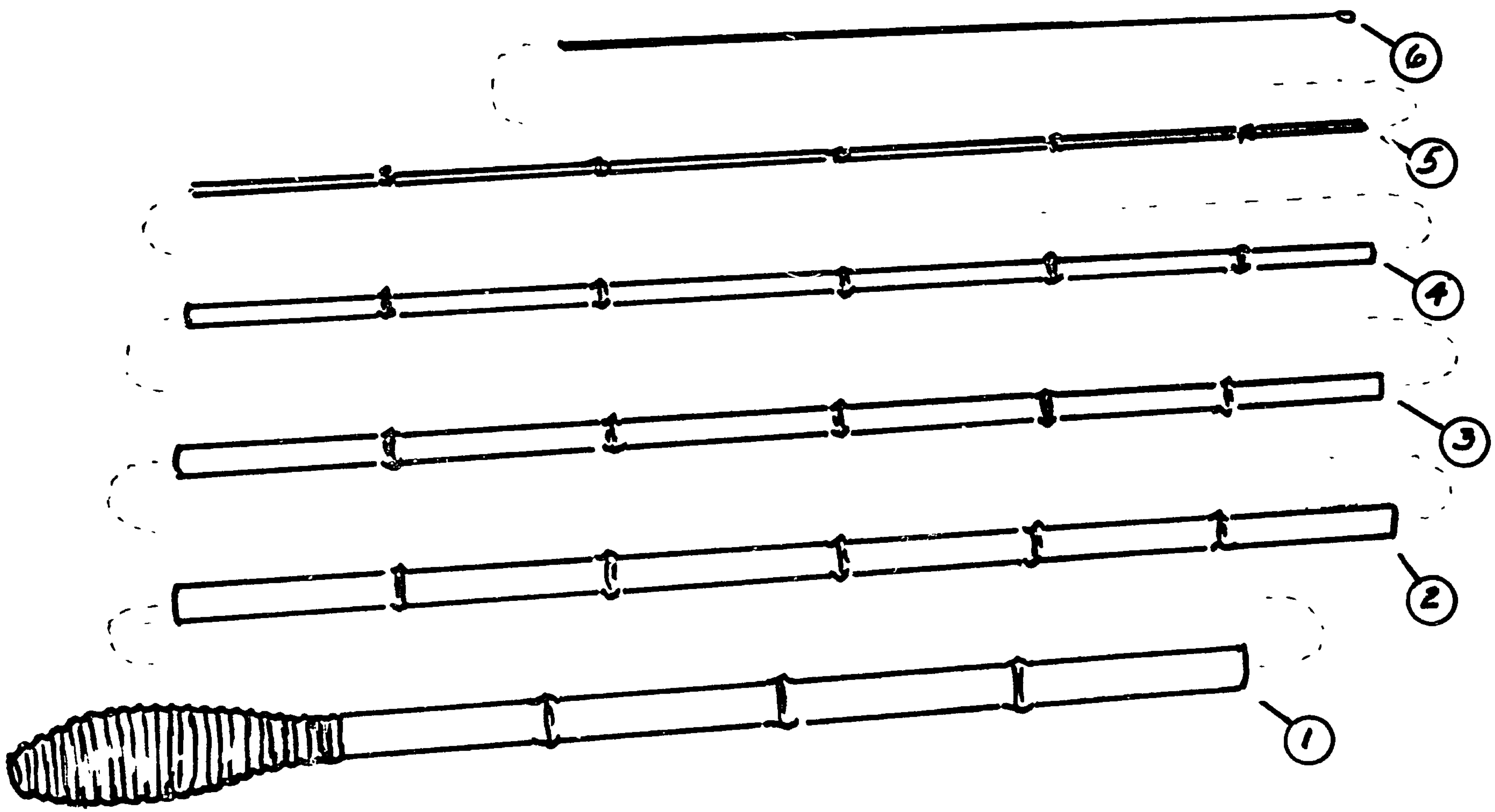
- o Product lines
- o Production plan
- o Marketing
- o Personnel
- o Manufacturing facilities
  - Site and building
  - Process equipment
- o Production processes

Traditional industrial engineering techniques were used to analyze present methods in order to make proposed changes for improving the effectiveness of specific operations. These techniques included the creation of the following:

- o Flow process charts (present)
- o Flow diagram (present)
- o Flow diagram (interim proposed)
- o Assembly chart
- o Dimensional analysis (table and graphics)
- o Conceptual sketches of tools to permit the manufacture of standardized sections

After analyzing each component of the existing conditions and the apparent major bottlenecks to achieve increased productivity, recommendations were made for significant improvements. These suggestions were based upon the anticipated utilization of readily available materials, existing and indigenous technology, existing management capability, and the knowledge that available funds for capital improvements were minimal.

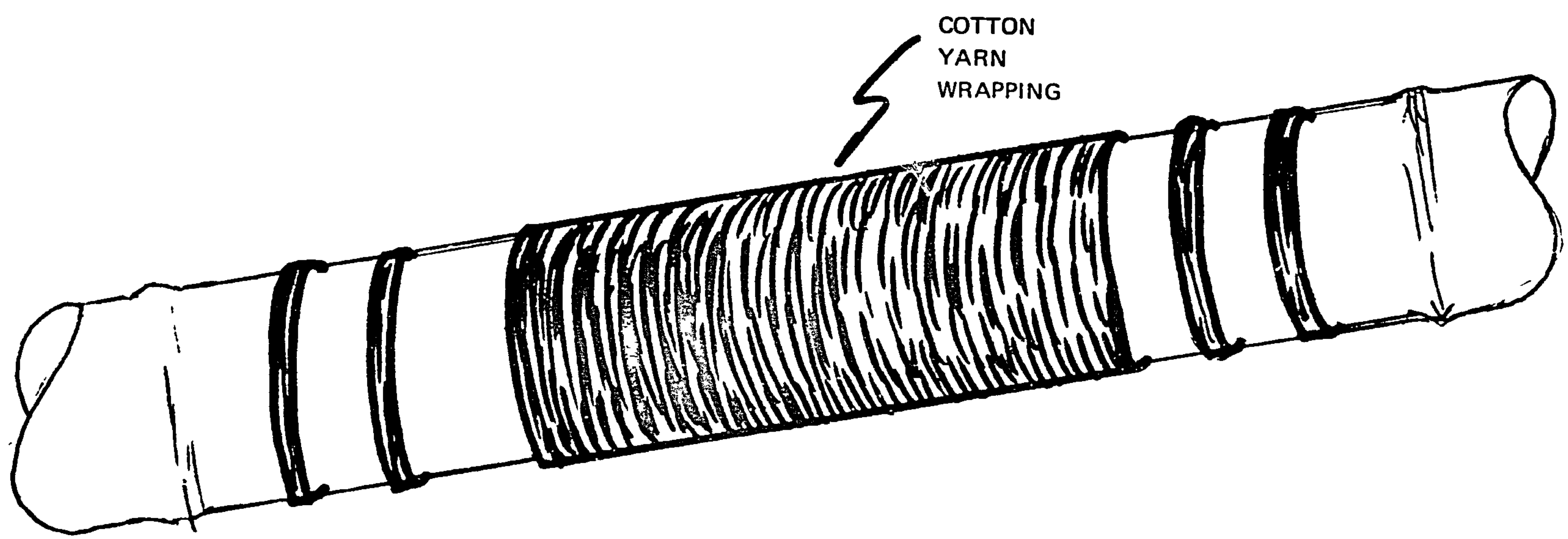
Because of the small size of the enterprise and the relative simplicity of the labor-intensive processes, more sophisticated analytical techniques were not employed. In theory, this plant could have been turned into a highly automated operation employing few people, but this approach would have been counterproductive in terms of employment generation, and the company resources to take this approach were not present.



FISHING POLE ASSEMBLY (SKETCH)

Appendix C

TYPICAL WRAPPED JOINT (SKETCH)



Appendix D

STANDARDIZATION OF REAMING AND GRINDING: SAMPLE DIMENSION DATA

Methodology

In order to determine the feasibility of standardizing joint socket dimensions, 60 bamboo samples were taken from production stock. Twenty samples each were taken from Section 1, Section 2, and Section 3 of a three-section fishing pole assembly.

By using a metric vernier caliper, the butt diameter and the top diameter of each sample were measured and recorded. The average wall thickness at both the butt and the top end of each sample was then measured and recorded (see following page). These data were analyzed to determine the dimensional extremes within each group of 20 samples.

First, for the proposed joint between Section 1 and Section 2, the smallest top dimension of a Section 1 sample was graphically compared with the largest butt dimension of a Section 2 sample. Similarly, the largest top dimension of a Section 1 sample was graphically compared with the smallest butt dimension of a Section 2 sample.

The graphic analysis indicated that by using a 6.0 mm diameter socket dimension, there would be enough material left on the bamboo sections after sizing to provide adequate joint strength.

This same process was duplicated to determine that a 9.0 mm diameter was the optimum socket dimension for the proposed joint between Section 2 and Section 3.

Appendix D (continued)

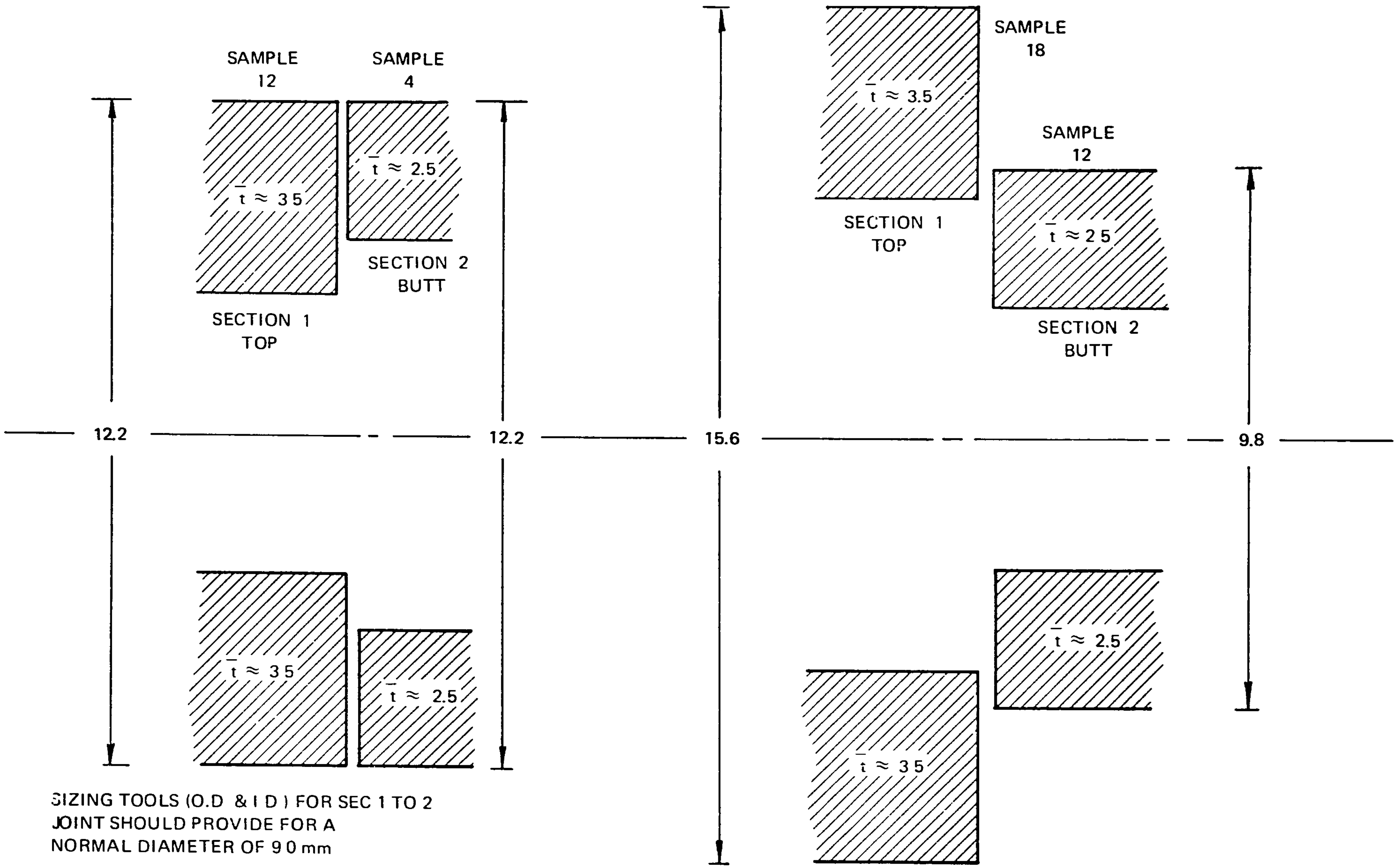
STANDARDIZATION OF REAMING AND GRINDING: SAMPLE DIMENSION DATA
(Diameters in Centimeters)

Sample No.		Section 1		Section 2		Section 3	
		Butt	Top	Butt	Top	Butt	Top
1		14.9	14.5	11.5	10.2	7.1	5.0
2		16.6	13.8	10.7	8.4	7.8	4.5
3		15.5	12.5	10.3	8.7	7.1	4.4
4		16.1	15.1	12.2	9.1	7.4	4.4
5		14.5	14.0	11.1	9.0	7.6	4.5
6		14.5	13.5	10.1	9.0	7.1	5.0
7		16.4	14.3	11.5	10.4	7.2	5.2
8		16.7	14.4	11.1	9.2	7.1	4.6
9		16.1	13.9	11.1	9.3	7.2	5.4
10		16.8	13.3	10.4	9.8	7.5	4.8
11		16.1	14.1	10.9	8.8	7.7	5.1
12		13.5	12.2	9.8	9.0	7.3	5.0
13		15.8	14.0	10.4	9.1	7.3	5.2
14		14.4	14.3	10.9	9.8	7.5	5.1
15		16.8	14.3	10.8	10.0	8.2	5.6
16		16.3	15.0	11.7	10.2	7.7	5.5
17		14.6	15.4	10.7	9.1	7.7	4.7
18		17.1	15.6	11.5	8.4	6.9	5.1
19		14.7	12.4	10.4	8.2	7.5	5.0
20		14.9	12.7	10.3	9.3	7.5	5.1
Average		15.6	14.0	10.9	9.3	7.4	5.0
Modal Range	Min.	13.5	12.2	9.8	8.2	6.9	4.4
	Max.	17.1	15.6	12.2	10.4	8.2	5.6

Source: Samples taken at cut to length operation.

Appendix E

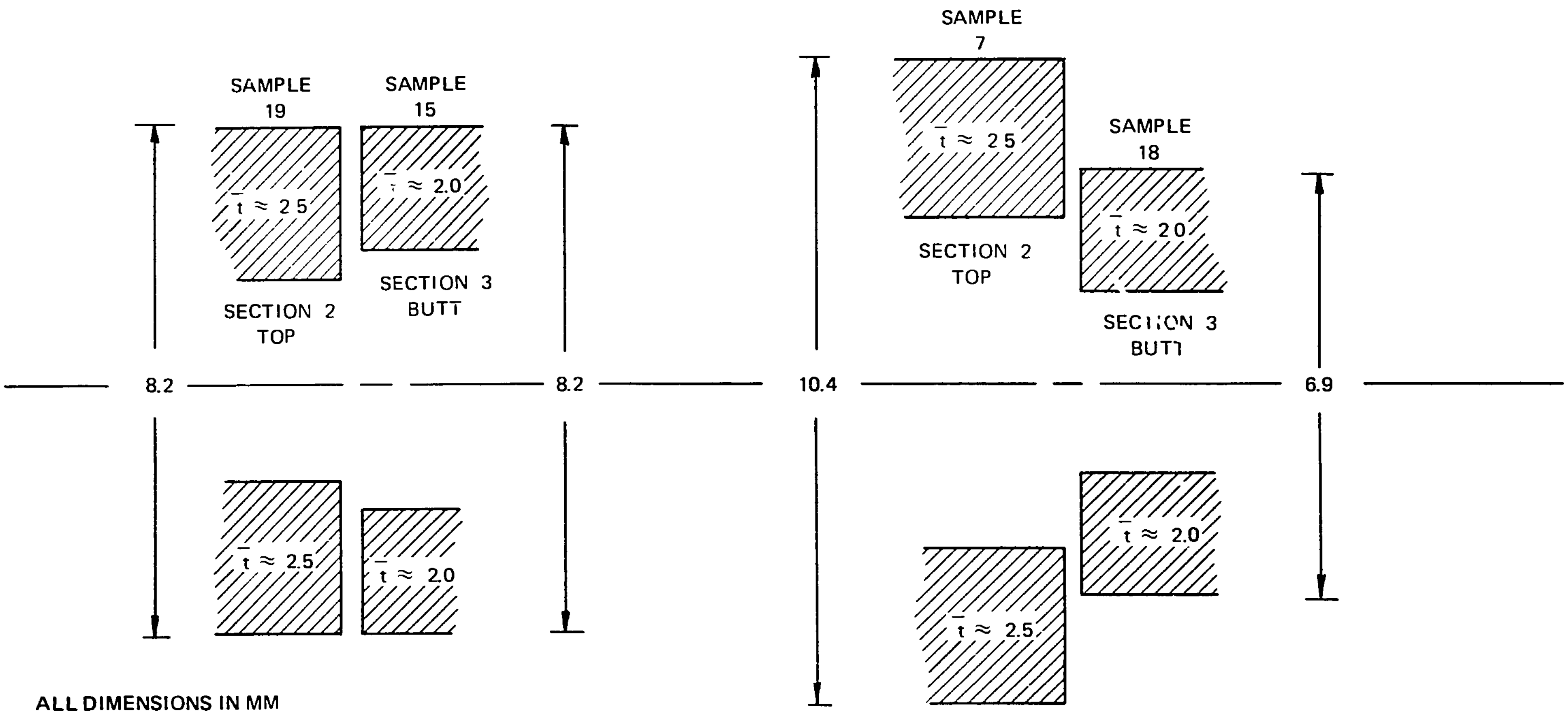
EXTREME COMBINATIONS – SECTIONS 1 & 2



SIZING TOOLS (O.D & I D) FOR SEC 1 TO 2 JOINT SHOULD PROVIDE FOR A NORMAL DIAMETER OF 9 0 mm

ALL DIMENSIONS IN MM

EXTREME COMBINATIONS – SECTIONS 2 & 3

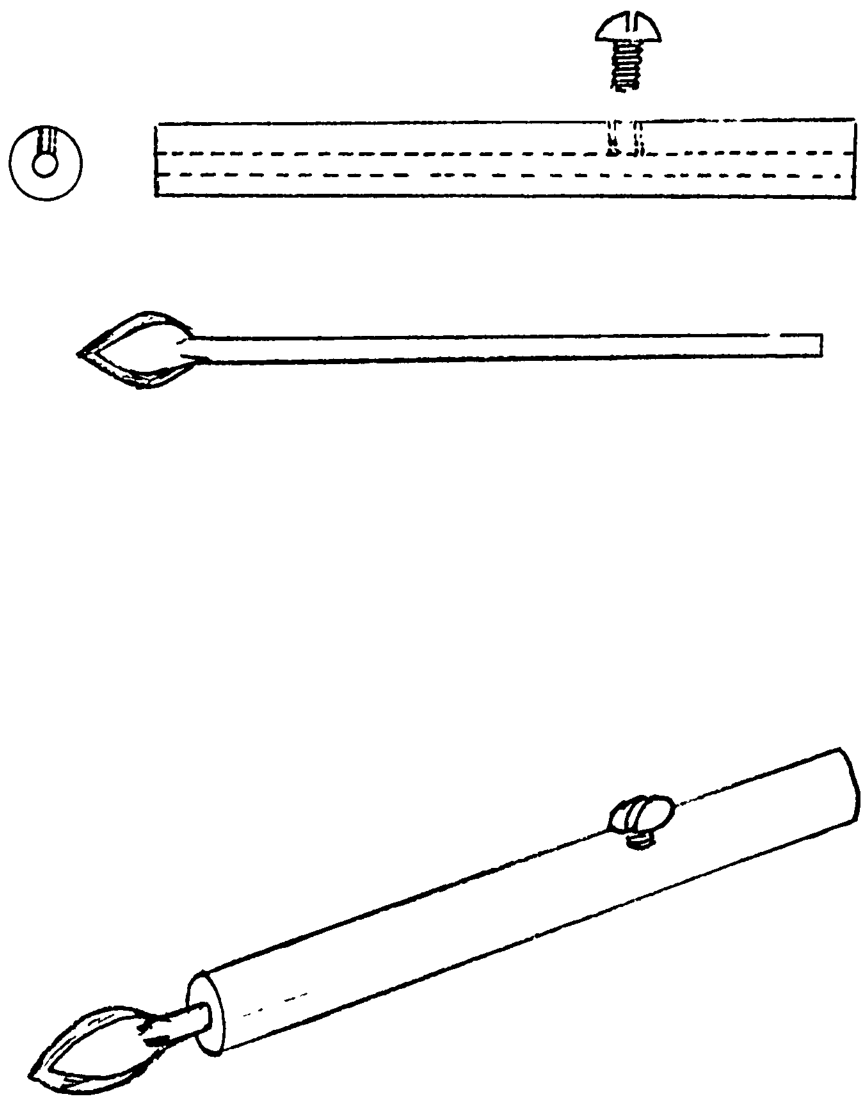


ALL DIMENSIONS IN MM

SIZING TOOLS (O.D. & I.D.) FOR SEC 2 TO 3 JOINT SHOULD PROVIDE FOR A NOMINAL DIAMETER OF 6.0 mm

Appendix F

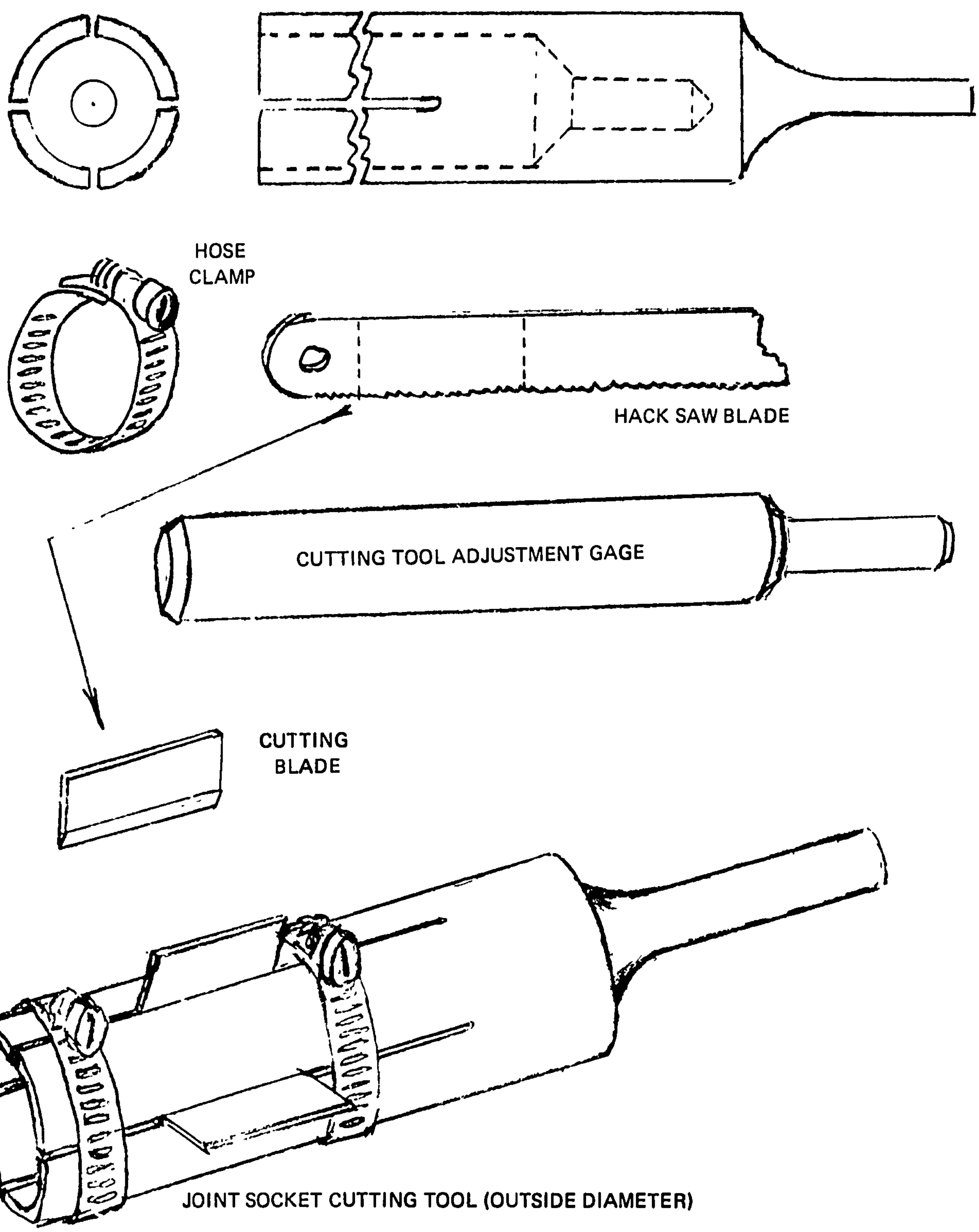
CONCEPTUAL DESIGN



JOINT SOCKET CUTTING TOOL (INSIDE DIAMETER)

Appendix G

CONCEPTUAL DESIGN



JOINT SOCKET CUTTING TOOL (OUTSIDE DIAMETER)