

Activities of the T.I.C.

The Eighteenth General Assembly of the Tantalum Producers International Study Center will be held on Tuesday, October 26th 1982, at the Cercle Royal Gaulois in Brussels. The formal business of the association will be carried out, including discussion of collected statistics for production and processing of tantalum, consideration of applications for membership and a proposal to augment the number of available places on the Executive Committee, as well as election of the Committee.

Mr Lucien Le Lièvre, Senior Partner, Coudert Brothers, in charge of their Brussels office, will make a presentation comparing the anti-trust laws of the United States and the regulations on competition within the European Economic Community. He will be accompanied and assisted by Mr Fred L. Lukoff, Attorney, Coudert Brothers. Both Mr Le Lièvre and Mr Lukoff have considerable experience of these laws and will draw on their knowledge to compare and contrast them.

Participants will be guests of the T.I.C. at luncheon following the meeting.

Invitations have been sent to all member companies by the Secretary of the T.I.C., to whom inquiries about the meeting or the association may be addressed.

Message from the President

The President of the T.I.C., Mr Conrad L. Brown, sends the following message to the members :

Since my term as President of the T.I.C. will end during the Eighteenth General Assembly, this article represents the last written communication I will have with the tantalum community in this capacity. I have enjoyed serving as President, and believe we continued to make progress over the past year in fulfilling the objectives of the T.I.C.

The Seventeenth General Assembly held last June was well attended, with the program informative and educational. I trust all participants departed from the Assembly with the feeling that the cost and time afforded it were justifiable.

We have several new applications for membership which will be acted upon at the Eighteenth Assembly, and a number of other companies have inquired about applying for membership. At the present time, we have sixty-four members and we could have as many as seventy when the Nineteenth Assembly convenes in Malaysia next May.

In regard to statistical data, we have requested the processors who are members of T.I.C. to report shipment data for 1981 and for the first three calendar quarters of 1982. This will broaden the data base beyond the production and shipment information the miners and smelters have been reporting for the past few years. I foresee other possibilities for data collection among the remaining segments of the membership and, in due course, the T.I.C. should be in a position to publish a broad spectrum of statistical data of value in assessing the needs and requirements of the industry in general. It should be noted that data requested from the membership is sent to an outside and disinterested firm on a confidential basis, and this company reports only composite data to the T.I.C., in order to avoid competitive harm to individual members.

The National Material Advisory Board, Washington, D.C., recently issued a report entitled "Tantalum and Columbium Supply and Demand Outlook" which contains considerable information and a summary of conclusions and recommendations regarding tantalum and columbium production and uses. The report is for sale and those interested should write to the National Technical Information Center, Springfield, Virginia 21151.

At this writing, tantalum demand has further decreased from an already low level due to falling backlogs in the capacitor industry, which accounts for approximately 50 per cent of tantalum consumption worldwide and for about 65 per cent in the United States. Reportedly, the capacitor manufacturers have all but written off the remainder of 1982 by expecting it to stay at the lower level. This, along with other factors, will no doubt drop 1982 demand below the 2.3-2.5 million pounds of Ta₂O₅ units forecasted earlier this year.

In closing, I wish again to express appreciation to the T.I.C. membership for the opportunity of serving a term as President. It has been a valuable, and at times challenging, experience. In return I hope that my efforts have in some way enhanced the stature and objectives of the T.I.C.

Warm regards,
Conrad L. Brown, President.

T.I.C. EIGHTEENTH GENERAL ASSEMBLY

The Eighteenth General Assembly of the Tantalum Producers International Study Center will be convened at 9.30 a.m. on Tuesday, October 26th 1982, at the Cercle Royal Gaulois, rue de la Loi 5, 1000 Brussels.

AGENDA

1. Presidential address.
2. Minutes of the Seventeenth General Assembly (held in Tulsa, Oklahoma, on June 8th 1982).
3. Membership.
4. Proposed change to the Charter (that the number of available places on the Executive Committee be increased from seven to nine).
5. Report of the Executive Committee.
6. Statistics :
(a) production
(b) processing.
7. Statutory elections.
8. Nineteenth General Assembly : plans.
9. Other business.

After the formal business of the Assembly, there will be a presentation on "The U.S. anti-trust laws and the E.E.C. laws of competition : a comparison" by Mr Lucien Le Lièvre, Senior Partner, Coudert Brothers, in charge of their Brussels office, assisted by Mr Fred L. Lukoff, Attorney, Coudert Brothers.

For further details of the meeting arrangements or information on the T.I.C., please contact Mrs J.A. Wickens, Secretary, Tantalum Producers International Study Center, rue aux Laines 1, 1000 Brussels, Belgium; cable address Tictan Brussels.

The U.S. National Stockpile

(The following article has been extracted from a presentation by Mr Roy Markon, the former Commissioner of Purchases for the GSA, at the T.I.C. meeting in Tulsa, Oklahoma, on June 8th 1982).

Shortly after his inauguration, President Reagan declared his policy to reduce United States dependence on imported minerals, warning that "it is now widely recognized that our nation is vulnerable to sudden shortages in basic raw materials".

Although all recognize that the United States possesses extensive natural wealth, including minerals, our country is nonetheless dangerously dependent on foreign sources for a number of imports vital to defense production or the manufacture of high technology equipment.

At present, the U.S. Stockpile consists of 94 commodities: 72 mineral commodities and 22 agricultural or pharmaceutical commodities.

The agricultural commodities comprise such items as rubber, cordage fibers and certain essential pharmaceutical items.

The mineral commodities, such as cobalt and tantalum, include most of the major industrial minerals except iron and steel. The current value of the stockpile is nearly \$ 11 billion, down from \$ 12 billion last year.

The amended Strategic and Critical Materials Stockpiling Act of 1979, with the President's guidance, provides for a National Defense Stockpile sufficient to cover U.S. needs for at least three years in the event of a national emergency. Moreover — and this is of prime importance — the Act specifically states that "the purpose of the stockpile is to serve the interest of National Defense only, and is not to be used for economic or budgetary purposes". This was not always so.

Materials were actively procured for the stockpile from 1946 through 1960. However, in 1962 the size of the stockpile was considered excessive. Large amounts of the accumulated commodities, considered to be in excess of revised goals, were sold in the following years.

From 1946 to 1979, stockpile policies changed direction many times and many changes were made in the established goals for individual commodities. During the period 1964 to 1975 stockpile holdings of some commodities, such as copper, aluminium, and nickel, were liquidated. Often, these sales were made as an expedient means of balancing the Federal Budget. The revenues generated were transferred to the General Fund of the U.S. Treasury, instead of being used to acquire commodities that fell short of goal requirements.

The result is that the stockpile, by any objective analysis, is sadly depleted. Only two of the 62 basic materials in storage are now in sufficient supply to meet national security requirements. The November 1981 Stockpile Report to Congress reported that raw materials in the stockpile were valued at \$ 11 billion — compared to a desired inventory of \$ 20 billion. Of this \$ 11 billion, only \$ 5 billion represented needed materials. The remaining \$ 6 billion worth of materials was considered excess to national security needs.

In March 1981 President Reagan announced a government plan to spend \$ 100 million on strategic minerals to rebuild the defense stockpile. He called this plan the first step in a program to "decrease this nation's vulnerability", and indicated that he would take further action regarding strategic minerals.

The appropriations bill that was subsequently passed by both houses of Congress allocated these funds to the National Defense Stockpile Transaction Fund.

Through the fund, GSA, the primary budgetary authority for stockpile acquisitions, began the long-delayed process of rebuilding the nation's stockpile of strategic minerals. It purchased 5.2 million pounds of cobalt from Zaire.

In addition to the cobalt purchase, the acquisition plan for 1982 called for purchases of iridium, quinidine sulfate, refractory grade bauxite, and tantalum. Also, last November, President Reagan directed GSA to purchase 1.6 million tons of Jamaican bauxite.

The United States currently imports more than 75 per cent of its requirements for each of these commodities.

Tantalum, in the natural mineral and concentrates, is one of a handful of commodities initially selected to replenish the stockpile following virtually 20 years of inactivity.

As outlined in the National Stockpile Purchase Specification published by Department of Commerce, each lot of tantalum source material must contain a minimum of 25 percent tantalum pentoxide (Ta_2O_5) and 50 percent of columbium pentoxide (Cb_2O_5). Since

columbium pentoxide (Cb_2O_5) is listed as stockpile goal material, the amount present in this purchase of tantalum will also be credited to stockpile goals.

At the present time, the National Defense Stockpile contains the following quantities of tantalum:

Tantalum Carbide Powder

Inventory 28,688 lbs. valued at \$ 4,644,000 (Goal 0)

Tantalum Metal Powder

Inventory 201,033 lbs. valued at \$ 44,227,000 (Goal 0)

Nonstockpile Grade

Inventory 100 lbs. valued at \$ 10,000

Tantalum Minerals

Inventory 1,399,143 lbs. valued at \$ 64,067,000 (Goal 8,400,000 lbs.)

Nonstockpile Grade

Inventory 1,152,159 lbs. valued at \$ 52,757,000 (Goal 0).

Early in the stockpiling effort, the Munitions Board of the Defense Department established advisory committees that included representatives from industry. Industry views were sought for advice on matters of storage, stockpile specifications, technology for materials handling, availability of supplies and so on.

In a report, the Defense Industrial Base Panel of the Committee on Armed Services of the House of Representatives stated that the U.S. had a net import reliance on tantalum of 96 percent of apparent consumption in 1979. Moreover, the Reagan Administration's newly released minerals policy report reveals that tantalum, used as an alloy, can offer improved performance in the aerospace industry. This could lead to an increased use of the material.

Use of tantalum in superalloys

(The following article has been extracted from a presentation by Dr. W.A. Owczarski, Manager, Technical Planning, Pratt and Whitney Aircraft Group, United Technologies, at the T.I.C. meeting in Tulsa, Oklahoma, on June 8th 1982).

INTRODUCTION

To a manufacturer of jet engines, superalloys are those nickel and cobalt base materials used to make an engine's heat resistant parts. The superalloy parts that take the greatest thermal loads are turbine blades and vanes, which are directly in the path of the hot combustion gases.

Higher combustion temperatures enable the engine to extract more energy from every gallon of fuel, and to develop more thrust for every pound of air it uses. Therefore, an improvement in the ability of a material to operate at higher temperatures can be directly translated into improved engine efficiency, economy and durability.

METALLURGICAL FACTORS

For use in turbine blades and vanes, alloys are almost always used as cast rather than forged materials. Cobalt-base superalloys consist of a cobalt-rich matrix with several refractory metal carbides distributed throughout. The high temperature strength of these alloys results from the refractory elements, such as tungsten and tantalum.

Nickel-base superalloys consist of an intermetallic phase (based on the compound Ni_3Al and referred to as gamma prime) which has been precipitated in a nickel-rich matrix referred to as gamma. The high density and fine distribution of gamma prime conveys strength to these alloys even at temperatures close to their melting point.

In general, cobalt-base superalloys have high melting points, moderate strength, good oxidation resistance and excellent hot corrosion resistance. Nickel-base superalloys have high strength, excellent oxidation resistance, good hot corrosion resistance and somewhat lower melting points. They can achieve a broader range of properties and are used for all blade and many vane applications. Nickel-base superalloys are therefore much more widely used than cobalt-based superalloys.

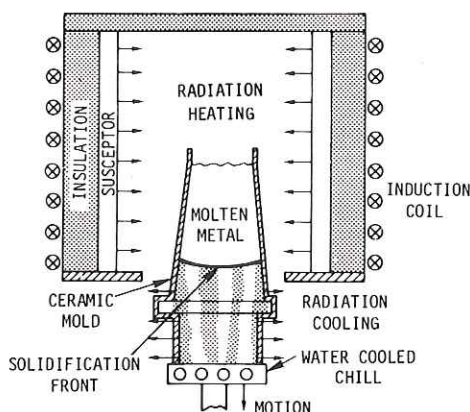
When tantalum is present in a nickel-base superalloy, it concentrates in the gamma prime precipitate with lesser amounts dissolved in the nickel-rich matrix phase. Tantalum strengthens the gamma prime phase as well as the matrix phase. The other most commonly added refractory metals, such as tungsten and molybdenum, primarily strengthen the matrix phase. As a result, tantalum increases yield and ultimate strength substantially and creep strength moderately.

Tantalum also improves oxidation resistance of nickel-base superalloys, which the other refractory elements do not. Molybdenum, in fact, can reduce hot corrosion (sulfidation) resistance. Tungsten can contribute to unfavorable segregation during solidification, which can result in increased difficulty in castability. Tantalum does not harm either corrosion resistance or castability.

Because of its several simultaneous positive benefits to properties and processing, tantalum was introduced into superalloys a number of years ago. It was used in some of the superalloys that were developed back in the late 1960's and early 1970's. Nickel-base alloys such as B 1900 (4.2 w/o Ta) IN-792 (3.9 w/o Ta) MAR M-246 (1.5 w/o Ta) IN-738 (1.75 w/o Ta) and the cobalt-base alloy MAR M-509 (3.5 w/o Ta) all contain moderate levels of tantalum.

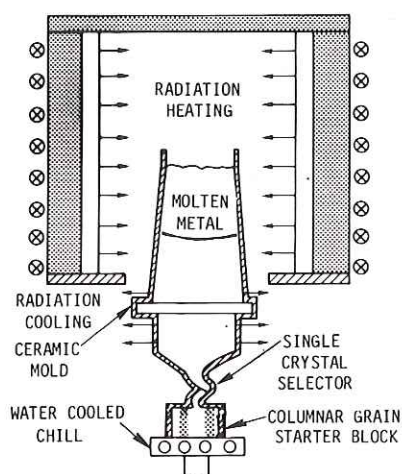
It took processing improvements to reveal and make possible increased benefits from greater tantalum additions. The development of columnar castings by directional solidification and the casting of single crystal parts opened new doors to alloy development. These advances have led to greater use of tantalum as an alloy addition.

Schematic illustration of the directional solidification casting process is shown below, as well as modifications to the process that will produce a single crystal part. The firm of Pratt & Whitney holds a dominant patent position in directional solidification technology. These patents, about 100 in number, protect the basic turbine airfoil articles as well as certain alloys and processes for both columnar grain and single crystal applications.



Columnar grain casting process

(a)



Single crystal casting process

(b)

ROLE OF CASTING PROCESS

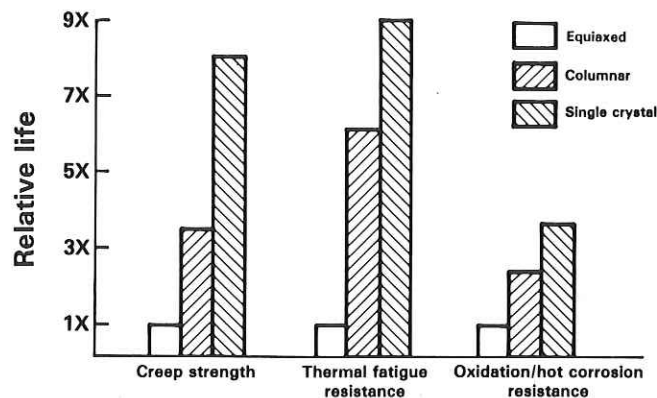
Solid metal is normally crystalline, i.e. the atoms are arranged in a specific geometric array that is repeated over very large numbers of atoms. The repeating geometric array of atoms is usually referred to as a grain, and an equiaxed casting consists of a large number of randomly oriented grains. Directional solidification allows only a single grain to survive, thus producing a single crystal part.

The boundaries between grains in polycrystalline metals are not as strong as the grains themselves at high temperatures. Multigrained superalloys contain elements such as carbon, hafnium and boron to strengthen the boundaries. Directionally solidified superalloys selectively eliminate grain boundaries in the principal (axial) stress direction but must retain the grain boundary strengtheners for transverse strength. These strengtheners tend to lower incipient melting points for the alloys and restrict the maximum temperature at which the material can be heat treated.

Single crystal casting technology eliminates the requirements for boundary strengtheners and thereby allows alloys to be constituted which can take advantage of higher heat treatment temperatures. These alloys contain more hardener, and therefore more gamma prime precipitate, which is distributed effectively and homogeneously by the higher heat treatment temperatures permitted. Our production single crystal alloy is designated PWA 1480. Its composition and relative strength is illustrated below.

Element	Equiaxed B1900 + Hf	Columnar MAR-M200 + Hf	Single Crystal PWA 1480
Ta	4.25	—	12.0
W	—	12.0	4.0
Mo	6.0	—	—
Cb	—	1.0	—
Cr	8.0	9.0	10.0
Co	10.0	10.0	5.0
Al	6.0	5.0	5.0
Ti	1.0	2.0	1.5
B	0.015	0.015	—
C	0.11	0.14	—
Zr	0.08	0.08	—
Hf	1.15	2.0	—
Ni	Balance	Balance	Balance

**SINGLE CRYSTAL
SUPERALLOY BENEFITS**



PWA 1480 is being introduced in two commercial engines that will be used in Boeing 747, 767 and 757 planes, as well as Airbus 300 and 310. Initial airline service for this material is scheduled to begin later this year. This new single crystal alloy offers a 50 °F metal operating temperature advantage over the best previously available turbine blade (PWA 1422) material and contributes significantly to the improved fuel efficiency of these engines.

FUTURE TANTALUM USE

The projected use of this kind of advanced alloy will increase the total use of tantalum in superalloys in the next five years, but the increase is not expected to be dramatic. Several factors will limit its growth.

First, there is a current sluggishness in the sales of commercial aircraft to airlines, which will affect the overall demand for superalloys. Secondly, introducing new materials into jet engine use is progressive. The number of parts that can take advantage of improved properties of high tantalum single crystal alloys is a small fraction of the total, since previous "best materials" will move to cooler parts of the turbine and serve effectively. Thirdly, the single

crystal technology is patented by Pratt & Whitney and is only licensed to the U.S. Government for application in the space shuttle. Tantalum consumption in superalloys accounts for a very small percentage of world production. The dominant uses of tantalum in the world market should continue to be capacitors and carbide tools.

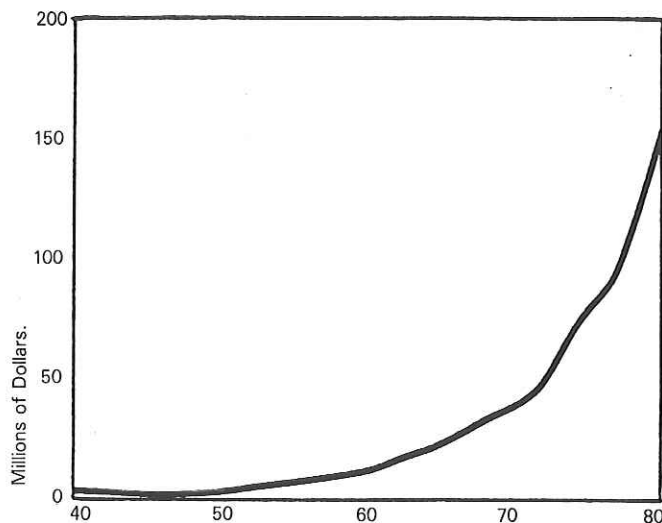
For the longer term, it is difficult to project what forces will act upon the use of tantalum in superalloys. The price escalation of tantalum in the late 1970's and questions about its long-term availability, along with general strategic metal worries, stimulated research into alternatives to tantalum, as well as cobalt, for use in superalloys.

One area of research has led to promising nickel-base alloy compositions containing high molybdenum and aluminium, and little or no tantalum. This work, supported by Defense Advanced Research Projects Agency and the Air Force Materials Laboratory, involves use of rapid solidification technology to produce unique composition powders. The powders, when followed by appropriate consolidation, deformation and heat treatment, produce aligned grain or single crystal superalloy products of exceptional mechanical properties. While the development and application of this kind of alloy and its related processing technology is currently in its early stages, it does point out that long-term future alternatives for tantalum may exist.

Fortunately, the concerns about tantalum availability have eased with new reserves recently discovered. The price moderation has also been welcome. Price stability and assured availability are necessary ingredients for increased usage of tantalum in superalloys. Lack of these ingredients will encourage alternatives. The long term picture of tantalum use is not yet "cast in concrete".

Industry, both large and small, embraced the electronic "book-keeper", and consumers (in the latter half of the decade) took the computer into their homes in the form of calculators and games. Thus, as the 70's came to a close, the electronic industry was growing at a rate of 15 % to 16 % per year.

HISTORY OF ELECTRONIC SHIPMENTS
1940-1980
(Millions of Dollars)



Source : E.I.A.

The impact of electronics in the 80's

(The following article has been extracted from a presentation by Dr. Lloyd O. Brown, Consultant, at the T.I.C. meeting in Tulsa, Oklahoma, on June 8th 1982).

IN THE BEGINNING

The usually recognized beginning of "The Electronic Age" came in 1883 when Thomas Alva Edison, while perfecting the electric lamp, discovered that an electrical current would flow between a heated filament and a positive metal electrode when both were enclosed in a vacuum envelope. This phenomenon, "The Edison Effect", was the forerunner of most of the electronic component and equipment development through the 40's.

In 1884, the first television patent was issued on a mechanical/electrical "device" to scan and reproduce pictures. Unfortunately, the state of technology, at the time, was insufficient to reduce this process to practice.

The founding of The Tabulating Machine Co. in 1896 becomes important only when one knows that this company, in 1924 under the direction of T. J. Watson, became The International Business Machine Company, the leader today in the field of electronic computers. Voice and music were first broadcast in 1906, and television, still as an electro-mechanical device, was demonstrated in 1926. With the exception of the development of Radar, and the beginning of electronic instrumentation, the 30's, deterred by the depression, yielded little progress compared to the two previous decades.

SINCE YESTERDAY

The electronic developments of import from 1940 to the present are much too numerous to mention here. Those I consider to have major impact for the 80's are : the transistor in 1948; the integrated circuit in 1959; the solid random access memory (RAM) in 1969; the microprocessor in 1971; and the advent of very large scale integrated circuits (VLSI). This last "development" is really more of an evolution from earlier integrated circuit arrays. The realization of its possibility and potential first occurred in 1977. The technology and circuitry of television and computers will become the "work horse" of the 80's. All these developments from the technological base on which electronics of the 80's will be founded and will grow.

The rapidity with which the electronic industry has grown since World War II is shown below. The growth in the 50's can be attributed to pervasion of monochromatic TV into the home. Growth in the 60's came from the transition to and acceptance of color TV. The 70's have been called the "age of the computer".

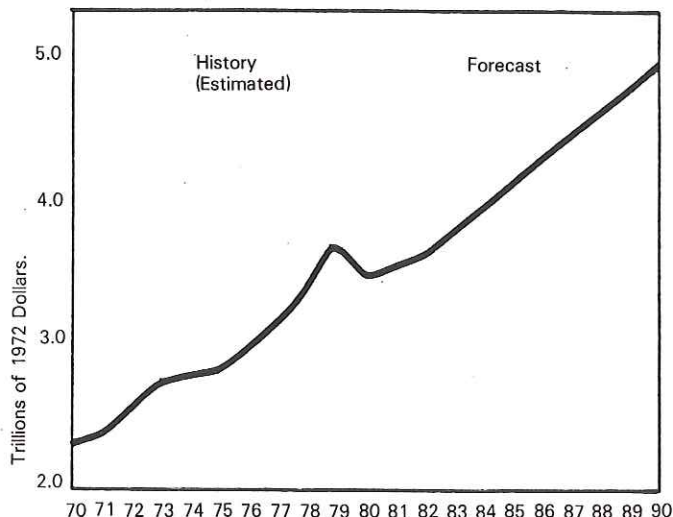
RECESSION AND CHANGE

To understand the nature of the growth of electronics in the 80's, we must first look at world economic environment as the decade begins. In the first two years of the 80's, an era of worldwide stagnation and recession set in. Two major factors contributing to this condition throughout the industrial free world are declining world productivity and the loss of "cheap" energy resources. Yet these two factors, along with the technological base currently in place, will be instrumental in pointing the way toward economic recovery and in providing the impetus for continued economic growth through the 80's.

Through electronics the world will counterattack the factors with the introduction of automation in all walks of life and the development of equipment and controls to use natural energy resources more efficiently.

With the counterattack of electronics, the Gross Free World Product, after recovery from the recession of 1980-81, will expand at the rate of 3.8 % per year (compound annual growth rate) through the remaining years of the decade.

GROSS FREE WORLD PRODUCT
(1972 Dollars)



AUTOMATION IN INDUSTRY

During the 70's Computer Aided Design (CAD) has been used extensively to shorten design time and improve the reliability of large complicated systems such as aircraft and VLSI. The 80's will see the application of the CAD philosophy to all areas of design: automobiles, architecture, plant lay-out, environmental planning and space systems, to name a few. It will be used wherever complicated, interactive design problems exist. While CAD implies (and requires) extensive software development, the hardware for implementation of CAD in its many uses will follow close on the software coattails.

Manufacturing and process control will see an expanding use of robotics and automation. Machine/machine interface, and computer/processor interface will replace the man/machine/processor interface of today. Already this change has started. In the Japanese automobile industry, robots are rapidly replacing manual labor for welding, spray painting and in routine assembly. Great strides have been made in computer aided manufacturing (CAM) particularly in areas of high technology and critical control requirements. Several firms in the United States have announced their intention to automate their manufacturing process.

As computer-aided design and manufacturing expand into new areas, many of the initial results will appear as weird as buggy whips on Model T's, leading some to think of it as the CAD/CAM comedy hour. With increased understanding and usage, however, productivity in all sectors of industry will grow by leaps and bounds and product reliability will reach levels never before thought possible.

THE PRIVATE CONSUMER

By the middle of the decade, both dedicated and general purpose computers will be commonplace to the average citizen. In the area of household management, dedicated computers will control the environment of the home, manage the use of energy for maximum efficiency (and minimum cost), provide automatic warning and reporting of any breach in the home security and help in maintaining household budget accounts.

Information, from investment guides to encyclopedic notes, will be available at one's finger tips through two-way computer controlled cable. Display of such information will be by way of the home TV screen. A variety of entertainment and education will be available through the touch of a key. "Talking" books printed with a machine readable code similar to the standardized price/product code currently in use will be read (spoken) with an electronic wand passed (by the reader) along the printed lines. This product will be introduced as a teaching aid to be used in the home, though the time may come when the necessity to read will be made obsolete by this or similar products.

The "Supermarket" of the late 80's will bear more resemblance to the old New York "Automates" of the 30's and 40's than to the shelved piles of boxes and cans of today. In these markets, single items of each available product will be displayed (behind glass) along with the pertinent information as to size, price, content and brand. Shopping will be done by inserting a plastic key into a slot below each item selected. Accumulation (and bagging) of the desired products will be totally automated from a warehouse contained in the store. Delivery of the order will be made by insertion of the key at a "check out" counter, with the total charges being automatically transferred from the customer's account to the store account at the local bank. "Off the street" customers will be served through the issue of a "store" key and the order will be delivered upon cash payment to an automated or live cashier.

Remote marketing, with a detailed catalog service, will be available to the householder through the two way cable system, again with automatic fund transfer for payment.

Telecommunications will offer far more features to the user than today. Already available are multi-call answering through hold circuits, call transfer and automatic dialing of selected numbers. Future features will include automatic dial back of "busy" numbers, phone conferencing with three to six phones, vision phone using the subscriber's home TV screen and voice-actuated dialing. The major change in telecommunications, however, will remain invisible to the user, that is, digital transmission of the signal. This change will not only increase the reliability of communications but will also open up wide areas of use (other than oral communications) unavailable in the current analog system.

Appliance controls will become fully electronic (and automated) for more efficient operation. Electric motors (recent estimates place the number of electric motors in the average home at 30) will be electronically controlled so as to produce required performance independently of load with minimum energy expenditure.

PROFESSIONAL APPLICATIONS

Professional uses (medical, legal, scientific, etc.) will encompass: automated analysis of both physical samples and data; retrieval of information pertinent to a particular problem by direct command (key word) or from the results of automated testing; diagnosis of problems taking into account all known factors in the problem environment; and monitoring of performance of problem-related tasks.

In the field of medicine, electronics (and the microprocessor) will open areas of analysis and diagnostics hitherto unheard of. Considerations are now being given to remote surgery utilizing the services of an eminent specialist located in one area of the world to operate on a patient far removed from the scene through the use of robotic manipulators and three dimensional microscopic TV.

While this total field will not be large (dollarwise) compared to the industrial and private consumption markets, the increase of professional services will more than offset the added costs.

AUTOMATION IN COMMERCE

The warehousing functions of stocking products and filling orders will be fully automated and computerized. Inventories will be computer filed with automatic debiting as orders are filled, and, of course, credited as new stock is received and "shelved". Through direct computer-to-computer communications, re-ordering will be accomplished at preset levels — dependent on cost to maintain inventory, expected near-term sales, and producers' delivery lead time.

Financial and banking organizations will make increasing use of automatic tellers and electronic funds transfer in order to reduce operating cost and thus offer commensurately lower interest rates.

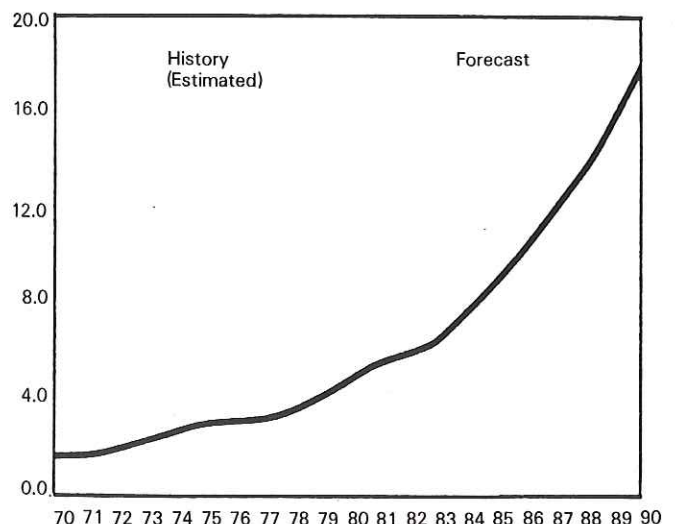
As mentioned earlier, communications will be fully digitalized with concentrators used to increase throughput so as to improve efficiency of use.

And, of course, the automated office introduced within the past few years will proliferate until the day of "hard copy" will be nearly a thing of the past.

ELECTRONIC PERVASION

A measure of electronic pervasion into the world economy has been obtained as the ratio of the world electronic sales to Gross Free World Product, that is, an input/output coefficient. From 1962 to 1972, this pervasion factor grew at a rate of 5.3 % per year. From 1972 to 1982 the rate increased to 11.5 % per year due largely to the general acceptance of the computer and related products. Using regression techniques, and taking into account the factors just cited in the growth of electronics, a forecast for pervasion through 1990 has been made. This forecast shows that pervasion of electronic product into the world economy will grow at a rate of 14.7 %. The graph has been plotted with the pervasion coefficient indexed to 1 in 1960.

ELECTRONIC PERVASION INDEX
(1960 = 1)

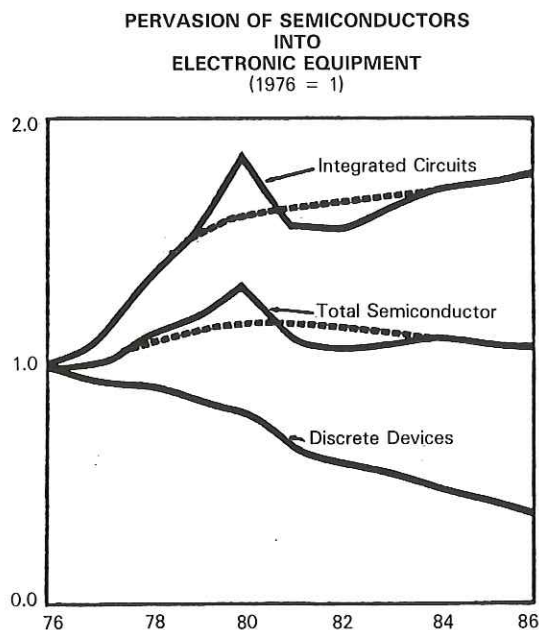


The electronics market is estimated to grow from \$ 176 billion in 1981 to \$ 818 billion in 1990. The compound annual growth (1982 through 1990) of the market will be approximately 19 % per year.

How does all this relate to the tantalum market ? Several analysts have shown that unit sales of tantalum capacitors bear a strong linear relationship to unit sales of integrated circuits. The ratio of capacitors to circuits in the United States seems to be about 1 to 8. Since semiconductors have been my major field of interest and study for the past ten years or so, let's see how this industry's markets will grow.

SEMICONDUCTOR PERVASION INTO ELECTRONICS

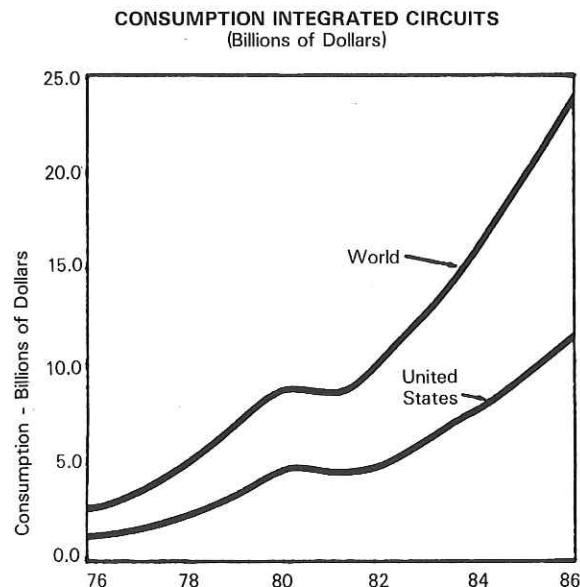
Using an analysis similar to that used to develop the electronics market, semiconductor pervasion into electronic products (rather than GFWP) has been calculated and forecast, indexed to 1976 = 1.



Three points should be made about this chart :

- The S shaped perturbations in the 1979-1982 time frame result from an accumulation and elimination of pipeline inventory at the electronic equipment manufacturers' level. I suspect that a similar shaped curve could be found in capacitor sales. The dashed line is an estimate of the "true" pervasion coefficient arrived at by "eye ball" integration.
- Total semiconductor usage per average piece of end equipment has been, and will remain, relatively constant over the time frame of the chart.
- Pervasion growth of integrated circuits has been obtained largely at the expense of discrete semiconductors, although from 1976 (and earlier) through 1979 part of this growth can be attributed to the replacement of magnetic core memory by semiconductor RAM's.

Using the pervasion index and the forecasted electronics market, a forecast (both world and United States) for integrated circuits has been made through 1986. This forecast shows that the IC market will grow at an annual rate of approximately 24 % per year.



The forecast method used here might be called a "top down" forecast since it first forecasts the world economy and then proceeds downward to the end equipment and component levels. A "bottom up" forecast of the semiconductor market was recently made, and the two forecasts show a high degree of agreement (95 to 98 %).

From this analysis one can scope the tantalum capacitor market, ceteris paribus, to grow at approximately the same rate as the IC market, i.e., 24 % per year.

The lack of programmers trained in the understanding of broad systems concepts and their many interfaces could thwart the growth of the electronics industry. A serious shortage of trained people may be a roadblock to the demand for equipment envisioned in the forecast. It would also create a scarcity of the components required to fulfill the forecasts.

Further, at the component level, the availability of viable substitutes that can be used with, at most, modest end equipment re-design changes can depress the capacitor (and semiconductor) market even though electronic equipment sales meet expectations.

On the economic side of the coin, a continuation of high interest rates can suppress the « re-greening » of industry and remove one of the basic tenets on which these forecasts rest.

The danger of focusing on short-term gratification at the expense of long-term gains can lead to continued decline in productivity and, at best, weak economic recovery and growth. In other words, don't focus too much attention on the bottom line.

T.I.C. STUDY

"Explanation of Tantalum Market Behavior : 1980-1985", the latest study sponsored by the association, is available at a price of \$ US 600 per copy. Inquiries may be made to the Secretary of the T.I.C., rue aux Laines 1, 1000 Brussels.

MEMBERSHIP

The following company has resigned from membership of the T.I.C. :

Cabot Berylco Inc.,
Reading,
Pennsylvania 19603, U.S.A.