"SURVEY OF QUARTZ CRYSTAL INDUSTRY AND THE IMPACT OF OFF-SHORE IMPORTS"

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DRSEL-FC-SI-I-2

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The depressed condition of the American crystal industry in 1981 resulted in a decision by the Dept of the Army Materiel Command to conduct a survey to determine its ability to meet the requirements of the military services should a national emergency arise.

The survey indicated that although the recent economic recovery has greatly benefited the industry, continuing increases in imports of foreign made, low-cost, quality units is a continuing concern.

Visits to foreign competitors indicate an increasing use of automation in processing. Local industry has done much to improve the quality of processing, but little has been accomplished to reduce labor content and improve productivity.

It appears, however, that the industry does have the capability and capacity to meet the needs of the military should a national emergency arise.

Before we get into our topic, it might be well to spend a moment to familiarize you with who we are at CECOM (Fig. 1)

One of the major Commands of the Dept of the Army is the Dept of the Army Materiel Command - AMC. Under AMC authority are eight (8) major subordinate Commands. The two of most concern to you in the quartz crystal industry are ERADCOM - the Electronics Research and Development Command - with headquarters at Adelphi, MD., and CECOM - Communication-Electronics Command with headquarters at Ft Monmouth, NJ.

One of the laboratories of ERADCOM is located at Ft Monmouth, NJ and includes the Electronic Technology and Devices Laboratory (ETADL). The Frequency Control and Timing Branch, under Dr. John Vig, is a part of this laboratory with primary concern for R&D, Manufacturing Technology, and Standardization activities in the frequency control field.

CECOM's primary functions cover research and development of C3I and ADP Equipment, and procurement and production of communications and electronic equipments and components vital to the Army's mission. One of its directorates is the Procurement and Production Directorate, containing the Production Division, of which the Industrial Preparedness Branch is a part.

One of the responsibilities of the Industrial Preparedness Branch is to insure the adequacy of the electronics industrial base for electronic items used by the Dept of the Army. Specifically, to insure that this base will be available in times of national emergency.

It was apparent two years ago that the quartz crystal industry in our country was in a very depressed condition. Two reasons for the condition were obvious: (1) the overall economic recession and (2) the increasing number of low cost, quality imported units. Figure 2 is evidence of these imports. I am indebted to Mr. Marty Kiousis of M-tron for allowing me to use this material which he had prepared for E.I.A. members. As can be seen, imports of frequency control devices had increased from 10 million units in 1977 to almost 80 million in 1982. In the first quarter of 1984 alone, imports of crystal devices totalled 51.1 million! For the same period of 1983, the total was under 24 million!

To determine the true condition of the crystal industry and where it was headed, the Industrial Preparedness Branch was tasked by AMC to conduct a survey by visiting the industry to discuss the problems and request recommendations from them.

Our initial visits in 1982 confirmed our beliefs:

Most companies had experienced major cut-backs in personnel;

Some had closed secondary plants;

Many had closed down their cutting and lapping operations because they could purchase finished crystal blanks off-shore more cheaply than they could produce them internally;

Some were buying finished crystal units from competing off-shore companies and reselling them after marking with their logo;

Bases and cans were being purchased from...
overseas because of lower price.

The major supplier of cultured quartz was threatening to close his plant because of continued losses unless a purchaser was found.

The volume consumer market had been pretty much abandoned and left to the Far East producers, while the local industry concentrated on the higher cost, higher technology, industrial and military market. During a visit to Europe and Israel, we found this to be true in these areas as well.

To paraphrase that old song: "What a difference a year makes." When we began the survey, those people we spoke with were uncertain when the recession would end, and, in general were pessimistic about the outlook for the industry. It now appears that the recession ended with the close of 1982, and, as we continued our visits in 1983, the improved overall economic climate was reflected in increasing orders on the crystal industry. Forecasts I have seen for 1984, all point toward an improvement of up to 20% in the electronics industry over the sales of 1983.

In the issue of January 12, 1984, "Electronics" magazine forecast the US crystal consumption to be $168.4 million in 1984, after a consumption of $146.3 million in 1983. They forecast a continuing growth to over $200 million in 1987.

In Western Europe, the same article indicated usage of quartz crystals at $132.78 million for 1983 and forecast 1984 at $140.5 million. Japanese consumption was $174.36 million in 1983 and is estimated to be $196.17 in 1984.

In mid 1983, an unfortunate incident contributed to the rebound of the domestic industry. An accident at a Japanese quartz growing facility caused a shortfall of cultured quartz, at the very moment when consumer electronics were demanding more and more output and Far East output capacities were at a maximum. As a result, production lead times were lengthened and domestic OEMs turned to the domestic industry for their needed frequency control products.

In addition, foreign producers turned to US growers for their raw quartz requirements. This increase may or may not be short-lived, since the Far East grower of quartz is now back in business and the Far East crystal unit producers, as evidenced during a recent visit, are continuing to increase their production capacities and capabilities.

Some of the problems pointed out above remain with us, although layoffs in local industry have stopped and much hiring is evident.

In addition, as you know, the major cultured quartz growing company, that threatened to close, found a buyer and its output is up significantly from '82 and early '83. The second largest domestic supplier of quartz, as of 9 months ago, had all of his output scheduled thru 1985. The increased business is a result of the accident previously mentioned, and the improved economic climate.

A major problem with much of the domestic industry is that processing equipment has not been substantially improved over the last 20 to 30 years, except in a few instances. While much has been done to improve the quality of processing, little has been accomplished to reduce labor and improve productivity. During our visits, we noted an increasing use of computers for data management, order processing, design programs and automated testing techniques, but the labor-intensive processing of 30 years ago is still the general rule. Very few domestic companies have successfully automated the processing of crystal units. In the Far East, automated techniques are far ahead of what has been accomplished here in the United States.

In May of 1983, Philippe Villers, speaking at the American Association of Engineering Societies in New Orleans, made this statement: "We have three choices: automate, emigrate or evaporate."

In the frequency control field, a fourth choice might be "consolidate." Mr. Villers last choice (evaporate) is unacceptable to anyone concerned with industrial preparedness and, certainly must be unacceptable to you in the quartz crystal industry.

Over the last several years, emigration has been tried by American industry in an attempt to beat high labor costs, with varying degrees of success. We have gone to such places as Mexico, Puerto Rico, Costa Rica, Philippines, Hong Kong, etc., and in some cases, saw an erosion of quality.

Incidentally, the continuing cost of living increases in Japan have forced their industry to emulate the American attempts. One now finds subsidiaries of Japanese companies in Malaysia, Taiwan Korea and other areas of the Far East. This has also occurred in Hong Kong. Much of this industry has moved to the Peoples Republic of China. However, labor costs are not the only factor in the lower price of the foreign products.

Rhetoric aside, cheap labor is only one of the reasons American business has been lost to overseas competitors. The labor component of manufactured goods decrease as manufacturers automate production lines.

Automation solves several problems. It substitutes equipment for labor in a country where money is cheap and manpower is expensive. It makes it easier to meet Federal mandates for workplace safety and pollution control. It increases the reliability of production by minimizing disruption due to human error.
Finally, by reducing the number of workers employed, automation produces impressive gains in output per manhour. As an example of what is being done in the electronics industry, the Electronic Engineering Times reported that Apple Computer has designed the new "Macintosh" assembly plant to lower the labor content of the computer to less than one percent.

I believe the domestic crystal industry has no choice. If we wish to compete for the volume market, automation and robotics are the answer. Some of the things I have seen in my visits around the world include the following:

Cutting 8 to 10 lumbered "Y" bars at a time, using a dual blade pack on enlarged versions of the old Norton-Varian slurry saws—as opposed to 3 to 5 at a time here in the States.

All phases of lapping done on a timed basis on planetary laps. I saw no radio frequency lapping. Whereas I was brought up with the premise that blanks had to break over the edge of the lapping plate to maintain flatness, I saw carriers with two and three rows of blank holes which more than doubled the output per lap load.

I visited one company where 80 people were turning out more than 350,000 dual resonator monolithic crystal units per month. That is about 25% of the operators used by our industry to turn out an equivalent quantity.

This line included complete automation of the mounting and cementing operation. Sticks of bases automatically fed—first the 3 point mounting was spread and aligned, then dipped in the mounting cement—vacuum picks picked up the blanks and placed them in the mounts, and finally, they were fed onto a belt and through the curing furnace.

The mounted resonators then move to an automatic laser trimmer for dividing of the electrode and adjustment of each electrode to provide the necessary separation, offsets, final frequency, etc.

Sealing is also mechanized, as it is in every plant I visited over there.

Units are automatically fed into an automated set up for final test. The printout pin points any failures and the reason for the failure.

At another company we visited, we were told that one of their branches makes tuning fork crystals, clock crystals and engine control crystal units. In 1976, with 330 employees, this plant turned out 205,000 units per month. In 1983, with only 400 employees, they turned out 3,000,000 per month. It is obvious that a high level of automation must be in use at this plant.

Many of the methods available for mechanizing and automating processing are not new—they've been around for years. What makes them practical today is the availability of microprocessors and inexpensive, small, computers which provide accurate control and immediate readout of results.

For instance, the Japanese made automatic, carousel type, frequency plater, which has been displayed at this conference for the last few years, is in wide use. I can recall a similar plater, made by Edwards Hi-Vacuum of England, which was in use in the Frequency Control Branch at Ft. Monmouth, in the early 1950's. Of course, micro-circuits and computers, which result in the accuracy and productivity achieved today, were not available at that time.

The older members of the audience will remember the mechanization program sponsored by the Signal Corps, at Bulova Watch Co. again during the 1950's. Ideas generated there included automatic X-ray and sorting, and frequency and thickness sorting. It included automatic loading and unloading and frequency control of lapping, automatic plating and sealing, etc.

At the time, one of the drawbacks was that the system required large quantities of one type and frequency in order to be successful. Today, in the consumer field of electronics particularly, these volumes are there. In addition, the availability of computerized controls will allow for the programming of smaller quantities of types and frequencies and intermixing of them.

The Bulova ideas, matched with today's technologies, should go a long way to restoring this industry to its former position. It won't be easy—but it can be done.

Someplace in the archives there must be copies of the Bulova reports and drawings. If any of you are interested in them, I will attempt to track them down and determine how copies may be obtained.

In peacetime, military business is only a small part of the overall crystal market. While the Defense Electronics Supply Center (DESC), which is the procuring agency for all the services for replacement parts, has over 30,000 active stock numbers, its procurement amounts to only about $2M/yr in quantities usually less than 100 pieces per buy.

There is another phase of military business which is not readily recognized. In the past, when a piece of military equipment was designed, the crystal was assigned an existing or new "CR" designation and defined in MIL-C-3098. (Incidentally, MIL-C-3098 is now undergoing a massive revision to update it and bring it in line with current requirements and technology). Today, many military equipments are designed by the OEM (Original Equipment Manufacturer) who assigns a manufacturer's part number to the crystal and it is bought under that nomenclature.

It is my personal belief that MIL-0-55310, the oscillator specification, will become a more
dominant factor in the crystal industry. Whereas, the crystal unit in the past has been a separate entity with the other discrete components on a printed circuit board, the use of chip and printed components, has led to a widespread use of hybrid oscillators. In most of the equipments being designed today for the military, self-contained TCXOs or OCXOs are specified. This is also true in the microprocessor field where hybrid clock crystal oscillators are the rule, rather than the exception. More and more, I believe that the crystal industry will become suppliers to the oscillator industry of plated resonators, or will enter the oscillator market to a greater degree than is already evident.

Design: engineering, installation and debugging of automated equipment costs time and money. Is any help available?

The Department of Defense (DoD) has two programs designed to assist industry in the modernization of its production facilities.

One such program is IMIP (Industrial Modernization Incentives Program). IMIP is a plant-wide concept for modernization, covering all phases of management, engineering, purchasing, and production improvements. There have been few IMIP programs and none in the frequency control area.

The second program, Manufacturing Methods and Technology (MM&T) is a more modest approach and usually is tailored to improve production of a particular device or to improve a specific process. In either case, the objective is to improve yields and reduce costs of manufacture of devices required by the DoD.

MM&T programs for Army electronics needs are executed both by ERADCOM and CECOM. Unsolicited proposals for such programs are welcomed. I urge you to submit any ideas which you may have that are relevant to military needs for our consideration. Keep in mind that, in return for the financial assistance which is given under the programs, all information must be divulged to the industry for its use.

Funds for these programs are by no means unlimited and approval requires that a very strong case must be made showing the benefits which will accrue to the government as a result of the program.

ERADCOM's Frequency Control Branch, over the past ten years, has sponsored several MM&T programs for the development of manufacturing techniques for crystal units and crystal oscillators with such companies as GEND, Bendix and Frequency Electronics.

In conclusion, let me emphasize that, although I have indicated a very simplistic solution to the industry's problems, I recognize that solutions are complicated, time consuming, and will not be accomplished without infusions of capital.

We recognize, too, that the Government has certain responsibilities as well - the revisions to MIL-C-3098 and MIL-0-55310 will be of great assistance in standardizing MIL-requirements; the proliferation of commercial drawings for crystal units and oscillators in Military equipments must be reviewed constantly and controlled to as great an extent as possible; close review of existing QPLs should be made (55% of the existing listings were granted prior to 1972 while MIL-C-3098E was still in effect - An even greater percentage were granted prior to issuance of the latest slash sheets for particular units).
Figure 1

DARCOM

ERADCOM

ET & DL

FREQ CONTROL

CECOM

P & P DIR.

PROD. DIV.

IND. PREP. BR.
QUARTZ CRYSTAL IMPORTS

PIECES vs. CALENDAR YEARS

SOURCE: M. Kiousis, M-Tron, Inc.


1st QTR - 1982 = 14.2 M
1st QTR - 1983 = 23.9 M
1st QTR - 1984 = 51.1 M

Figure 2