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ASSISTANCE IN THE ESTABLISHMENT OF A PILOT FURNITURE PLANT

DP/DRK/86/011

THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Technical report: Quality control training manual*

Prepared for the Government of the Democratic People's Republic of Korea
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

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Vienna

* This document has not been edited.

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EXPLANATORY NOTES

- A full stop (.) is used to indicate decimals.

- A comma (,) is used to distinguish thousands.

- The General Bureau for Building Materials in Pyongyang is considered as the Government's Implementing Agency.

- The Pyongyang Wood Complex in Pyongyang is considered by the Government as the Project site.

ABSTRACT

The activities covered by this technical report are part of the project DP/DRK/86/011, entitled 'Assistance in the Establishment of a Pilot Furniture Plant', agreed between the Government of the Democratic People's Republic of Korea (DPR Korea), and the United Nations Development Programme (UNDP), with the United Nations Industrial Development Organization (UNIDO) acting as executing agency. The expert mission was carried out from 2 March to 1 July 1988.

Improvement of the quality of furniture, which is now at a rather low level, is emphasized by the Government authorities and included in the project as an output.

This manual has been prepared for the training of controllers and other technicians concerned with implementing and performing a modern concept of an integral quality control system.

The present quality of furniture and existing quality standards have been analyzed and new quality standards proposed.

Special attention is given to understanding essence and importance of the quality of products and to the factors that quality depends on.

Methods, controlling instruments and procedures used in the quality control of furniture are explained. Some documents and an organizational chart for the control of quality are proposed.

This report has been translated into Korean and has been used as the instruction manual for training controllers in the Pyongyang Wood Complex.

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1. INTRODUCTION

This manual has been prepared in order to accomplish the output No. 4, foreseen in the project document for project DP/DRK/86/011, Assistance in the Establishment of a Pilot Furniture Plant. The execution of this objective called for the 'establishment of a system of integral quality control, with ten technicians trained as controllers'.

The major activities of this output are:

4.1 Make a survey of existing standards of products and components.

4.2 Establish a new system of internal standards for products, components and parts,

4.3 Develop a training programme for controllers,

4.4 Train ten controllers in the procedures and techniques of quality control.

The critical point in the existing furniture production in the Pyongyang Wood Complex (PWC) is a rather low level of the quality of products. After studying this problem in the PWC furniture factory a conclusion has been drawn that quality in this factory suffers from many causes, while all efforts toward improvement of quality is rather one-sided.

Proper quality standards do not exist and quality control is based on a short list of quality criteria with some elementary requirements.

Prior to this manual the proposal of internal quality standards had been worked out and given to the management of the PWC for their consideration and possible acceptance.

The main purpose of this manual is to train controllers and thereafter be a guide in the performance of quality control. It could also help the management in establishing an adequate policy for the management of quality.

The last part of this manual contains a syllabus for the training of controllers.

2. QUALITY OF PRODUCTS IN GENERAL

Everyone of us likes to have a good life, in other words good quality of living. But good quality of living depends on several essential things, such as: quality of products, quality of services, quality of ecological environment and quality of cultural environment (see fig. 1).

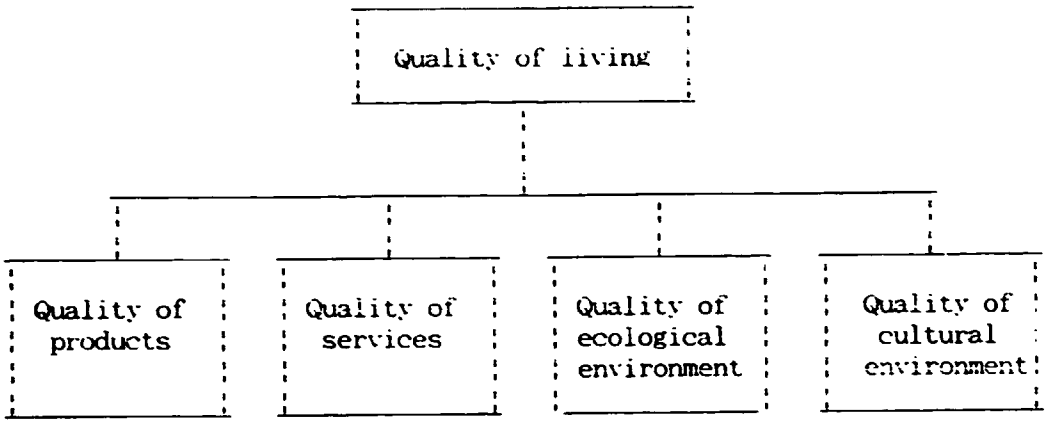


Fig. 1: Importance of quality

Each man can make a great contribution to all of these factors. A manufacturing company has a particular responsibility for the quality of products. I. this manual consideration is given to the quality of furniture.

This is a crucial question: What is quality? Can it be said that something is of good or bad quality? Yes, it can if the quality requirements have been determined, and cannot if quality requirements are not determined. Only by comparing the real features of the product with those prescribed can a conclusion be reached about its quality level.

The quality requirements are mostly written in the form of quality standards. These standards, once established, are a base for testing and assessing the quality of products.

It is very important to understand modern concept of quality management based on the integral quality control system. Also it is very useful to know new methods and techniques currently employed in quality control.

2.1 Two major kinds of products

Basically there are two major kinds of products: products to be consumed and products to be used. The products from each of these groups belong either to production or consumer goods (see fig. 2).

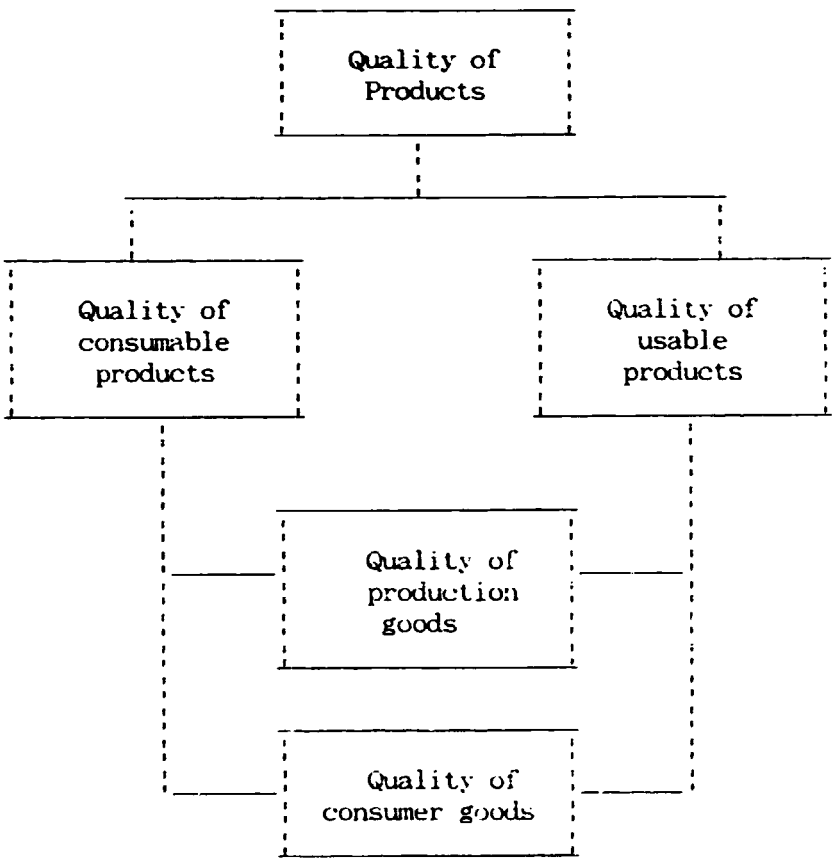


Fig. 2: Two kinds of products

What is the difference between consumable and usable products? Consumable products usually have a long production period and rather short period of consumption (eg. food). On the other hand, usable products have relatively short periods of production and a long usage time (eg. furniture) (see fig. 3).

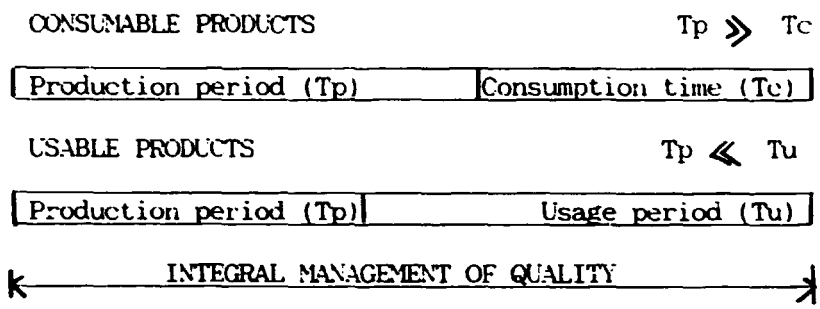


Fig. 3: Difference between consumable and usable products.

From the quality standpoint, we differentiate the quality of usable products from the quality of consumable ones. Due to their long usage period, usable products have more drastic consequences in case of bad quality.

It is very important to understand that the integral management of quality must cover both periods: the production and the usage time.

2.2 Factors having the major influence on the quality of products.

The quality of products depends on many factors, but they could be all classified in four major groups:

- people
- methods
- equipment
- material (see fig. 4)

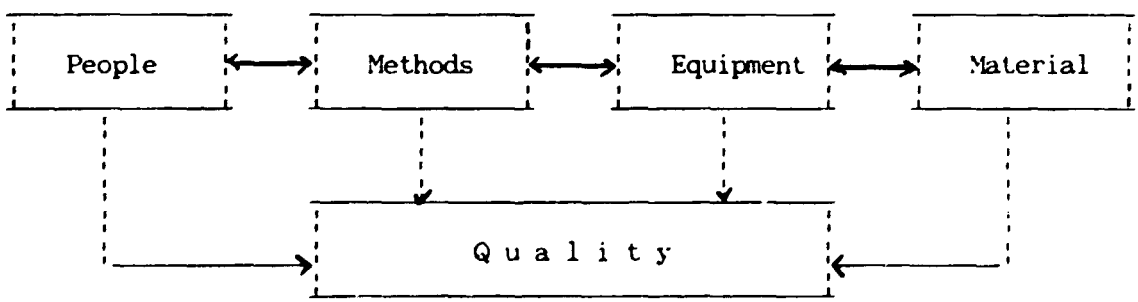


Fig. 4: Factors having the major influence on quality.

People are the most important factor, because to some extent all other factors depend on them.

Each product is composed of three crucial components:

- materials (M)
- Energy (E), and
- Intelligence (I)

The sum of these factors is one whole. So, if one participates more, the others participate less, and vice versa (see fig. 5)

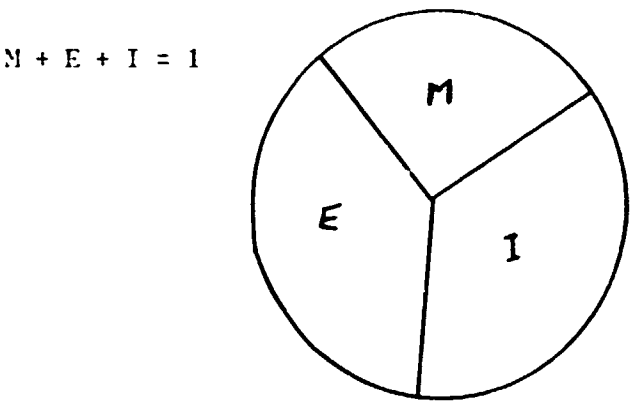


Fig. 5: Relation between M, E, and I (material, energy and intelligence).

In other words, increasing intelligence, which means knowledge and skills of people, we can save a great deal of both materials and energy.

A certain quality of a product is defined by prescribing quality characteristics to be achieved. The quality characteristics of a product (Qp) are conditional on the quality of the entire company system, which is composed of:

- Quality of the technological system (Qts),
- Quality of the production system (Qps),
- Quality of the business system (Qbs), and
- Quality of the organizational system (Qos) (see fig. 6).

$Qp = f\ (Qts, Qps, Qbs, Qos)$ or, as per fig. 6

$$Qp = f(Qm,Qeq,Qtl,Qw,Qms,Qss,Qit,Qwp,Qes,Qdt,Qcs,Qpr,Qpl,Qrds,\ldots$$
$$\ldots.Qprs,Qsels,Qscrs,Qsps,Qfins,Qinfs,Qdecs)$$

All together there are a minimum of 20 different factors contributing to the quality of products. Keeping all these factors under control is widely known as **Integral Quality Control.**

2.3 Quality during the life cycle of a product.

During the development stage of a product, (design, construction of prototype), the number of errors is rather high. During the trial series, as well as during the beginning period of production the number of failures declines, but it is still high. In these stages, the main attention must be paid to the quality of a new product.

During the regular serial production the number of errors is low and stable, because only accidental mistakes occur at this stage (see fig. 7).

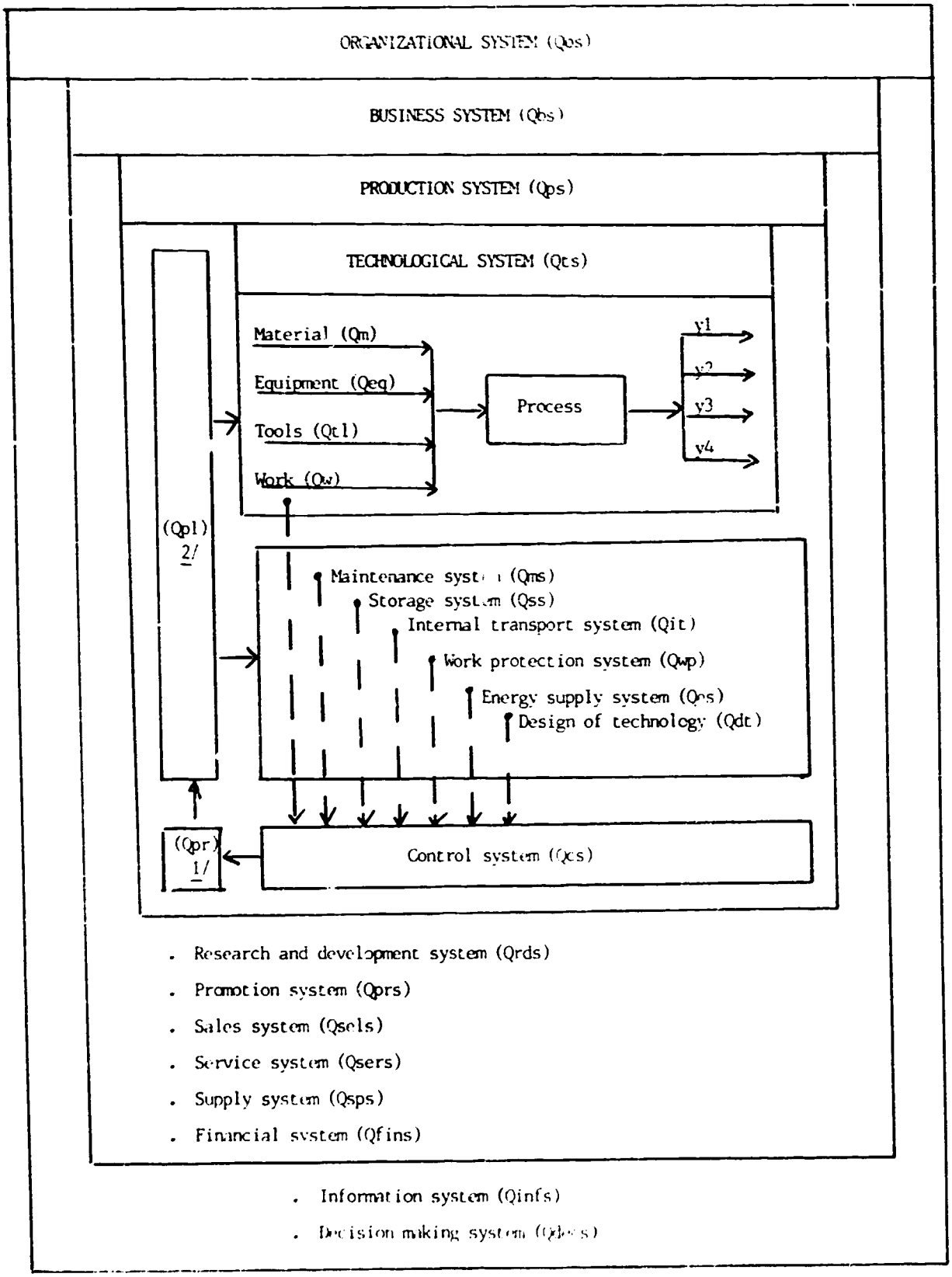


Fig. 6: Relation between technological, production, business and organizational systems.

1/ Qpr - Quality of data processing.

2/ Qpl - Quality of planning.

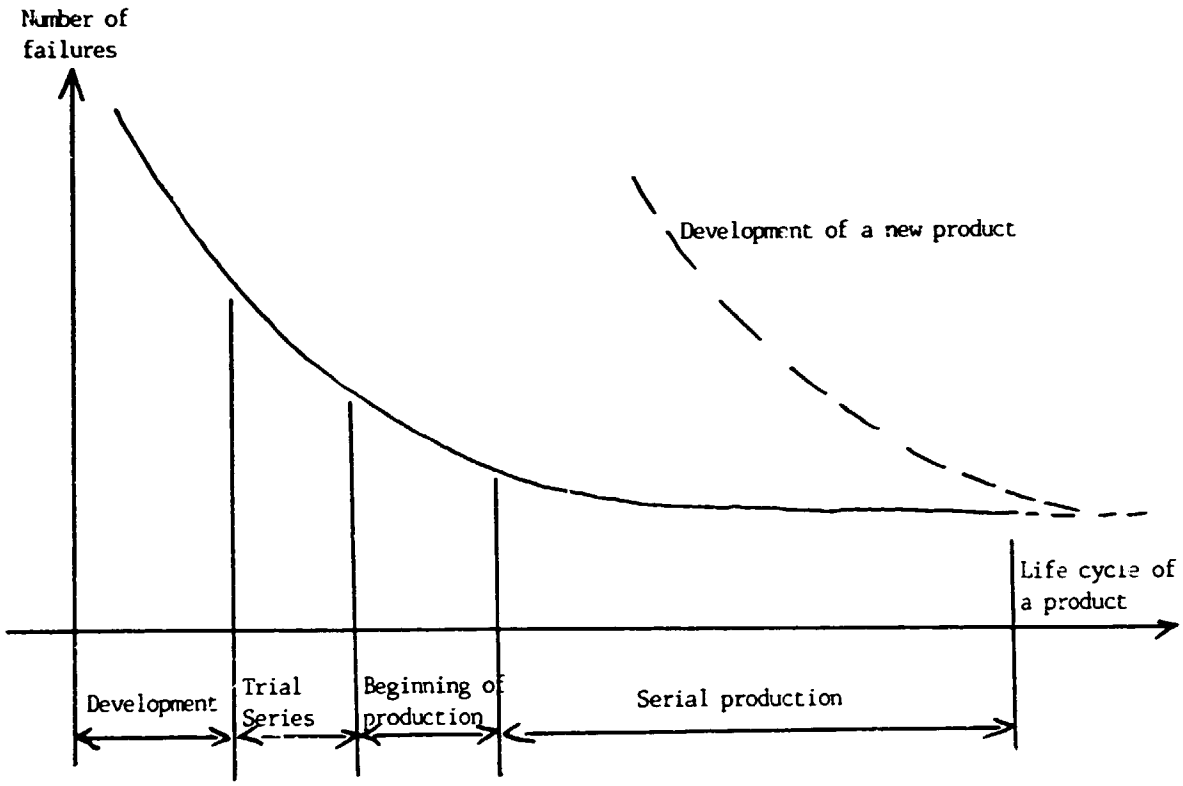


Fig. 7.: Quality during the product's life cycle.

2.4 Quality during the use of a product.

During the first period of use, immediately after a product is sold, the number of failures is higher than during the subsequent period. This period of early failures must be covered by the manufacturer's warranty, while afterwards the regular service is sufficient.

When the product becomes old and worn out, the number of failures will increase, and that is no longer the producer's responsibility (see fig. 8).

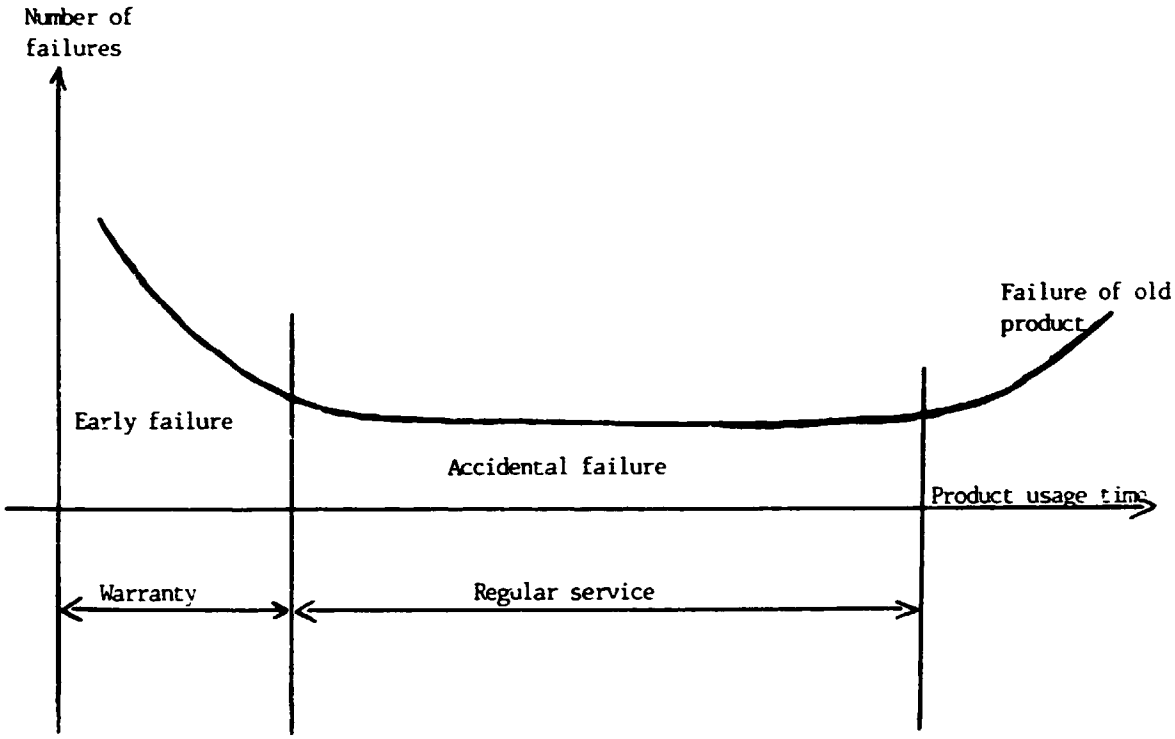


Fig. 8: Quality during the use of a product.

2.5 Essence of the management of quality

The essence of the management of quality is:

- setting a quality policy,
- planning quality,
- testing quality,
- management of quality (see fig. 9).

Testing of quality comprises:

- planning testing,
- performing the tests, and
- data processing.

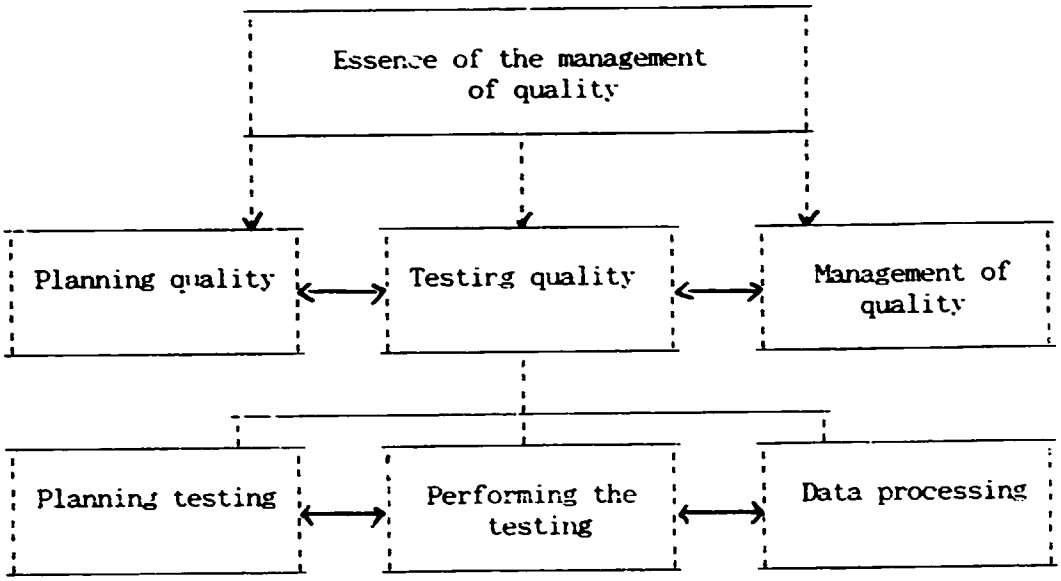


Fig. 9: Scheme for the management of quality.

The purpose of the management of quality is to get full satisfaction of all the interested parties: the producer, the customer, and the society (see fig. 10).

P = Producer
C = Customer
W = Warranty
L = Legal regulations
S = Society

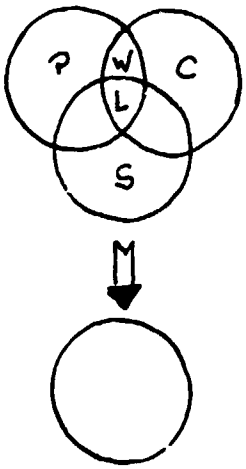


Fig. 10.: The intention in the management of quality is to get the sameness of different interests.

In order to achieve this, the management has to define the policy of quality, answering the following questions:

- Who is responsible to carry out the policy of quality?
- How should the policy of quality be carried out?

- What are the rules concerning the policy of quality, and
- What measures can be taken in case the policy of quality is not carried out or has been carried out the wrong way.

One example of the distribution of duties and responsibilities for quality among different departments in the company is shown in fig. 11.

Duties and responsibilities for quality	Work areas: Management of the company	Sales department	Product development and construction	Planning and work preparation	Purchasing department	Production	Quality control
To establish a policy of quality	▨	▩	▩			◉	▩
To find out demands of the market	○	▨	○				○
To design and construct products	◉		▨	◉		◉	◉
To make a plan for production and quality control			◉	▨		◉	▩
To purchase materials and components				◉	▨	◉	○
To produce, control and assemble products					○	▨	▩
To do final quality control and to revise quality	○	○				○	▨
To service the customers' needs and to solve their complaints	○	▩	▩	▩	▩	▩	▨

▨ Responsible ▩ Must collaborate ◉ Can collaborate ○ Must be informed

Fig. 11: Distribution of duties and responsibilities for quality.

The integral quality control must cover all activities of the production cycle (see fig. 12).

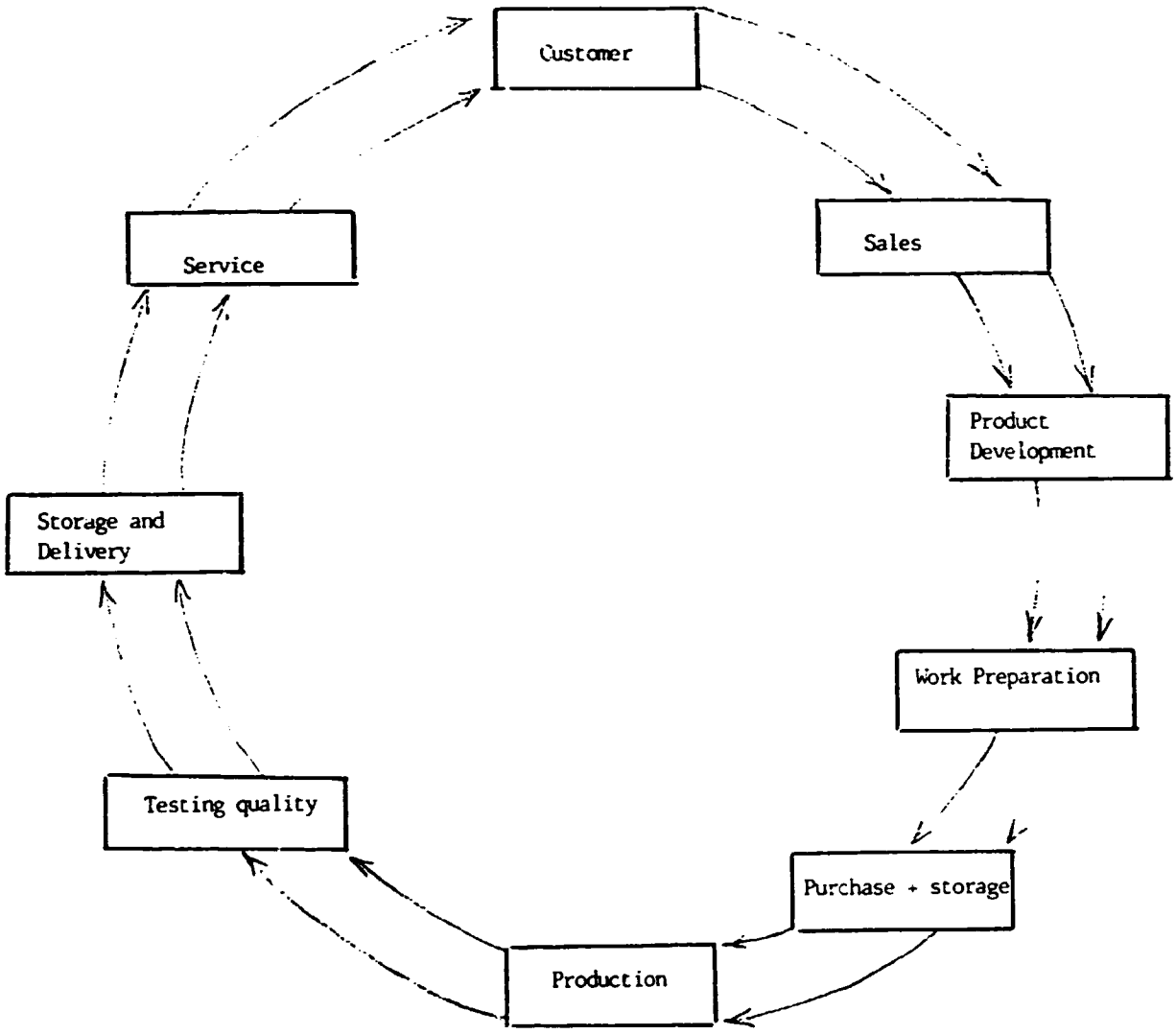


Fig. 12: Integral quality control should cover the whole production cycle.

The quality of products must be considered a major economical question. From that point of view it is very important to determine an optimal level of quality which is in accordance with the factory's resources and capabilities.

The optimal level of quality is determined by the greatest difference between accepted sales price and production cost of a product (see fig. 13).

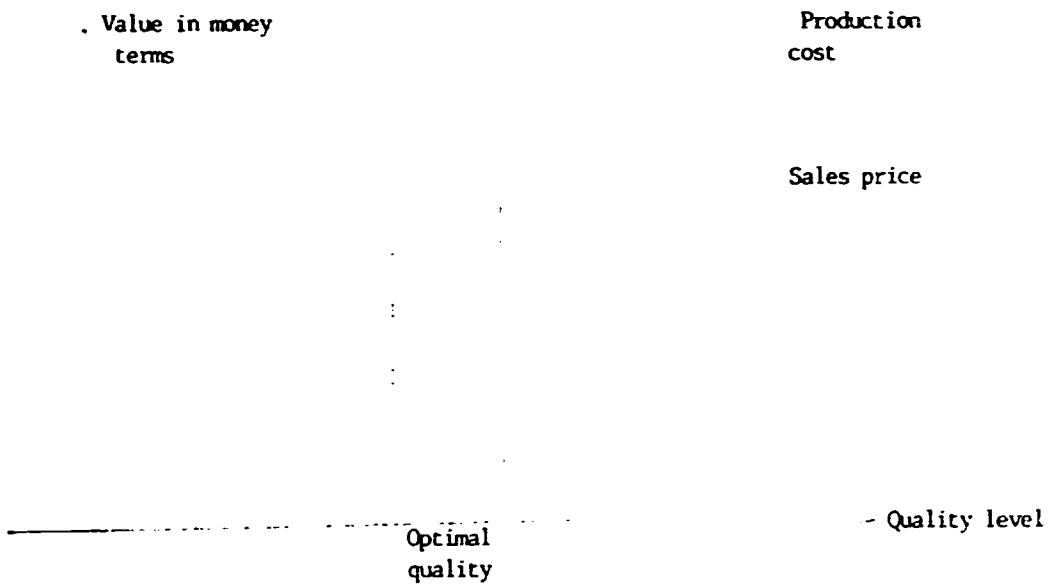


Fig. 13: Optimal quality.

This approach to the problem of quality has been used in order to get a better understanding of quality and the factors it depends on.

3. SOME QUESTIONS AND ANSWERS REGARDING THE QUALITY OF PRODUCTS

The duty of the quality controller is not only to discover defects, but to analyze why defects occur, and what the right remedy for them is.

The starting point in setting a correct policy of quality is answering the question: What is the 'right' quality?

Quality simply means conformance to requirements.

The next question could be: How is the quality of products determined?

The quality of products is determined by quality standards or special requirements stated in specifications, contracts, technical descriptions or management orders.

Furthermore, the following could be asked: Are written instructions with respect to quality available? How well are instructions followed? What happens when instructions are not read?

If instructions are not read, they cannot be followed. And, what prevents the instructions from being follow...

The answers to this question could be the following:

- confusion,
- broken equipment,
- faulty materials,
- lack of communication,
- haste,
- tardiness,
- absenteeism,
- physical ailments,
- carelessness,
- lack of concentration,
- sloppiness, etc.

Why is quality so important?

First of all to keep customers satisfied with the products. To build up a reputation for the company. To reduce production costs. To get higher prices. To reduce the cost of the warranty and of the customer service. To be competitive on the market.

Does it cost too much to produce a quality product?

Yes, it costs very much, because the following expenses must be covered:

- direct labour,
- indirect labour,
- direct materials,
- indirect materials,
- depreciation of equipment and buildings,
- heat, light, power, water,

- maintenance cost,
- inspection cost,
- taxes and insurance.

And, also, it costs very much to fix a defective product, because the following expenses must be covered:

- cost of shipping the defective item,
- cost of retrieving the defective product,
- cost of replacement (material and labour),
- cost of reshipment,
- cost of lost sales,
- cost of lost company reputation.

What impact do defects have on the company's chances for success?

- The company is losing its reputation among customers and the government authorities.
- Defects are very costly.
- Rework is very expensive.
- Money spent to correct defects could be used for purchase of new equipment.

Why do defects occur? Because of:

- haste,
- bad attitude,
- overtiredness,
- sloppiness,
- lack of concentration,
- absenteeism and tardiness,
- improper use of tools and equipment,
- carelessness,
- faulty materials,
- worn out equipment,
- lack of right information.

Almost the same answers are applicable if instructions are not followed.

And, what can be done to decrease the number of defects and ensure the good quality of products? A lot can be done, but the following important factors must be pointed out:

- Pride should be taken in the work as if a personal signature was going be be put on each product.
- The customer's point of view should be taken into consideration.
- Defects should not be allowed to pass by; these should be caught and reported.
- All instructions should be read carefully and job specifications followed.
- Proper equipment and tools should be used.
- Work should be accomplished at a comfortable pace, it should not be rushed.
- Employees should be kept abreast of changes in job specifications.
- Attention should be given to details.
- Employees should be punctual every day.
- Employees should come to work fully rested.
- The work area should be kept free of clutter.
- A 100 percent quality level should be aimed at.

How can standardization and interchangeable parts contribute to the improvement of quality?

They contribute to the improvement of quality for the following reasons:

- a lower number of different parts is produced.
- A reasonable number of different tools is used.
- A reasonable number of different jigs is used.
- Preparatory work is simplified.
- Quality control is simplified.
- Training is simplified.
- Inventory parts are lowered.
- Through bigger production series the machines are set less frequently.

How can information contribute to the improvement of quality?

- The matter of quality should be discussed in each department once every two months.
- Workers must know the requirements for quality and the real situation in the factory.
- Workers must know the results of the measures undertaken to improve quality.
- Workers must know the main reasons why defects occur.

The duty of the quality control unit is not only the inspection of quality, but also broadening the consciousness on the importance of quality and giving correct advice on the causes of poor quality and how to overcome defective work.

4. QUALITY CONTROL IN FURNITURE PRODUCTION

4.1 The existing quality control system and the quality of furniture within the Pyongyang Wood Complex.

The quality control department is organized as a separate organizational unit under the supervision of the head engineer. This unit is staffed with engineers and other skilled persons. There are altogether nine persons covering quality control of all factories within this complex. In addition to this, there is an inspection of quality of finished products performed by the Government's body.

The quality is partially determined by the State standards prescribing mainly outer dimensions (for example: Standards No. 4727-84, 4729-84, 4730-84, 4731-84 and 4728-85) and by the quality criteria prescribed by the General Bureau for Building Materials, containing a very limited number of requirements (for example the General Bureau Standard 1004-87 for casegoods furniture). This standard prescribes moisture content in the solid wood with tolerances of 10% ± 2%. It prescribes tolerances in outer measures (for example height ± 5mm, width ± 4 mm, depth ± 3mm). Cracks are allowed upto 1 mm. Rotten (decayed) wood, wood with insect holes, pitch pockets, dead knots, ingrown bark and visible scars are not allowed.

All fronts must have the same veneer pattern. Sharp outer edges and sliding parts must be softened by sanding the assembled product. The product must not wobble when laid on a flat floor and assembled.

Metal parts must be plated.

The inside measures of the casegoods must be the same as the outside dimensions of doors.

The varnish used must be transparent either in natural or chestnut tint.

All products must be controlled after assembly. Dimensions are to be checked by ruler and appearance by visual inspection.

The commodity mark is attached on the accepted products with the following data: name of the product, unit price, number(s) of the related standard(s), date of production and date of inspection.

The product must be packed individually and kept in a storeroom without excessive humidity. The products must not be piled on each other.

There is no classification of furniture according to its quality.

It is obvious that main attention of the quality control is given to the inspection of a finished product, and less to the control of materials and parts during processing.

Adequate jigs are scarcely used in the production process. The parts are not selected according to their visibility in a product. The assembly is the most difficult operation and done with a great deal of handwork.

Material is the limiting factor for the quality of products, and it is out of the field of influence of the controllers. After sawing in the sawmill the best wood is selected for the joinery production, and material which is not suitable for joinery is used for furniture production.

The worn out machines and inadequate tools contribute to the very low quality of products. Sanding is done very roughly and that is apparent on the finished surfaces.

To improve the quality of furniture it will not be enough to buy new equipment and tools, but also to undertake many other measures, first of all to ensure that all concerned understand the importance and essence of quality and to learn how to achieve and maintain an appropriate quality level of products.

4.2 General considerations on quality control in the furniture industry.

Quality control in the furniture industry takes into consideration an average quality, because variation of quality is natural and cannot be avoided. This variation results from many factors connected with raw materials, components, equipment, tools and workers' abilities.

The limits within which the quality of a product may vary are defined and maintained by applying systematic quality control. Compared with many other branches of industry, there are many reasons for the variation of quality in furniture production. Typical variables are the following:

- Properties and condition of the lumber used: moisture content, number and size of knots and other faults, specific gravity, strength properties.
- Properties and condition of other raw materials and semi-manufactured products: veneer, wood based panels, plastic parts, fittings etc.
- Dimensional accuracy of machined parts: thickness, width, length, forms
- Dimensional accuracy of assembled products: external and internal measures, clearances between moving parts.
- Quality of surface finishing: evenness of surface, colour shade, gloss of lacquered surface,
- Durability of finished products.

The quality of furniture may not be too high nor too low because it will result either in too high a production cost or in its non-acceptance on the market.

4.3 Quality control of materials.

The starting point for quality control is the inspection of materials to be processed or used. It must be done before the materials enter the factory. For example, sawnwood, veneer and plywood can be checked before delivery in the factories producing these semi-manufactured products.

All other materials and semi-manufactured products should be checked on receipt.

It is important to check the quality, but quantity must also be controlled.

The most important measure of control before processing is checking the moisture content of all wood based products (sawnwood, veneer, panels).

(a) Sawnwood is inspected for:

- kind of wood (species),
- quality: number, size and distribution of knots, and splits, rot and other faults, colour shade and grain structure,
- dimensions of lumber (deviations),
- average moisture content (should be 8 to 10%).

(b) Veneer is inspected to determine:

- kind of veneer (species),
- colour shade and grain structure,
- thickness and variations,
- evenness of surface,
- moisture content (should be 10 to 12%).

(c) Wood based panels: particle boards, plywood, blockboards, and fibreboards are inspected as to the following:

- surface quality,
- thickness and variations (standard tolerances are ± 0.3mm),
- moisture content (should be the same as for solid wood).

(d) Glues, lacquers and paints:

- Glues can be checked by making glueing tests.
- The viscosity of glues, lacquers and paints must be checked before use. It could be done with standard Ford cup No. 4, having 100 ccm volume. Viscosity is measured in seconds and the flowing time must meet the recommendations of the manufacturer of that material.

4.4 Control of manufacturing accuracy in processing.

The actual accuracy of parts and details machined on woodworking machines is mostly ± 0.1 to ± 0.3 mm, taking into account the changes in dimensions resulting from variations in moisture content during the manufacturing process. The accuracy of small details, like joints, can be higher thanthat of larger parts. For example, a 10 mm detail can be machined with an accuracy of ± 0.15mm, while a 1000 mm long part only with an accuracy of about ± 0.3 mm. So tolerances in small details are more narrow than in bigger components.

The accuracy of rectangularity of panels is of particular importance in the production of casegoods furniture. In panels less than 500 mm wide the rectangularity may vary ± 1mm.

In order to determine realistic quality demands for manufacturing accuracy it is necessary to know the precision of the machines to be used in the processing.

It is apparent that practical accuracy attained in the furniture production is lower than expected. This is usually owing to improper use of machines, the poor condition of the machines or the tools or use of the wrong type of tools.

(a) Advantages of high accuracy.

The major advantages of high and controlled accuracy in furniture manufacturing are:

- interchangeability of parts is possible,
- joints are easy to assemble and have a good strength,
- easy assembling and a sliding fit between parts without manual fitting,
- manufacture in large series is possible,
- number of faulty parts or products decreases,
- higher quality of products,
- less claims from customers,
- better financial results for the factory.

(b) In order to achieve higher accuracy the following measures are necessary:

- The machines must be regularly serviced according to their working instructions.
- The correct type and only well maintained tools must be used,
- Machines must be set up by using high quality special measuring instruments. The setting is checked by test feeds and using nominal measuring gauges.
- Working drawings of parts must be dimensioned indicating numerical values of the nominal dimensions to be achieved.
- Only high quality measuring instruments must be used.
- The unavoidable variations in dimensions must be concealed by structural means, taking them into consideration at the design stage.

- Nominal measuring gauges and templates must be used to control dimensions during machining.
- Jigs must be used in machining and assembling whenever possible.
- The machining and assembly shops must be adequately lighted.
- The accuracy must be continuously controlled by spot tests.

Working drawings with numerical dimensions must be used for the following operations:

- setup of machines,
- design and construction of jigs,
- control of measures in machining and assembling.

4.5 Ordinary measuring instruments

The following measuring instruments are necessary for the control of quality in the production of furniture:

- tape rulers with millimeter scale,
- rigid straight rulers with millimeter scale, reading by steps 1/10 mm.
- Vernier calipers, reading by steps of 1/10 mm.
- Fixed-angle gauges for 90°,
- Adjustable angle gauges (see fig. 14).

Particular attention must be paid to proper handling and storage of all measuring instruments.

4.6 'Nominal measure' gauges

To control the setup of machines and the accuracy of machining operations specially constructed 'nominal measure' gauges are very useful.

The most important types are:

- gauges for length and width,
- gauges for thickness,
- gauges for boring pitch,
- gauges for joints,
- templates for profiles.

These gauges can be constructed and made locally using steel or duraluminium, or in some cases laminated wood.

The 'nominal measure' gauges are especially recommended for standardized dimensions which are repetitive. Usually they are constructed to perform several measuring operations. The adaptable gauges must be constructed of steel.

The main advantages of gauges are the following:

- that there is no risk of misreading,
- that the rapid and accurate setup of machines can be achieved,
- that simple, rapid and reliable interoperational control can be performed by spot tests,
- that the measure control is also accurate in badly lighted workshops.

4.7 Tolerance gauges

The tolerance gauges are needed for controlling joints constructed to be machined with tolerances. A tolerance system in a furniture factory could offer numerous advantages. Creating a complete and realistic tolerance system is, however, a complicated task. But simple tolerance gauges with minimum and maximum values can be used easily in any production. All dimensions between minimum and maximum are acceptable.

The gauges with the middle step or nominal measure sometimes are used for setting up machines.

4.8 Continuous quality control by workers.

The quality control in a furniture factory must be continuous and should cover all stages of production. Faulty parts must be rejected immediately when the faults appear. Such a part should not continue through the subsequent stages of production and should not reach the assembly area if not corrected to satisfy the quality criteria.

The workers in the factory should be trained to put aside all faulty parts as soon as a defect appears. It is best if an operator at the next operation is responsible for not processing faulty parts. He should return them to the previous work station. This system is well known as a 'quality circuit' and it has proven to be very efficient.

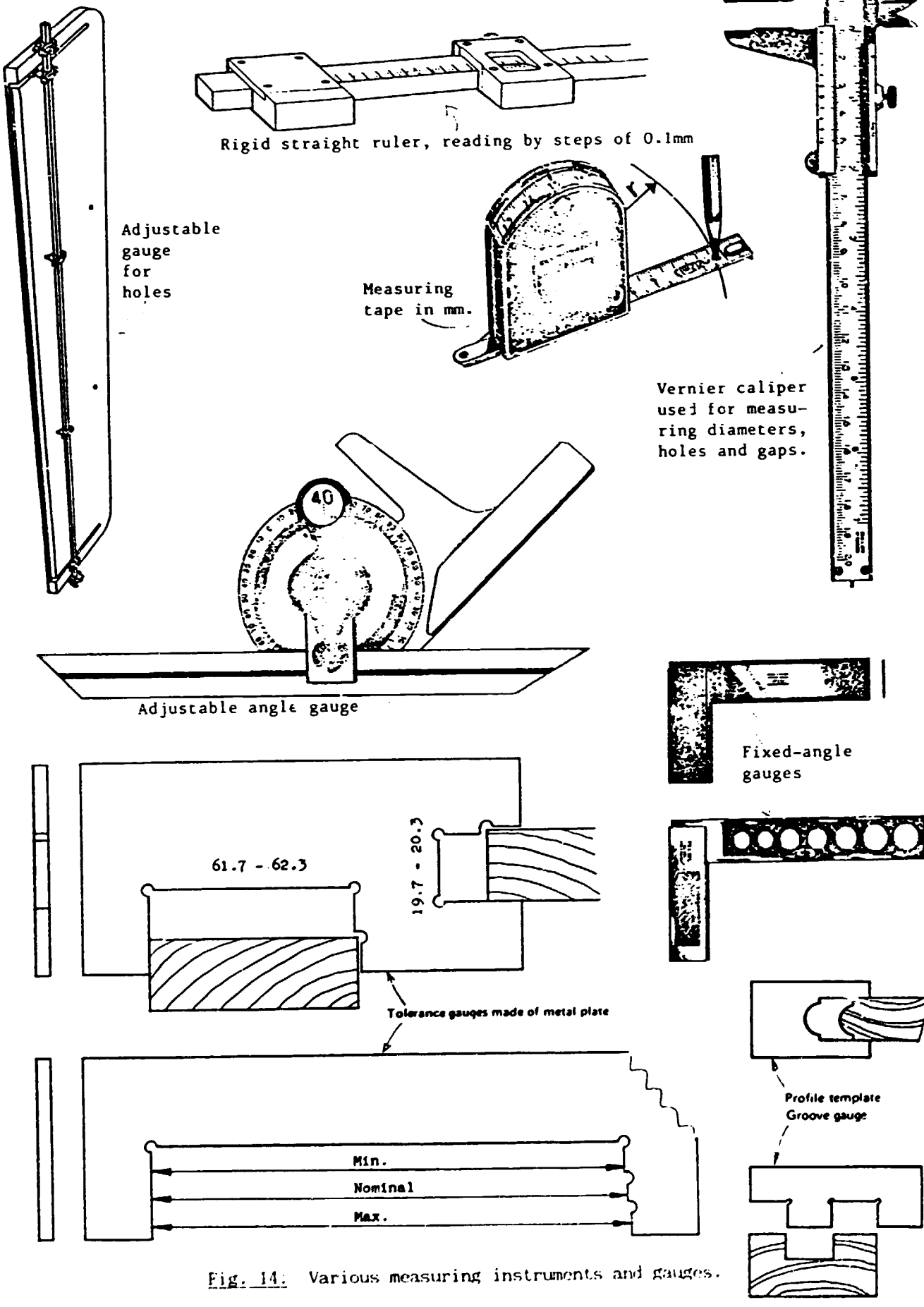


Fig. 14: Various measuring instruments and gauges.

The visual piece-by-piece control is the responsibility of operators.

4.9 Quality control in surface finishing.

The present tendency in the furniture production is to lacquer or paint the parts and carry out the assembly as the last production stage. The quality control check of the finished surfaces is principally the same in both cases. The quality of a finished surface is very important because the outer appearance of furniture depends to a great extent on its finish.

The checking of the quality of a finished surface is usually done by visual observation without special instruments.

The principal objects of control are:

- evenness of surface,
- gloss of surface,
- colour shade and its evenness in lacquered products,
- visible glue penetrations and remains under the surface film,
- quality of edges and corners,
- quality of surfaces close to joints.

To check the resistance of the lacquered film to scratches, heat, liquids, etc. special instruments should be used, and it is rarely done in the factories, but in special quality testing institutions.

4.10 Quality control of assembly

The assembly of furniture is usually divided into two steps: partial assembly (pre-assembly), and final assembly. Consequently, the quality control of assembly should also be divided.

The principal objects of control are:

- main dimensions,
- overlaps in minor measures,
- rectangularity,
- other angles,
- parallel run of parts,
- clearance and function of moving parts,
- general check.

The accuracy of assembly is best controlled with specially constructed 'nominal measure' or tolerance gauges if a tolerance system is used in the factory. The rectangularity is of major importance for casegoods furniture and should be checked by using diagonal measure gauges.

Jigs should be used in assembly whenever possible because they enable high accuracy to be attained. The guiding surface of jigs should correspond to the primary measures of the product. These are the measure that is essential to the proper function of the product or its parts.

The final check is always done on a product that is finished and ready for packaging. This last control includes a general check of the product. All functions of a product are checked: working of doors, drawers, built-in mechanisms, etc.

An accepted product is provided with the manufacturer's stamp and packaged.

In case of packaging and shipping knock-down furniture, random samples should be taken, assembled and checked for function and general quality. In the case of shipping knock-down furniture special attention should be paid to the completeness of all parts, fittings, hardware and assembly instructions.

4.11 Testing of finished furniture

Testing of finished products requires particular testing equipment to test durability and resistance of the product. This is done in the specialized and authorized institutions, in accordance with special testing standards.

4.12 The new approach to quality control

All traditional systems and methods of quality control focus on the detection and selection of wrong parts or products and on undertaking corrective actions in order to prevent repetition of faulty work. But it looks like counting dead people. All repairing work is costly and impedes production in one way or another.

The new approach to the problem of quality intends to prevent mistakes in the production. For that purpose different electronic detectors are developed for each particular case, which will stop production or give a signal as soon as the first defect is detected. Such automatic detectors are known as 'Poka Yoke', the term taken from the Japanese language, where poka yoke has been invented and originally used.

This approach leads to the '0' (zero) defects production which is an ideal for both the producer and the customer.

'Poka Yoke' could be used easily in the furniture production to detect sizes, holes, completeness of package and so on.

5. MANAGING QUALITY CONTROL IN FURNITURE PRODUCTION

The main task of the management of quality control is to establish and maintain an efficient quality control system.

In the establishment of a quality control system, the first decision is on the standards to be adopted. In developing quality standards consideration must be given to the physical characteristics of furniture products which are directly measurable (length, thickness, rigidity, strength, etc.) as well as those attributes which are not easily measurable (beauty, smoothness, appeal, etc.).

In defining quality standards both the customer's and the manufacturer's point of view must be taken into consideration. Contacts with customers are needed to define, in terms of quality, their needs and wishes. A manufacturer also must take into account his available resources and capabilities. The quality standards are a compromise between the customer's requirements and the producer's possibilities. However, since the definition of quality emanates from the customer and is further reinterpreted by the manufacturer, there is a strong argument for viewing quality from the customer's standpoint.

There are two basic ways through which definitions of the quality of a product emerge. One is when the manufacturer is asked to conform to a certain standard (to meet export's or a subcontractor's requirements). The other way is when the firm has developed its own standards.

Determining the level of tolerances is the next step. Here the manufacturer is concerned with permissible variations around the nominal sizes of basic criteria set in the quality standards. This is expressed in terms of basic criterion plus or minus an acceptable tolerance limit (Example: 1820 $\pm$ 0.8 mm). The tolerance limit should be broad enough to accomodate variations caused by factors inherent in the production process.

The next step is to determine the manufacturing sequence. From this sequence, the manufacturer should establish those critical points where quality standards should be strictly adhered to.

The following step involves listing procedures to be followed in checking the quality level prescribed by the standards. For this purpose different tools are used in furniture manufacturing, such as: rulers, calipers, straight edge rulers, fixed and adjustable angle gauges, thickness gauges, go-no-go gauges, etc. Controlling rules and adequate forms also have to be used (see fig. 14).

Normal inspection routines include: 'first product inspection', 'random sampling', 'inspection by batch' and 'inspection of all products'.

Finally, the quality control system must be activated and all responsibility for its functioning must be defined. The definition of responsibilities must answer the following questions:

- Who is responsible for ensuring the quality of the raw materials used?
- Who is responsible for checking quality at each critical point?
- Who is responsible for the final control of the finished product?
- What kind of data must be collected during the checking of quality?
- What kind of information must be prepared in order to prevent a repetition of defects?
- Who is responsible for undertaking corrective actions when deviations exceed the accepted tolerances?

When these and similar questions have been satisfactorily answered, the system can be implemented, and the proper corrections and adjustments will be made where and when necessary (see fig. 15).

Every quality control initiative should be both preventive and remedial in objective. Prevention is concerned with determining, at various production stages, the reasons why defects occur, in order to keep them to a minimum at the final stage of production.

The remedial aspects involve sorting out the defective parts at the final stage so as to ensure that only acceptable products reach the customers.

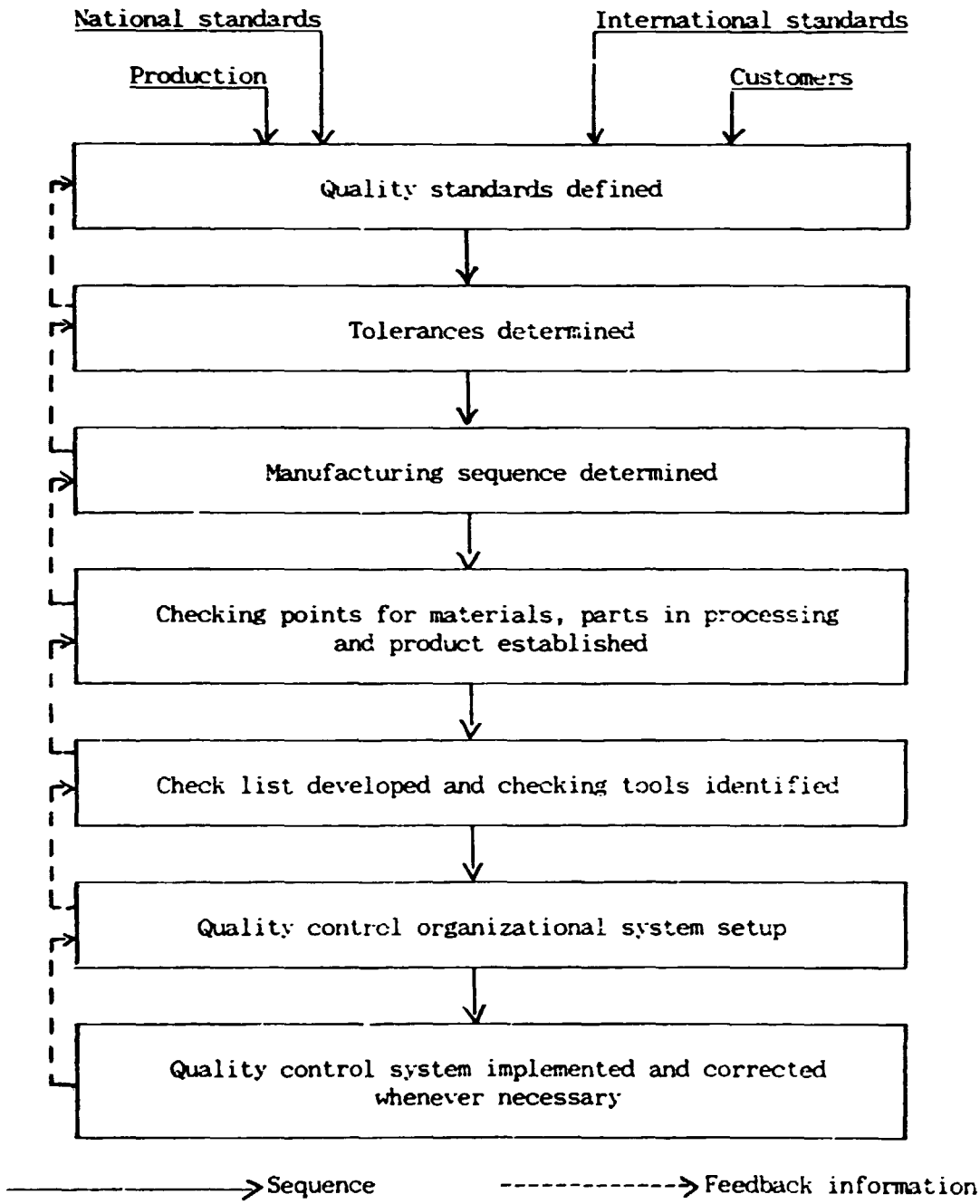


Fig. 15: Sequence in developing a quality control system.

Quality control means identifying causes of variations from set standards or specifications and undertaking corrective actions whenever these variations are out of tolerances.

6. QUALITY CONTROL PROCEDURES

A common way to ensure quality is to conduct inspections at various points in the manufacturing process. These inspections, by using measuring devices to compare the product and its performance with specified standards, will identify defective products.

The quality control unit should get one set of the production documentation, containing:

- working drawings of parts to be produced,
- list of materials and components,
- list of tools,
- list of jigs,
- technical description of the product,
- operational lists,
- assembly drawing,
- packaging instructions,
- special requirements for the product, if any.

The chief of the quality control unit should study all the production documents, especially quality standards and tolerances. That is, at the same time, quality control of documentation, which is most essential for ensuring proper quality of products. He should also study the quality control information pertinent to the past production of the same product. Based on both these facts, he will prepare the quality control technology, prescribing:

- Materials to be controlled, including: place, method, instruments and reporting forms,
- parts to be controlled in the process, including: controlling sequence (when, i.e. after which operation), methods, measuring instruments and reporting forms,
- end-control of products and eventual classification by the quality level, ordering major features to be inspected, controlling instruments and reporting forms.

All these tasks will be written in the form of the quality control job orders, which will be dispatched to the individual controllers for the preformance of the control (see fig. 16).

Company:_____ Date:_____

QUALITY CONTROL JOB ORDER NO._____

Controller:_____ M_____ P_____ E_____

Factory:_____ Product:_____ Order:_____

No.	Object of control	Place of control	Quantity	Method of control	Instrument	Form	Reporting

Special instructions:

M - materials
P - in process control
E - end control

Chief of the quality control unit_____

Fig. 16: Quality control job order form.

A very important part of the quality control task is the regular checking of woodworking tools, jigs, and, from time to time, checking the precision of the machines. To control parameters of tools comparator and adjustable angle gauges can be used. Jigs could be controlled by rulers, comparators and different gauges.

To find out the precision of a machine it is necessary to measure a sample of a certain number of machined parts, measuring deviations from the nominal size. The number of parts to be measured depends on distribution of deviations from the nominal size and on the expected reliability of the result.

The standard deviation is obtained from the following formula:

$$s = \sqrt{\frac{\Sigma(xi - \bar{x})^2}{n - 1}}$$

where s = standard deviation
n = number of measurements,
xi = values of single measurements (x1, x2, ... xn)
$\bar{x}$ = average value of all measurements.

It determines the precision of the machine, because the normal distribution from -3s to +3s covers 99.7% of all cases.

The standard deviation indicates:

- whether the machine is set properly (is there a difference between the nominal or intended size (Xn) and the average size ($\bar{x}$)?),
- scatter of deviations from the average size, which indicates the precision of the machine, the need for its repair or the broadening of the tolerances if the existing ones are too narrow (see fig. 17).

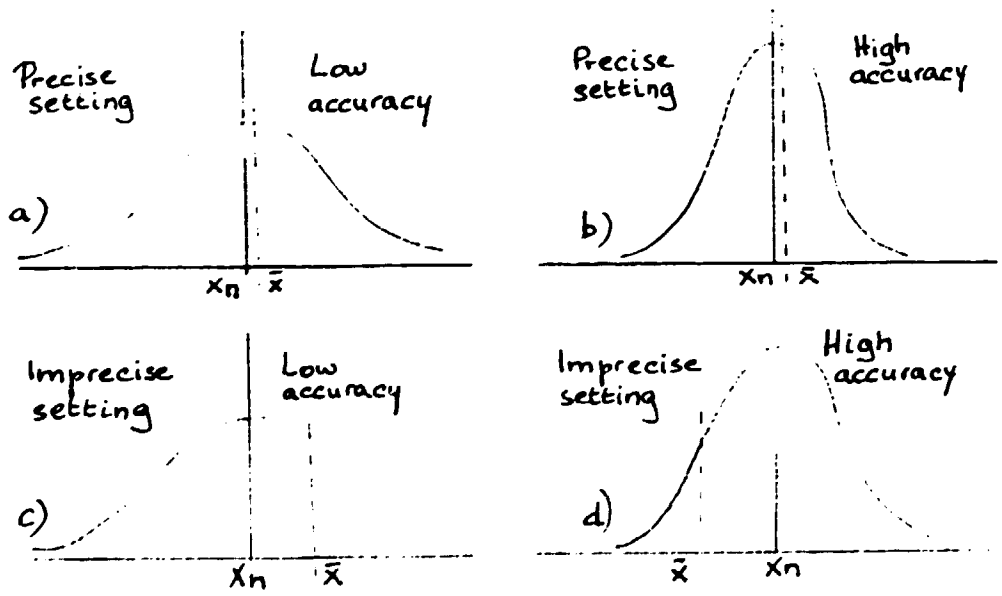


Fig. 17: Standard distribution and precision of machines.

The standard deviation method is widely applied in the statistical quality control, mainly to determine reliabilit f products and reliability of other information related to quality.

7. QUALITY CONTROL REPORTS

The basic rule for the control of quality is that all findings, tolerable and untolerable, must be notified in written form and reported. The quality control which does not produce and use written information is useless and unnecessary. Without proper written information quality control cannot fulfil its preventive role, which is of the utmost importance.

The first level report, and the most important one, is given to operators and supervisors in the production, at the same moment when a defect or any kind of deviation from the standardized quality is noticed. This information could be verbal or written, but it must be clear with respect to identifying the kind and cause of the defect.

The next are daily reports written on the prescribed forms, with one copy forwarded to the production manager, the second to the chief of the quality control, and the third copy for the controller's record (see fig. 18).

Company _____ Date: _____

Quality control daily report Controller: _____

Factory _____ Product _____ Prod.order: _____

No.	Object of control	Quantity	Feature controlled	Accepted pieces	Rejected pieces	Reason for rejection M E T W pieces	Other

Remarks and suggestions:

M = materials, E = equipment, T = tools/jigs, W = workmanship

Controller: _____

Fig. 18: Quality control daily report form.

This form (report) should be completed for each product controlled during one day. The purpose of this report is to determine, from the quality point of view, critical materials, critical constructions, critical parts, critical operations, critical sub-assemblies and products, as well as major causes for occurance of deviations.

The so-called 'Xi, x, and X, R' control cards are very suitable to register dimensional deviations and to determine causes for their abnormal distribution. (An 'Xi control card' is shown in fig. 19).

Based on the daily reports, the chief of the quality control unit will prepare a monthly quality control report. It is best if a monthly report contains all defects and causes of defects arranged in the form of an ABC (Pareto) analysis. They could be shown as percentages of unacceptable cases, computed from all inspected pieces or measurements (see fig. 20).

Separate ABC analyses could be prepared for materials and components, for furniture parts and sub-assemblies, for production operations and all products.

To better control quality, it is strongly recommended to calculate or, at least, to estimate cost of bad quality and to include such information in the monthly report.

The monthly reports are to be submitted to the management of the factory, to the product development department, to the work preparation and purchase departments.

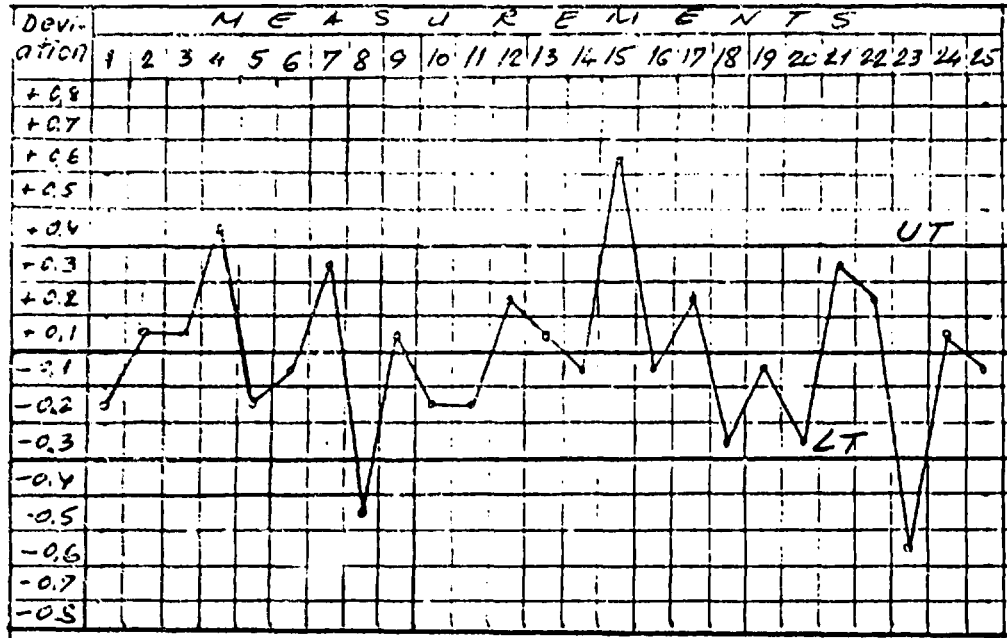
Finally, the chief of the quality control unit should prepare quarterly and yearly control reports which show how the whole programme for the improvement of quality is going on. These reports are to be submitted to the top management of the company.

The chief of the quality control unit should take part in all meetings concerning the quality of products arguing for joint efforts in order to improve quality. He must also be a member of a product development team to point out errors noticed on he existing products which must not be repeated.

Company: PWC — Date: 20 May '88

Xi CONTROL CARD No. 101

Factory: FFP Product Cupboard Operation: Thicknessing UT +0.3
Machine Thicknesser Part Door frame rail Nominal size: 19 mm LT −0.3



n	n×X	$x_i-\bar{x}$	$(x_i-\bar{x})^2$	$n_i(x_i-\bar{x})^2$
1	0.6	0.612	0.375	0.375
1	0.4	0.412	0.170	0.170
2	0.6	0.312	0.097	0.194
3	0.6	0.212	0.045	0.135
5	0.5	0.112	0.013	0.065
5	-0.5	-0.088	0.008	0.040
4	-0.8	-0.188	0.035	0.140
2	-0.6	-0.288	0.083	0.166
1	-0.5	-0.488	0.238	0.238
1	-0.6	-0.588	0.346	0.346
Total: 25	-0.3			1.869

Remarks: Dispersion of deviations
−35 to +35 = −0,837 to +0.837 mm
Recommendation: The machine is to be checked and repaired

$$\bar{x} = \frac{\sum n \times x_i}{n} = \frac{-0,3}{25} = -0,012$$

$$s = \sqrt{\frac{\sum (x_i-\bar{x})^2}{n-1}} \approx \sqrt{\frac{1,869}{24}} = 0,279$$

Submitted to: Production manager
QC record Controller ____ Chief quality control ____

Fig. 19: Xi control card

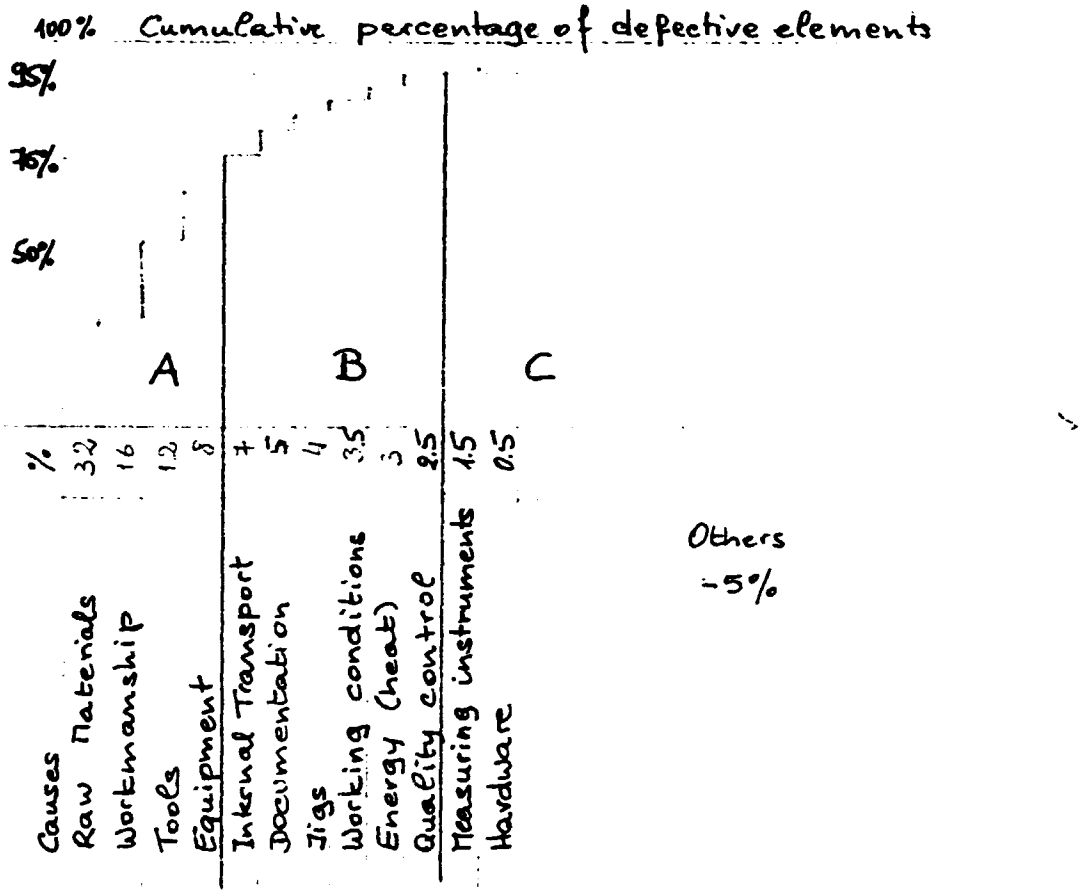


Fig. 20: ABC diagram

8. INTERNAL ORGANIZATION OF QUALITY CONTROL IN THE PWC

The essence of quality control is:

- planning quality control,
- performing quality control,
- data processing and reporting quality control.

The internal organization of quality control within the Pyongyang Wood Complex should be designed to cover all these three aspects.

Planning quality control could be covered by the chief of the quality control unit.

Performing quality testing should be divided into three sections:

- control of raw materials and incoming components
- in-process control, and
- end control of finished products.

Since different methods and measuring instruments are used for each of these control fields controllers should be specialized accordingly.

Data processing is a daily task and should be performed by one person who possesses statistical knowledge.

Reporting naturally belongs to the chief of the quality control unit (see fig. 21).

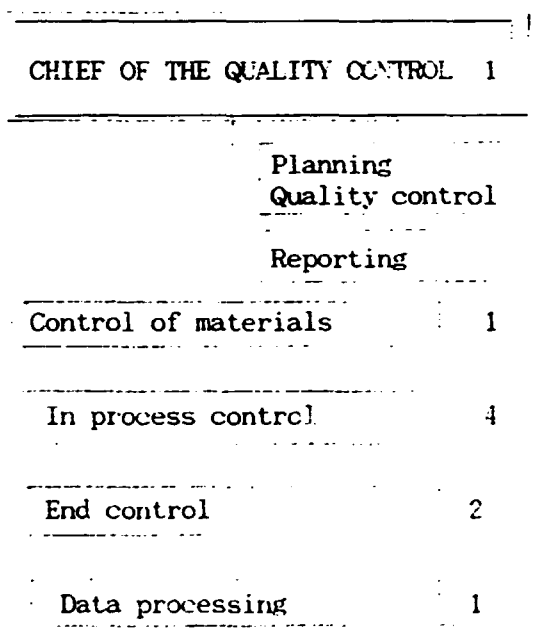


Fig. 21: Organizational scheme of the quality control unit.

9. SYLLABUS FOR TRAINING CONTROLLERS

Purpose:

This syllabus may be used for training quality control controllers in the furniture production, in order to acquaint them with the essence of an integral quality control system, covering methods, instruments and procedures, as well as with the duties and responsibilities of controllers who are performing quality control.

Training place:

Theoretical lectures will be given in the classroom, and thereafter practical work will be exercised in the different stages of furniture production.

Method:

The training manual prepared will be translated into Korean, reproduced and distributed to the controllers. Theoretical lectures will be aimed both to lead to discussions and to give the necessary explanations, paying more attention to the particular questions of quality which the existing furniture production is faced with. Also internal quality standards are prepared and translated into Korean language. During theoretical lectures the purpose and the way of using internal standards will be explained.

The theoretical part of the training will be the same for all controllers, while the practical training will be divided and the following will each be trained separately:

- Chief of the quality control unit: (training will cover the planning, overall control and reporting),
- Controllers for raw materials and components (incoming control),
- Controllers of manufacturing (control of manufacturing accuracy during processing),
- Controllers for end control (control of finished products).

Instructors:

Theoretical lectures will be conducted by the Chief Technical Advisor of the project, while practical training will be conducted jointly by the Chief of the quality control unit and the CTA.

Training programme:

Stage	Topic	Training time (in hours) Theoretical	Training time (in hours) Practical	Level of competence to be reached
01	Introduction and general information about quality of products	2	-	Understanding the modern concept of quality control, to be able to explain and promote an adequate quality policy, and to motivate workers for better quality of workmanship.
02	Quality control in the furniture production: - quality of furniture and variables it depends on, - quality control of materials (sawnwood, veneer, wood based panels, glues, lacquers, paints, hardware and other components) - control of manufacturing accuracy in processing (advantages and measures to achieve high accuracy) - quality control in surface finishing, - quality control of assembly, - end control of finished products, - continuous quality control by workers, - A new approach to quality control.	4	16	Proper quality control of materials, manufacturing accuracy, finishing, assembling and end control of finished products. Determining the main objects of inspection. Determining defective work and other deviations. Being able to define causes and to give proper remedial advice. Measuring the moisture content of the wood. Measuring viscosity of glues and lacquers. Determining the dry substance content of glues and lacquers
03	Measuring instruments and gauges used in the quality control of furniture: - ordinary measuring instruments (tapes and rulers with millimeter scale, rigid straight rulers, Vernier calipers, fixed and adjustable angle gauges),	2	8	Proper use and maintenance of various measuring instruments and gauges used in quality control of furniture manufacturing. Precise measurement of dimensions and other quality characteristics. Control of accuracy of instruments.

Stage	Topic	Training time (in hours) Theoretical	Training time (in hours) Practical	Level of competence to be reached
	- 'Nominal measure' gauges (for length and width, for thickness, for boring pitch, for joints, for profiles), - tolerance gauges, - assembly gauges, - finishing patterns, - moisture meter, - Ford cup viscosimeter - laboratory scale.			
04	Quality standards for: - materials, - workmanship.	2	1	Understanding and use of standards. Understanding defects and tolerances appearing in furniture production.
05	Some questions and answers regarding the quality of products: - what is quality? - why is quality important? - what is the cost of quality? - what is the cost of bad quality? - why do defects occur? - what is the impact of defects on the success of production? - how are instructions followed? - how are defects decreased? - standardization and quality - information and quality.	2	-	Persistance in everyday efforts for improving quality, and possession of arguments against attempts to justify bad quality as a result of certain circumstances in the production.
06	Testing of furniture products (elementary information)	1	-	Understanding purpose and methods of testing.

Stage	Topic	Training time (in hours) Theore-tical	Practi-cal	Level of competence to be reached
07	Managing quality control in furniture manufacturing	1	-	Understanding quality policy and management techniques in quality control. Defining the manufacturing sequence. Defining the duties and the responsibility for quality in the company.
08	Quality control procedures	2	4	Understanding working procedures in quality control.
09	Reporting in quality control	1	2	Preparing various reports. Collecting and sorting data for daily reports. Other reports to be prepared by the quality control unit.
10	Internal organization of the quality control unit	1	-	Understanding the internal organization of the quality control unit. Better collaboration within the quality control unit.
	TOTAL	18	34	

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ANNEX I

INTERNAL STANDARDS FOR THE QUALITY OF FURNITURE

- P R O P O S A L -

TABLE OF CONTENTS

INTRODUCTION

This proposal for the furniture quality standards, to be used in the Pilot Furniture Plant and, possibly, by the entire General Bureau for Building Materials, is based on International Standards (ISO), German standards (DIN), and Swedish standards (SIS), with adequate simplifications and adjustments to better suit the local conditions.

In this standard, the quality of material and workmanship are graded in three levels. The grading is mainly based on visual and tactile determination of material properties and precision of manufacture, which could affect the utility and appearance of the finished products.

The durability (strength of frames, rigidity, surface resistance, etc.) is determined according to other standards.

This standard is applicable to furniture and built-in furnishing products.

General requirements for good furniture could be spelled out as follows:

- Furniture must have the right measurements to fit the human body, to give the user a correct posture, and not cause pressures in wrong places. It must also fit special requirements of eg. old people and children.
- Furniture must have a clear function, allow alternative uses and have good assembly and maintenance instructions.
- Furniture must be light, moveable, or, if heavy, it should be possible to disassemble it for removals, with a possibility to clean underneath it or behind it.
- It must be strong with good construction, hard wearing surfaces, no sharp edges and steadfast against deformations.
- It must be easy to clean and to replace worn parts.
- It must be safe, not liable to fall over, nor to crush fingers, and be without any sharp corners at the height of small children.
- The durability (long use) of the furniture must correspond to the prices paid by customers.
- It must fit the climate, relieve heat or moisture, and fit the space available in size and form.
- It must be compatible with social and cultural surroundings, suit aesthetic needs in form and colour and give an impression of quality.

- It must be suitable to be produced on an industrial scale, fit the raw materials available locally and utilize them to their best advantage.
- It must match the skills and knowledge of the workers.

2. DEFINITION OF GRADING LEVELS

A complete and finished piece of furniture or parts thereof are classified according to requirements into levels: I, II and III. In this standard, the word 'defect' means any kind of deviation or failing in the material and the manufacture of the product.

Level I

No defects affecting the desired function and appearance are allowed, whereas scarcely noticeable defects which insignificantly affect the intended appearance are allowed.

Level II

No defects affecting the desired function are allowed, whereas a few clearly noticeable defects affecting desired appearance are allowed.

Level III

Defects affecting the desired function are allowed if reasonable hygienic and normal safety requirements are fulfilled. No broken parts are allowed, but other defects affecting only the appearance are accepted.

The quality required for the different parts of the furniture is given in the following table:

	Quality level of furniture		
Parts	I	II	III
Well exposed parts	I	I	II
Less exposed parts	I	II	III
Concealed parts	II	III	III

Note:

Well exposed parts:

Table tops, front doors, armrests, seats and backs of chairs, fronts of drawers, headboards and footboards of beds, etc.

Less exposed parts:

Legs of tables and chairs, aprons, shelves, sides of casegoods furniture, inside of drawers and cupboards, stretchers, bedsides, visible backs, etc.

Concealed parts:

Undersides of drawers, invisible backsides, undersides of seats, bottoms, upholstery frames, etc.

3. GUIDE TO THE USE OF THE TABLES

The quality requirements are stated as a maximum measure (mm) or percent (when possible). The measuring instructions should be according to ISO-standard No. 000. However, most of the requirements are stated as defect severity grades: 0, 1, 2, 3 (as defined below) when the assessment is carried out without any measuring aids.

The defect severity grades are the following:

0 Defect indicated is not permitted.

1 The defect can only appear at one place and should be very small or form a hardly noticeable contrast against the surrounding surface.

2 The defect can appear clearly visible either as a single large defect or a number of smaller defects.

3 Defects can appear to an unlimited extent unless they affect the function of the furniture or provide an injury or damage risk.

For the assessment of quality, the better (face) side of material is observed, while the opposite side can be of lower quality, but only one grade lower.

4. QUALITY OF MATERIAL

4.1 Solid wood and surface veneer

Defects	Quality level of furniture		
	I	II	III
Bark, insect damage, decay, unsound knots, pitch pockets	0	1	2
Knotholes, loose knots, wane, hole scar	0	1	2
Inbark, bark ringed knot	0	1	2
Visible pith (of maximum width)	0	1(3mm)	2(6mm)
Open cracks and splits	0	0	2
Filled cracks and splits (not in colour), drilled and plugged knots	0	1	3
Knot groups, stripes of sapwood in the wood with distinct heartwood formations, discolouration (filled knots size maximum)	0	2(6mm)	3(12mm)
Filled cracks and splits (in colour), small surface cracks	0	1	3
Cross grained or slope grained wood	1	2	3
Strips of heartwood contrasting to the general appearance	1	2	3
Sound knots or firmly fixed dead knots (maximal size)	1 (6mm)	2 (12mm)	3 (30mm)

- If the defect is employed deliberately with a decorative effect, the next higher level may be quoted.

4.2 Other materials used in the furniture production

Defects	Quality level of furniture I	II	III
(a) Particle boards used visibly in the construction (not veneered):			
- discoloration, cavities, unevenness, filled cracks in the material	0	1	3
(b) Metals:			
- visible parts with corrosion attacks or without any kind of corrosion protection	0	0	3
- mill scale, offside scale, cavities and hollows	0	1	3
- porous welds or solders	1	2	3
(c) Plastics:			
- open cracks in the material	0	0	2
- filled cracks in the material	0	1	3
- discoloration	1	2	3
(d) Stone materials:			
- loose fossil, crack indications	0	1	3
- deviations in the colour and structure	0	2	3
(e) Glass:			
- structural faults (cavities, threads, sand or other particles)	0	1	3
- Irregular flatness, scratches, tarnish	0	1	3
(f) Upholstery filling materials:			
- filling materials containing metallic parts, wooden chips, paper, strings, etc., filling materials of animal nature not cleaned and desinfected, materials giving a penetrating smell	0	0	0
- cavities detectable through the covering material, uneven springiness detectable through the covering material, hard quilled feathers detectable through the cover	0	1	3
(g) Upholstery cover material:			
- slippage and tearing in the material, weaving defects	0	0	2
- major defects in leather (such as open scratches, discolorations, rough grain, grain ruptures, etc.	0	2	3
- irregularities in leather (such as healed wounds, healed surface scratches	1	3	3

5. QUALITY OF WORKMANSHIP

5.1 Dimensions

Deviation	Quality level of furniture I	II	III
Deviation from stated total linear dimensions	1mm	2mm	4mm
These requirements are only valid if dimensional deviations might have any effect on the proper fitting of one unit to another or to a building for built-in furniture products			

5.2 Angles

Deviation	Quality level of furniture I	II	III
Deviation from the right angle			
- when sides are max. 400 mm, maximal deviation	0.4mm	0.8mm	1mm
- for any length thereafter, the deviation is measured in percent of the total length between corners, max.	0.1%	0.2%	0.3%
but not exceeding	1mm	2mm	3mm
- deviation from intended shape, parallelism, symmetry, etc. (legs, armrests, etc.)	1	2	3

5.3 Flatness

Deviation	Quality level of furniture I	II	III
(a) Uneven contact with supporting flat surface (rocking)	1	2	3
gap between leg and/or plinth and floor not exceeding	1mm	2mm	4mm
(b) Deviation from flatness (bow, cup, twist, etc.)			
in percent of the length of the edge or diagonal where the deviations appear most, but not exceeding	0.3% 1mm	0.6% 3mm	1% 5mm

5.4 Straightness

Deviation	Quality level of furniture I	II	III
Deviation from the intended straightness in percent of the length of crossbars, slots, rods, etc. maximum	0.3%	0.6%	1%

5.5 Parallelism of gaps

Deviation	Quality level of furniture I	II	III
Deviation from parallelism of gaps (eg. clearance gaps between or around drawers and hinged doors			
- of gaps shorter than 400 mm, maximum	1mm	2mm	3mm
- of gaps longer than 400 mm in percent of the length, maximum	0.2%	0.4%	0.8%
but not exceeding	1mm	3mm	6mm

5.6 Width differences of gaps

Deviation	Quality level of furniture I	II	III
Difference of width between gaps intended to be equal (eg. clearance gaps between or around drawers or hinged doors) maximum	1mm	3mm	4mm

5.7 Alignment of drawers and doors

Deviation	Quality level of furniture I	II	III
(a) Deviation from edge alignment, maximum	1mm	2mm	4mm
(b) Deviation from front plane alignment, max.	1mm	2mm	4mm

5.8 Action of drawers

Deviation	Quality level of furniture I	II	III
Unsmooth sliding action closing force, max.	40N	60N	80N

The method of measuring for the paragraphs: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 and 5.8 is according to ISO 000.

5.9 Action of doors

Deviation	Quality level of furniture I	II	III
Unsmooth action	1	2	3

5.10 Assemblies, joints

Deviation	Quality level of furniture I	II	III
(a) Penetration through the material by fasteners-nails, screws, dowels, etc.	0	1	2
(b) Bulge caused by the same reason (but not penetration), cracks due to forced assembling or to expansion (contraction) of materials	0	2	3
(c) Filling or repairs not in same colour, glue drippings	0	1	3
(d) Filling or repairs in same colour, visible glue or discoloration from glue	1	2	3
(e) Gaps in joints or assemblies but not exceeding:	1 0.2mm	2 0.5mm	3 1mm
(f) Gaps in joints between sides and bottoms of drawers but not exceeding:	1 0.4mm	2 0.8mm	3 1mm

5.11 Veneering

Deviation	Quality level of furniture I	II	III
Blister delamination	0	0	1
Repairs in deviation of colour	0	1	3
Chipping or fractures	0	1	3
Repairs in same colour	1	2	3
Bleed through	0	2	3
Glue visible in veneer seams	0	2	3
Gaps in veneer seams	0	2	3

5.12 Edges

Deviation	Quality level of furniture I	II	III
Unprotected edge on partcile board	0	2	3
Lipping not uniformly level with connected plane maximum deviation	0	1 0.3mm	3
Chipping of edge material	0	1	2
Colour of lipping deviating from connected material, concealed lipping appears as shadowing or irregularity (under veneer), edge rounding not uniform along one and the same given edge	1	2	3

5.13 Fittings, hardware

Deviation	Quality level of furniture I	II	III
Fittings with sharp edges	0	1	3
Screws not matching in size, sunk fittings not flush with surface (eg. hinges and locks)	0	1	3
Major gaps between (around) fittings and connecting material	0	1	3
Screws not correctly driven home or with damaged screw head slots	0	2	3

5.14 Surface evenness and smoothness

Deviation	Quality level of furniture I	II	III
Surface not cleaned from pencil marks, etc.	0	1	3
Leg ends and bottom edge of plinth rough and not chamfered	0	0	3
Sharp or uneven raises, rugged surfaces	0	1	3
Scratches, dents, depression marks, undulated and uneven surfaces, cuttermarks, rollermarks, sawtracks	0	1	3
Sanding-through of surface veneer or other surface material (before coating)	0	1	3
Deviations from intended shape	0	1	3
Uneven sanding	0	1	3
Fibre swelling	0	2	3
Transversal sanding marks	1	2	3

5.15 Finish coating

Deviation	Quality level of furniture I	II	III
Deviation from intended colour	1	2	3
Deviation from intended gloss	1	2	3
Discolorations caused by glue penetration through veneer	0	2	3
Visible bubbles caused by particles of dust or entrapped air	0	2	3
Blisters in coating film (delamination)	0	1	3
Bridging over improperly fitted joints or sharp mouldings	0	1	3
Blushing, blooming, flatting	0	2	3
Orange peel	1	2	3
Wet spots caused by presence of grease or oil	0	1	3
Pinholes, pitting	1	3	3
Pigments (if not deliberately employed)	1	2	3
Crawling, runs or sags	0	1	3
Checking, cracking, scratches in the top coat	0	1	3
Visible repairs of the top coat	0	1	3
Poor coating, not equal coating	1	2	3

5.16 Upholstered seats, padded armrests and loose cushions

Deviation	Quality level of furniture I	II	III
Unevenness felt through upholstery	1	1	3
Irregular corners	1	2	3
Loose cushions badly fitted in size to the furniture	1	2	3
Gaps or incorrect alignment between cushions and between cushions and furniture	1	2	3
Visible cut ends of the covering material with loose threads	0	1	3
Visible staples or nails (when not for decorative purposes)	0	1	3
Not symetrically cut and fitted cover pattern	0	2	3
Unequal gathering of fabric on parts intended to be alike	0	2	3
Uneven filling in edge upholstery	0	1	3
Spots and stains caused by the presence of grease, oil or colours	0	1	3
Unequal seat or cushions intended to be alike	1	2	3
Colour of thread in seams deviating from surrounding material (if not on purpose for decorative reasons)	1	2	3
Cover not stretched sufficiently (if not deliberately applied for a desired appearance)	1	2	3
Seams unequally placed	1	2	3
Buttoning or tufting non-symetrical or uneven	1	2	3
Covered armrests not uniform in pattern	1	2	3
Varying thickness on pipings	1	2	3
Stitching flaws	1	2	3
Uneven or unequal radius on corner seams	1	2	3
Button with diverging pattern direction	1	2	3

6. DEFINITION OF DEFECTS

6.1 Wood

Bark-ringed knot	A dead knot surrounded with bark.
Bole scar	A surface wound that has been enclosed by the growth of the tree.
Cross-grained wood	Wood in which the grain alignment is irregular.
Dead knot	A knot which has more or less completely broken off its growth connection with the rest of the wood.
Decay	Decomposition by fungi.

Inbark	Bark which is partially or completely enclosed in the wood.
Insect damage	Mark or hole caused by insects
Pitch pocket	Cavity containing resin
Sap stains	discoloration appearing under the action of wood-coloring fungi.
Sapwood	The outer layers of wood in the tree, outside the heartwood.
Slope of grain	The divergence of the grain from the direction of the longitudinal axis of the wood.
Sound knot	A knot showing no indication of decay and intergrown with the surrounding wood.
Unsound knot	A knot attacked by fungi.
Visible pith	Appearance of pith on the cut surface of the wood.
Wane	Surface of the wood untouched by the saw.

6.2 Glass, metal

Tarnish	Film of colour formed on the surface of glass or metal.
Mill scale	Flakes of metal derivating from mill rolling
Offside scale	Flakes of metal formed under heat-rolling or welding.

6.3 Other definitions

Bow, cup, bulge, wave	An unintentional surface curvature occuring in wood or other materials.
Twist	Spiral distortion.
Flatness deviation	The degree of bow, cup, bulge, or wave is measured as the biggest distance between the surface and a median plane for all four corners. The degree of twist is measured as the distance between one corner and the median plane for the other three corners.
Clearance gaps	Visible openings around doors, drawers, etc.
Blistering	Improper adhesion and separation of the coating film from the finished surface.
Blushing	Lacquer coat turns grey or white instead of remaining clear and transparent.
Bubbling	The formation of bubbles in the partially dried lacquer film
Bridging	Lacquer film bridged over improperly fitted joints or sharp mouldings.
Orange peel	The rough surface of a lacquer coat which appears like skin of an orange.
Flatting	The finish coat lacks the normal desired effect and has a dull appearance.