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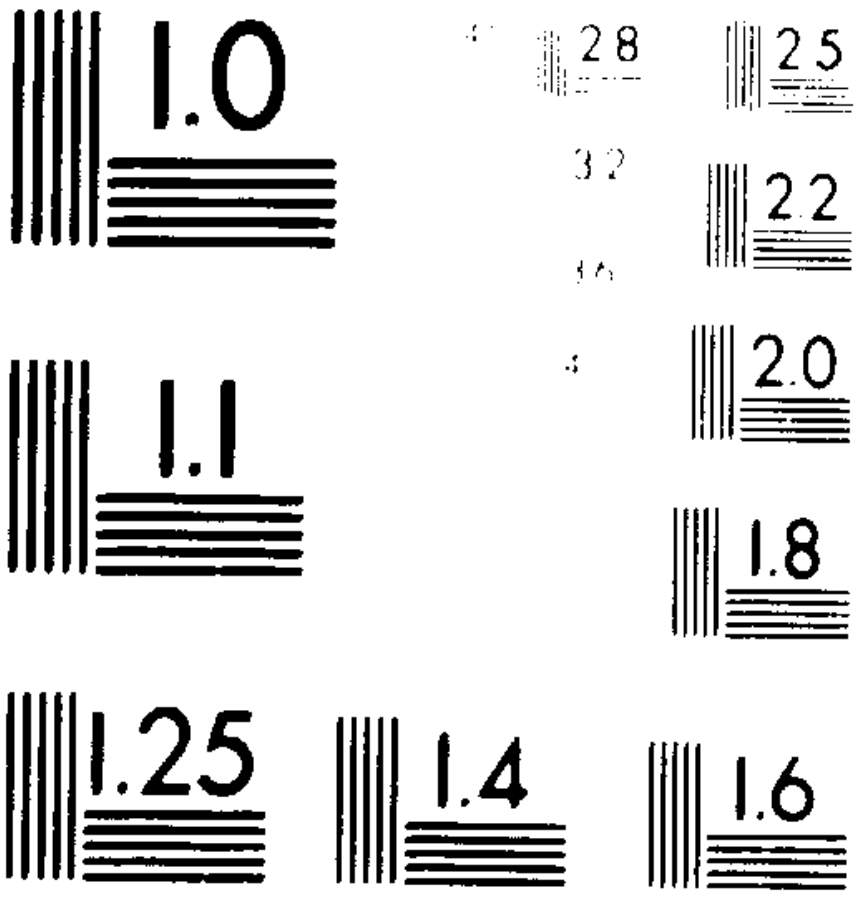

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CONSULTANCY IN THE MANUFACTURE OF MAGNETIC HEADS

SI/CPR/80/804

PEOPLE'S REPUBLIC OF CHINA

Terminal report*

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

Based on the work of Hans Juergen Schmehling
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* This document has been translated from an unedited original.

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Summary

The purpose of the project SI/CPR/80/804/11-01/31.9.C. was to assist Radio Factory No. 7 in Chengdu/Sichuan in improving the quality of the products manufactured and in developing new types of heads.

The duration of the mission was three months, from 24 May to 23 July 1984, including outward and return travel.

There are technological problems in two stages of production. Suggestions for the elimination of these problems were made and discussed. However, implementation will require further lengthy preparations and tests.

There is no testing centre for fundamental research or special measurements.

A plan for a measurement and testing centre was worked out. Advisory services in the procurement of the necessary measuring instruments and equipment would be advantageous.

The main quality problems arise through unsatisfactory intermediate tests in the individual production stages, the inadequate use of jigs and fixtures and the high working speed.

Measures for the improvement of quality were presented and some of them have already been introduced.

At the moment, all raw materials and unfinished parts are delivered by Japan. After the expiration of this agreement with Japan, the company would like to become as independent from Japan as possible and make all the unfinished parts itself. However, the prerequisite for that is the development of complete departments for stamping, deep-drawing and plastics injection moulding.

These ideas were discussed, but the company would need further assistance in these areas in order to carry out these plans.

Contents

Introduction

Radio Factory No. 7 in Chengdu/Sichuan has been making magnetic heads for two years.

It operates with Japanese equipment and Japanese know-how. The Japanese do not provide any support on the theoretical side or in the solution of fundamental problems.

The factory sends 75 per cent of its products to Japan under offset agreements, while 25 per cent are sold in China.

The three-month mission began on 24 May and ended on 23 July 1984. The project agency was the State Bureau of Electronic Industry.

The terms of reference were to assist in:

- The production and design of magnetic heads;
- Improvement of quality and quality control in manufacture.

The company management had prepared a list of questions and problems. These questions were chiefly related to manufacturing problems and quality improvement and to the theoretical bases of magnetic head technology. It was discovered that quality improvement is not a question of final testing or the testing method used. The present form of quality testing can perfectly well be retained.

The question is only one of unsatisfactory intermediate quality testing during the individual phases of manufacture.

Measures for improving manufacture and quality at the individual stages of the process were worked out discussed and transmitted to the design department and the company management.

Experimental series were worked out and guidelines were indicated for further testing methods for the analysis of problems occurring later.

It was not possible to demonstrate a number of measurement problems and methods because the necessary equipment and accessories were not available.

In addition, a number of lectures were given on the theoretical bases of magnetic head construction, their functions and electrical parameters as well as on manufacturing processes.

Some of the suggestions for improvement have already been put into practice, while lengthy preparations are required for others.

In all major alterations, the company must at the moment of course take the opinion of the Japanese into account.

A meeting of Chinese experts on the manufacture of magnetic heads was held at Chengdu from 10 to 14 July 1984.

Here also, papers were read on questions of manufacture and on head design.

I. Recommendations

Suggestions for improvements at the individual stages of production were discussed and transmitted to the company management and were accepted by them. The details are described in the report. The blueprint for a measurement and testing centre to be set up was also prepared and accepted.

The following list of equipment refers mainly to this measurement centre:

The items listed as "urgent" should if possible be obtained within six months.

A. Equipment

1.	Surface hardness tester	
2.	Film thickness tester (split film)	
3.	Surface roughness and flatness tester	Urgent
4.	Microscopes and inverstoscopes with 100x, 200x and 400x magnification, with hairline cross and reticles and micrometer mechanical stage	Urgent
5.	Coercimeter (Woelke)	Urgent
6.	Dual frequency L - Q - XL meter (Hewlett Packard, Genrad)	Urgent
7.	Dual frequency impedance tolerance meter (Woelke)	Urgent
8.	Digital ohmmeter	Urgent
9.	Wheatstone resistance measurement bridge	Urgent

10.	External field meter (Woelke)	
11.	Bench type demagnetizers	Urgent
12.	Magnetic head tester (Woelke)	Urgent
13.	Measurement heads for reference measurement	Urgent
14.	Instrument for measuring effective gap width (Woelke)	Urgent
15.	Erasing attenuation meter (Woelke)	
16.	Digital DC voltmeter. Input R $\geq$ 10 MOhm (Philips)	Urgent
17.	Three analog millivoltmeters 1 Hz - 1 MHz (Philips)	Urgent
18.	Frequency analyser 20 Hz - 20/200 kHz (Brüel & Kjaer)	Urgent
19.	Dual function generators - 3 MHz (Krohn + Hite)	Urgent
20.	Three double beam oscilloscopes - 15 (50) MHz	Urgent
21.	Tracking filter (Brüel & Kjaer)	
22.	Two adjustable band passes (Krohn + Hite)	
23.	Low harmonics generator/beat frequency oscillator: 20 Hz - 20 kHz	
24.	Two frequency counters	Urgent
25.	Wow and flutter meter (Woelke)	
26.	K-factor distortion meter (Woelke)	
27.	Stroboscopic meter (Philips)	
28.	Level recorder 10 Hz - 25 kHz (Brüel & Kjaer)	Urgent
29.	Tape tensiometer for reel-to-reel tape recorders	Urgent
30.	Tape tensiometer for cassette recorders	
31.	Five hand-held demagnetizers	Urgent
32.	Digital thermometer: -50 - 1200°C	
33.	Two DC supply units: ± 0 - 22 V	Urgent
34.	Five temperature controlled soldering stations 45 W	Urgent
35.	General accessories	
	Coaxial measurement cable with BNC plug	
	BNC adapters	
	Laboratory circuit boards for testing (Philips)	
	Operational amplifier - LM 307 N, LF 351 N	
	Assorted metal film resistors, low-loss capacitors	
	Cermet potentiometers	
36.	Horizontal surface lapping machine	
37.	Dosimeter for adhesive and pourable sealing compound	Urgent

B. Study tours

1. A visit to a magnetic head factory in a foreign country would be very useful.
2. Attendance at a course in a factory for special metal machining such as surface grinding and surface flat lapping is absolutely necessary.
3. In the establishment of departments for punching, deep drawing and plastics injection moulding, study tours and courses in companies specializing in these three activities are absolutely essential.

C. Information and literature

1. Magnetic recording handbook (Finn Jorgensen)
2. Magnetic tape storage technique handbook (Scholz)
3. The magnetic sound recording and playback process (Schmidbauer)
4. Handbook on basic mechanics and machining processes
5. Telefunken publication - Ferrites for magnetic heads
6. Company publication - Fundamentals of magnetism - vacuum melting
7. Company publication - Arc design and magnetic head manufacturing problems
8. Company publications of Loctite and other companies on single- and double-component adhesives
9. Standard sheets
   DIN 15910, 41298, 45507, 45513/6,7, 45519, 45520
   RGW RS 4071-73, RS 4070-73
   and comparable standard sheets of ANSI, JIS, TGL, IRIG
   TGL 28416, 32962, 33271, 33985

II. Assistance in production and quality improvement

A. Questions and problems

The company management had prepared a list of questions and problems to be answered or solved.

The list contained eight main groups of problems, each subdivided into several points.

1. Machining process for the gap surface
2. Machining process for the polished surface of the head
3. Head filling process
4. Assembly
5. Measurement technology
6. Quality testing and blueprint for a testing and development centre
7. Important points related to new magnetic head design
8. Technical restructuring of the factory

Under the first four points not only manufacturing problems but also quality problems involved in these processes were included.

B. Improvement of manufacturing processes

1. There are technological problems at two stages of manufacture. The first of these is the process of lapping the gap surfaces. (A.1). The gap surface is an important part of the magnetic head. Absolute flatness and low surface roughness are required for a straight, clearly defined gap with sharp edges and, in assembly of the magnetic heads, for a clearly defined rear shear gap or one approximating to zero.

   At the moment, this gap surface is rough-ground once and then finished with a fine grinding wheel. Lapping, on a horizontal lapping wheel without exerting force on the part to be machined, does not take place.

   Only by means of such a process can a surface be made flat and at the same time be given low surface roughness.

   A suggestion was made to this effect but the necessary machine would be required.

   One of the other problems was the lack of care in handling this sensitive surface in the cleaning and drying process after machining.

   In this case also, suggestions were made and have in part already been put into practice.

2. The main problem of machining of the head mirror surface (A.2) was similar in nature. Machining is carried out at right angles to the gap alignment, which entails the risk of compressing the gap during

the preliminary coarse grinding process. Here also, the final fine grinding is carried out with a positively clamped head.

Gap faults are one cause for the unsatisfactory frequency response on playback, which is beyond the tolerable level.

The entire machining process would be much improved by grinding with a form-grinding wheel in the direction of the gap alignment.

At the moment, this method cannot be used, but the suggestion was made and discussed.

One of the other sources of faults lies in the fixture for holding the heads. Owing to the pressure exerted by the grinding wheel, it is possible for the parts to slip during machining. Control of the dimensions is then no longer possible. In this case it was not possible to make any changes because the conversion of the fixtures takes too long.

3. The second technological problem occurs in the filling of the heads. The finished head is filled with the same two-component adhesive as is used to stick the head body in the screening cap. A deterioration of the magnetic properties of the head is caused by the internal stresses in the adhesive, which is much too hard for the purpose of filling. In ferrite heads, these stresses lead to the destruction of the ferrite. The use of different adhesives and suitable filling compounds is absolutely essential. Experiments have already been carried out along these lines so that changes can be introduced as soon as possible. Dosimeters are absolutely essential.
4. The problems occurring during assembly are caused by the preponderance of manual operations and by unsatisfactory checking procedures.

   The processes of lamination, mounting of the pole pieces in the half-shells, the assembly of the half-shells and their adjustment and fitting into the screening cap are all carried out by hand.

   Only in the lamination process is a fixture used, and it is inadequate. Only random checks are made, in part with the naked eye. All four operations have a direct effect on the parameters of the heads, such as the gap depth and thus its critical points, its impedance value, the

gap width, and, in the case of multi-track heads, the system difference.

Greater use of jigs and fixtures and 100 per cent checking after each operation, with illuminated magnifying glasses or hairline cross microscopes would be absolutely necessary.

Suggestions were made and accepted but their implementation is somewhat problematic, given the high working speed and the output required.

5. The problems arising in regard to measurement technique (A.5) are related to the tapes used and the recording process.

Recording is carried out on reel-to-reel machines. The heads used already displayed wear in the form of abrasions. There is no correction of the recording parameters according to the tapes used. The recorded tape is compared with a standard tape. Checking is carried out with a cassette recorder and a four-track head. This procedure cannot give exact information on magnetization.

It was suggested that a machine should be converted in such a way that the testing head can be moved vertically over the entire tape width.

This was agreed to, and the conversion is to take place shortly.

C. Quality testing and measurement centre

The final quality testing procedure can be retained in its present form without any major change.

The necessary additional checks were mentioned in the previous section.

Much attention was devoted to the planned development and measurement centre in the discussions and many suggestions were made.

The establishment of this centre is also advocated by the province of Sichuan and the city of Chengdu.

As the factory is to develop new heads itself in the next few years, this development centre is of great importance.

So far, the company has not been able to make basic measurements and analyses.

The factory does not have most of the necessary measuring instruments and those that it does have are in some cases very old.

The list of instruments needed was accepted by the company management. However, advisory assistance is needed in the procurement process.

Premises are available, though with inadequate electricity supply and earthing facilities. Air-conditioning would be advantageous.

D. The design of new heads

The most important points regarding two new types of heads were identified and discussed.

This refers firstly to the design of a four-pin twin function head and secondly to a modern three-pin erasing head.

The basic problems of both designs were indicated, and the main design characteristics and their influence were explained theoretically.

In the case of a new design, however, it is possible to lay down only a few data and mechanical details.

The main work lies in the measurement of all parameters and the improvement or supplementation of the design, using the results thus obtained.

However, these basic measurements can only be undertaken on the corresponding prototype and of course that requires a development department with a comprehensive range of measurement facilities.

E. Technical restructuring of the factory

This section refers chiefly to the re-equipping of three departments for stamping, deep drawing and plastics injection moulding, which would be necessary if the company wished to manufacture the necessary unfinished parts itself in future. In addition, a department for magnetic heat treatment would have to be set up.

Premises are available, but all the equipment would have to be obtained.

As it is intended to re-equip, plans were discussed, but implementation will not be easy.

Air-conditioning would be desirable for the rooms in which the final quality testing with the use of tape is carried out.

III. Conclusions

Almost all of the manufacturing problmes of the Radio Factory No. 7 can be solved by the introduction or development of intermediate quality testing during manufacture.

Of course, there must be immediate feedback of the results of such intermediate testing to the manufacturing operation.

The present rate of rejects is about 4 - 8 per cent per stage of manufacture. However, the reduction of this rate to, say, 2 - 4 per cent would require a disproportionately high expenditure of time and money.

The necessity for this is perhaps not immediately perceptible in view of the present very generous tolerances, especially at the final testing stage.

However, if it is intended to improve quality and thus indirectly increase output, the action indicated is essential. That is of course also true if it is desired to introduce stricter tolerances in future.

On the other hand, it is necessary to introduce new adhesives and filling compounds. A dosimeter is also needed for controlled operation.

The plans of the company management to produce other magnetic heads, e.g. floppy disc heads, in a few years' time are certainly realistic and practicable.

However, that involves a completely different technology and a full range of completely different manufacturing equipment.

IV. Acknowledgements

At this juncture, I should like to express my thanks to Mr. Wei Xuxeing of the Bureau of Communications and Television Industry, and Mrs. Fu Qi Fen and Mrs. Shao Juying of the Division of Foreign Affairs for their kind reception in Beijing and for the opportunity the afforded me of spending a few days sightseeing in Beijing after my stay in Chengdu.

I should also like to thank Mr. Zhu Yongming, Deputy Mayor of the city of Chengdu and the city officials Mr. Guo Longhui and Mr. Zhang Zhongyao as well as Mr. Shen Fu An and Mr. Shi Ji-Tao, officials of the province of Sichuan.

My special thanks are due to Radio Factory No. 7 in Chengdu, and above all to Director Wu Zong Si and Mr. Huan, Mr. Lai and Mr. Hoi, with whom I had daily working contacts.

We had many discussions and I believe we understood each other very well. From my point of view, the co-operation was outstanding. That was of course possible only through the services of the two interpreters, Mr. Yang and Mr. Deng, who excelled in translating even the most difficult technical terms. I should like to thank them as well.

In a number of excursions, the management of Radio Factory No. 7 gave me the opportunity of admiring the beauty of Chengdu and its environs. It was a very interesting mission for me and I hope that my services were of some value to Radio Factory No. 7.