Activities of the T.I.C.

T.I.C. SECRETARIAT

The Executive Committee of the T.I.C. has appointed Mrs. J.A. Wickens as Secretary of the T.I.C., effective 1 July 1977. Mrs. Wickens succeeds Mrs. J. E. Goodyear, who has been Secretary of the T.I.C. for two years. Mrs. Goodyear resigned as she has moved abroad.

GENERAL SYMPOSIUM ON TANTALUM

The T.I.C. will sponsor a General World Symposium on Tantalum from 10 May through 12 May, 1978. The site of this first meeting covering all segments of the tantalum community will be Rothenburg ob der Tauber, West Germany. Attendance is open to everyone with an interest in tantalum and is not limited to T.I.C. members.

The schedule of meetings has been arranged so that participants should arrive at Rothenburg on Tuesday, 9 May. The Ninth General Assembly of the T.I.C. for members will be held on Wednesday morning. The Symposium will open in the afternoon at 2:00 p.m. and continue through Friday 12 May.

The program will be as follows :

Wednesday, 10 May — Ninth General Assembly of the T.I.C., convened at 10:30 a.m.
— Lunch at 12:00 Noon.
— Opening of Symposium at 2:00 p.m.
— Presentation of Papers.

Thursday, 11 May — Symposium with papers presented in the morning and afternoon.
— Festive dinner of all participants.

Friday, 12 May — Depart Rothenburg to transfer to hotel in Nürnberg in the morning.
— Symposium reconvened at the Nürnberg works of Gesellschaft für Elektrometallurgie in the morning for a visit to the works and the Central Research Institute.
— Visit in the afternoon to the Grundig Works, the largest European plant producing television equipment.
— Evening reception by the City of Nürnberg in the Castle of the City, officially closing the Symposium.

Saturday, 13 May — Informal social gatherings and sightseeing at the option of participants.

By letter, the Executive Committee of the T.I.C. has asked all members to send a list of people or institutions whom they suggest may be interested in the Symposium. It will then be possible to direct specific information about transportation, hotels, and the detailed Agenda to those who might attend. These details will also be published in Issue No. 12 of the T.I.C. « Bulletin » in December.

Anyone with an interest in tantalum may attend the Symposium. Those who might like to come should write to the Secretary of the T.I.C. for specifics details of registration and attendance. As soon as these are prepared, they will be forwarded in response.

Production of Tantalum Products at GfE, Gesellschaft für Elektrometallurgie mbH

Gesellschaft für Elektrometallurgie was founded in 1911, in Nürnberg, Federal Republic of Germany, and is a part of the Metallurg Group, or Grunfeld Group, after the founder family. The Weisweiler works of the company was commissioned in 1917, and the Central Research and Development Department for the Group was established in Nürnberg in 1952.

The company has long been known for its production of a wide range of ferro-alloys, vanadium products and other specialty metals and metal compounds and is a major producer of tantalum and niobium products. A fully integrated production line has been established, with the Nürnberg works as center, working in close cooperation with the Central Research and Development Department.

The Nürnberg plant was one of the first to use the Marignac process for the separation of complex tantalum and niobium fluoride crystals, and in the early fifties, it became the first plant in Germany to install the solvent extraction process for the separation and recovery of tantalum and niobium. These metals, or their compounds, are recovered from a large variety of raw materials : natural tantalites or niobo-tantalites, as well as synthetic concentrates produced from low grade ores or tin slags. The natural ores

are processed directly by solvent extraction at Nürnberg, but the low-grade slags must first be upgraded, with the elimination of acid-consuming impurities such as Al_2O_3, SiO_2 and CaO.

The upgrading is carried out in the electric furnaces at Weisweiler, using processes developed by the Research and Development Department in Nürnberg for each different kind of raw material, so as to maximize tantalum and niobium recovery. The slags are reduced, yielding a large block of metal containing an increased concentration of tantalum and niobium, but still highly contaminated. During this first step, the raw materials are fed continuously into the furnace and the reduced slags are tapped periodically. Specially developed analytical procedures are applied to ensure a minimum tantalum content in the slag prior to discarding it.

After the blockmetal has reached a certain weight, the process is interrupted and the button is crushed and ground. The ground material undergoes further treatment aimed at eliminating impurities and a further concentration of combined oxides of tantalum and niobium. The final product is the « synthetic concentrate », which is used for hydrofluoric acid treatment, similar to the treatment of natural ores. Below is a typical analysis comparison of a starting material and the final product :

Starting Material	Starting Product	Final Product
Ta_2O_5	< 5 %	> 30 %
Nb_2O_5	< 5 %	> 30 %
CaO	> 10 %	< 1 %
Al_2O_3	> 10 %	< 1 %
SiO_2	> 30 %	< 1 %

The final product of the Weisweiler operation is a synthetic concentrate with a minimum of 60 % combined oxides of tantalum and niobium, and a maximum of 1 % each of CaO, Al_2O_3 and SiO_2.

This product, as well as the natural ores, is digested in a concentrated hydrofluoric acid solution, and the tantalum-niobium bearing filtrate is fed into a mixer-settler system where the elements are separated from one another by the liquid-liquid process.

Niobium is precipitated with ammonia as a hydrated oxide and hard calcined to produce a high-purity niobium oxide which is the source material for high-purity ferro-niobium or nickel-niobium alloys used in the production of super-alloys for aircraft engines and other high temperature applications.

The solution of tantalum fluoride is either converted into K_2TaF_7 or Ta_2O_5; the production of the latter is very similar to that of Nb_2O_5. As one requires a product of highest purity, the calcination process of Ta_2O_5 is done in a specially designed furnace guaranteeing that no contamination of the Ta_2O_5 occurs. Most of the pentoxide is used for carburisation in tube furnaces or in vacuum furnaces for the production of TaC, which is also manufactured by the Group's company in England.

The production of K_2TaF_7 is done by adding potassium fluoride to the solution of tantalum fluoride and this solution is then recrystallized to obtain the highest degree of purity. The fluoride is the starting material for the production of tantalum metal, which has been carried on in the facilities of the Central Research and Development Department since 1958. The research effort is constant to ensure the production of metal of sufficient purity and properties to meet the ever-increasing needs of the consumer.

A Technical Approach to Economic Forecasting

This article is a condensation of a paper presented at the T.I.C. Seventh General Assembly on 4 May, 1977, by Mr. David E. Maguire, Vice President and General Manager, Electronics Division, Union Carbide Corporation.

Those people who practise economics and economic forecasting have been increasingly frustrated with the inaccuracies of their projections. There are fundamental reasons for the growing confusion which relate to a changing set of « rules » as the world approaches the end point of yet another long term economic cycle. However, this paper presents a technical approach to economic forecasting which ignores dependence upon fundamental factors while focusing primarily upon a sequence of orderly events

which can lead to rather precise timing of the business (or operating) cycle turning points. The approach also sheds some indication upon the expected amplitudes of future business cycles.

A dependence on fundamental factors alone, without the benefits of the technical factors, can often lead to forecasts which are grossly in error, both in timing and amplitude. Technical factors focus on the *what* and *when* of economic indicators - not the *why*.

Economic cycles of varying lengths occur automatically and require no specific « trigger » either to set them in motion or to stop them. Recent work at the Massachusetts Institute of Technology has evolved a computerized model of the consumer and capital goods industries. It is important to recognize the built-in delays and momentum inherent in such a model. One important delay is the changing perceptions and expectations of the future by management of industry. An increase in orders and backlogs is likely to be viewed with scepticism at first, while much later in a cycle, viewed with great enthusiasm and an expectation of going up forever.

To measure the response of such a model to an increase in apparent demand, only the labor and material inputs to the model are allowed to change. First, inventories are drawn down, backlog increases, followed by production increases, then excess build up of inventory, production cut backs, etc. There are also many other cyclical characteristics taking place within the model such as length of work weeks, employment hiring, order quantities for materials, etc. The important point, however, is that given a single perturbation of demand, the model system will be shocked into oscillation with a time cycle length of approximately four years, very typical of the regular business (or operating) cycle seen in real life. If the model is again stimulated with the same demand perturbation, and this time only the capital input is allowed to vary, a longer interval cyclical response of approximately 13-15 years occurs, often studied in real life and associated with the work of Kuznets.

Letting the capital input vary, as in the last example, assumes there are no limitations in the availability of capital goods. In real life, there are strong interactions since the capital goods sector of the industry must increase its own capacity prior to meeting a higher demand for its output. It also competes for labor, material, and money resources with the rest of the economy. An even longer term cyclical element of approximately 52 years becomes evident. Many speculations can be forwarded as to *why* such a behavior can exist. Regardless of why, it is demonstrated in real life as revealed in the studies of Kondratieff who observed that there appeared regular long term cycles in the economies of the world which were approximately 52 years in length. The most apparent measurement of these cycles was a peak in prices such as occurred in 1814, 1864, 1920, and in the early 1970's. Each peak was followed by a period of slow growth and declining prices, in real terms, for about ten years; then a drastic decline in economic activity and real prices for another 15 to 20 years.

The interaction of the three distinct cycles operating in the world economy is worthy of examination. Adding these interacting cycles during the broad upswing in the Kondratieff cycle produces a pattern as shown in Figure 1.

Figure 1   ADDITION OF SINUSOIDS DURING RISING PART OF KONDRATIEFF WAVE
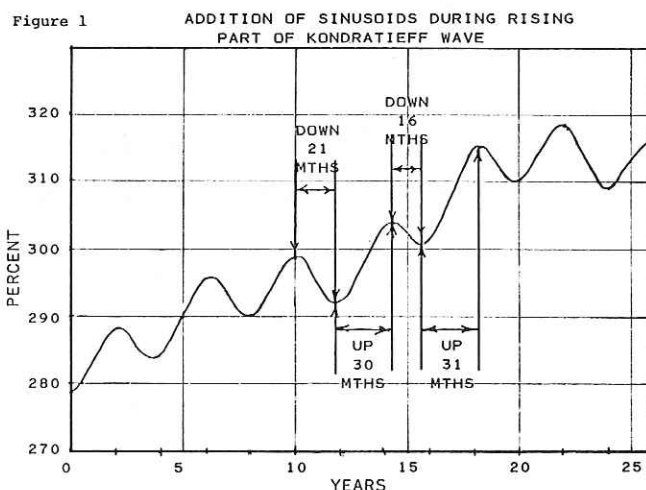
The business cycle expansions are longer than the contractions (or recessions) and, further, they lead to successively higher peaks in activity. Conversely, Figure 2 displays the cyclical additions during the broad downswing in the Kondratieff cycle.

Figure 2   ADDITION OF SINUSOIDS DURING FALLING
PART OF KONDRATIEFF WAVE
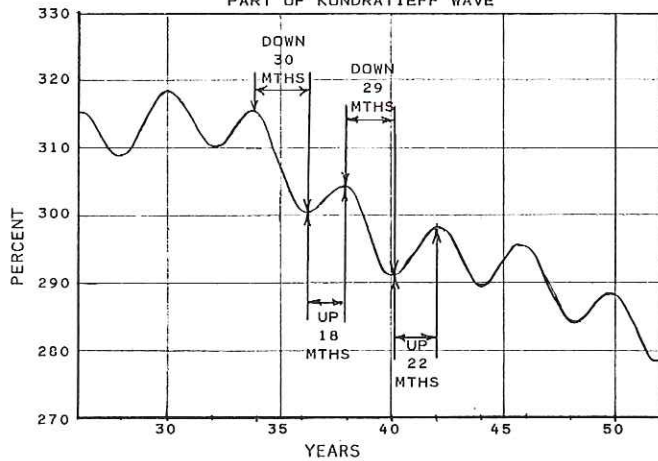
Here, the recessions are of longer duration than the recoveries and lead to lower levels of recovery. At the end, all of the three cycles are reinforced in a negative mode leading to the bottom of the long term cycle which in amplitude is the worst level of economic activity in 52 years. Interestingly, bottoms in activity were observed in 1825, 1880, 1932 and may again occur around 1984.

Given that cycles exist in the world's economies and further that they may interact, it would be of great assistance to have a technical tool to measure accurately the cycles from both a timing and amplitude aspect. One method for more precisely measuring the overlaid business cycles is by utilizing a technical tool called momentum analysis. One momentum analysis uses the ratio of the current month's index divided by the year ago month index number. This momentum measure is called 1/12, since it is the ratio of the current one month divided by the same month 12 months ago. Thus, momentum analysis is a measure of the rate of change in a set of data. When applied to economic data, momentum analysis invariably approximates the shape of periodic sine waves. Furthermore, it *always* results in a peak of the momentum wave ahead of a peak in the underlying statistics.

A further refinement can be added by use of a twelve month moving average which aids in the visualization of trend, particularly for volatile economic series. The 12 month momentum analysis is obtained by taking the current month value of the 12 month moving average (or the sum of the latest 12 months to date) divided by the 12 month moving average of the same month a year ago. This momentum measure, called the 12/12, also forms sine wave-like patterns and also *leads* the underlying data at peaks. Both momentum measures provide information with regards to the amplitude of the swings in the economic series or data under study.

This simple analysis technique can provide useful insights into the real world business environment on a stand-alone basis. Their patterns invariably provide early warnings that there will be an economic slowdown or recession in the near future. While these momentum studies are useful in and of themselves, it should be possible to refine our economic analyses if various elements and indicators of the economy have different timing cycles. That is, some will lead, some will be coincident with, and some will lag a basic measure of economic activity such as the Federal Reserve Board (FRB) index of industrial production.

Figure 3 is a table which defines the timing of peaks and valleys of stock prices, the FRB index, and their respective 1/12 and 12/12 momentum analyses over the past four business cycles.

FIGURE 3
STOCK PRICES VS FRB INDEX
TIMING AT PEAKS & VALLEYS

PEAKS	STOCK PRICES			FRB		
	1/12	12/12	ACTUAL	1/12	12/12	ACTUAL
	10-63	4-64	1-66	10-65	5-66	10-66
	9-67	6-68	11-68	6-68	3-69	10-69
	6-71	12-71	1-73	12-72	5-73	6-74
	1-76	9-76	9-76	3-76	12-76	?
VALLEYS						
	1/12	12/12	ACTUAL	1/12	12/12	ACTUAL
	9-66	3-67	9-66	7-67	1-68	6-67
	5-70	10-70	6-70	10-70	2-71	11-70
	10-74	1-75	12-74	3-75	10-75	3-75

From these data, Figure 4 was constructed to show the lead times in the stock prices and various momentum measures against the absolute peaks and valleys of economic activity as measured by the FRB index.

FIGURE 4
STOCK PRICE & MOMENTUM MEASURE LEAD TIMES
FROM PEAKS & VALLEYS OF INDUSTRIAL ACTIVITY
(MONTHS)

| FRB PEAK	SP 1/12	SP 12/12	FRB 1/12	FRB 12/12
OCT. 66	36	30	12	5
OCT. 69	25	16	16	7
JUNE 74	36	31	18	13
(JUNE 77)	18(?)	12(?)	15(?)	7(?)
FRB VALLEY				
JUNE 67	9	3	-1	-7
NOV. 70	6	1	2	-3
MAR. 75	5	2	-0-	-6

Note that stock price 1/12 momentum leads the peaks in activity by 1½ to 3 years which is not particularly useful. The stock price 12/12 leads the activity peak by 1 to 2½ years which is better. The FRB 1/12 is much more consistent by leading the activity peak by 12 to 18 months while the FRB 12/12 is closer yet with a lead time of 5-13 months. At the valleys, the stock price 1/12 leads by 5 to 9 months, while the stock price 12/12 is very precise with a lead time of 1-3 months. The FRB 1/12 and 12/12 measures are not useful in that they are either coincident or lagging.

Figure 5 shows the above timing points in a graphical form which suggests that an order transition and sequence of timing points may exist among various indicators and momentum measures of these indicators.

Figure 5
TIME RELATIONSHIP AMONG VARIOUS
MEASURES OF STOCK PRICES & FRB INDEX
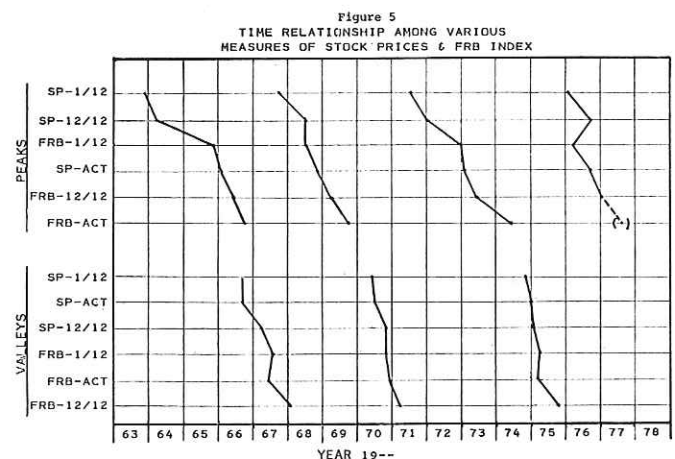
In other words, once the first « domino » has fallen, the others are sure to follow, leading up to the event of interest which is the last « domino ».

An examination of the relationships between the 12/12 momentum peaks and valleys of a number of commonly available economic measures is shown for each business cycle from 1961 in Figure 6.

Figure 6
CYCLICAL TIME RELATIONSHIP AMONG
MOMENTUM MEASURES OF 35 INDICATORS
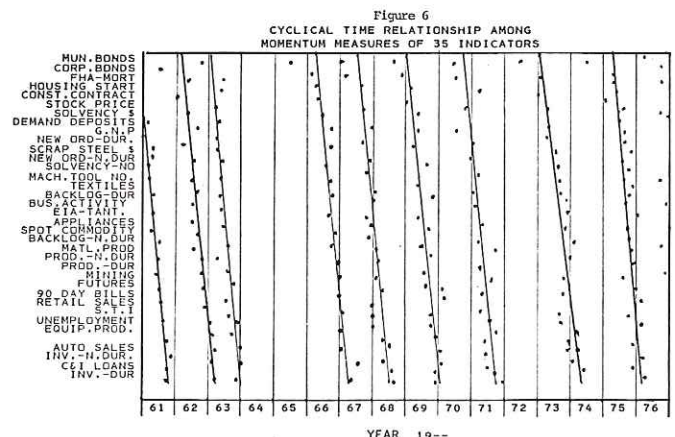
There is a fairly regular progression of momentum measures during each peak and valley in economic activity. This orderly progression suggests that if the key economic measure is analyzed for a specific business, and the position of its 12/12 momentum peaks and valleys among other available indicators is determined, it will be able quite accurately to anticipate and forecast the future peaks and valleys of the business. For example, if the business was, say, number 18 from the top among these 30 or so indicators, then the turning points in the earlier turning indicators could be observed as they happen and accurately estimate the turning point of the specific business. Further, as one after the other of these indicators turns, the forecast can be continually updated to even greater precision ! The EIA tantalum capacitor shipments 12/12 momentum peaks and valleys are mid-turners during cycles and approximately coincident with business activity.

The 30 or so indicators shown in Figure 6 are a bit too general for accurately pinpointing the tantalum capacitor business. Furthermore, some of these are being manipulated to a growing extent through political interference in economic activities. The more political interference, the more variable and conflicting the general indicators become with a generally worsening economic result. To avoid these problems, a few indicators have been selected which are readily available and timely : the S & P 425 industrial stock average, the FRB index of industrial production, the EIA (Electronic Industries Association) data for bookings of all capacitors, the EIA data for shipments of all capacitors, the Business Week Index published by Business Week Magazine, the EIA tantalum capacitor shipments, and, for application to the tantalum market, an approximation of the tantalum powder and wire shipments by U. S. producers. When these data are arranged into time series graphs similar to Figure 5, very clear timing patterns will be displayed with a reproducible sequence of events at both peaks and valleys.

By the time the first 5 to 8 measures have peaked, the peak in tantalum capacitor shipments 9 tot 12 months later can be perceived quite accurately. Further, as subsequent measures fall into place, the precision of the peak time estimate improves. A similar procedure works equally well at the valleys with the first few indicators leading the eventual valley in tantalum capacitor shipments by 6 months or so. The tantalum material shipments peaks and valleys are generally close to the capacitor peaks and valleys with an average 2-3 month lag time.

The cyclical slopes displayed for the economic cycles reflect unusual circumstances over the past two cycles. From other studies, the slope of the line connecting the cyclical turning points can be expected to extend for about 24 months beginning to end. The 1966/67 cycle was 24 months, the 1969/70 cycle was 30 months, and the 1974/75 cycle was 36 months. The psychological legacy of the two most recent cycles will probably restrain inventory accumulation on a broad front, and therefore, the current slope will be a more normal 24 months. Therefore, using the existing information, certain forecasts about future events can be made :

1) The stock market should reach a bottom in the third quarter of 1977.

2) Tantalum capacitor shipments will peak next month in June and bottom out in the first quarter of 1978, followed by a moderate rise into the next cycle.

3) Tantalum material shipments should peak in the third quarter of 1977, followed by a decline lasting until the second quarter of 1978.

Only modest rises in the next cycle due to the position in the long-term Kondratieff cycle can be expected. The period ahead will be characterized by flat to modest growth, with tough pricing (in real terms), another recession in 1980 which will be vigorously fought by the politicians through an avalanche of fiat money, which will lead to economic disaster beginning around 1981 and bottoming in 1984.


Japanese Tantalum Production 1975 and 1976

The latest reports received from the Japanese New Metals Association and the Ministry of Finance provide a comparison of the tantalum market in Japan :

PRODUCT (Unit : kg)	1975 Actual	1976 Actual	% Change
CONSUMPTION :			
Capacitors — Powder	34,778	81,398	134
Wire	5,843	13,695	134
Foil	711	99	(86)
Other	2,377	4,158	75
Total	43,709	99,350	127
Industrial — Powder	601	3,140	920
Mill Prod.	2,564	5,168	102
Carbide	14,284	19,700	38
Oxide	9,340	10,800	16
Total	26,789	38,808	45
Grand Total	70,489	138,158	96
SOURCE OF PRODUCTS :			
Imports	25,507	43,654	71
Produced	44,991	94,504	110
Grand Total	70,498	138,158	96

The proportion of total consumption used by the electronics industry increased greatly from 62.0 % in 1975 to 71.9 % in 1976. This consumption also represents an increase of 6 % over the electronic industry consumption of 1974, the previous peak year. Domestic production for this market segment reached 61,405 kg, 61.8 % of the consumption, the highest level ever produced within Japan. The previous peak domestic production was in 1974 at 54,500 kg.

Total tantalum consumption, however, did not attain in 1976 the level of either 1973 or 1974. The drop of 9 % from the 1974 peak is entirely in the consumption of tantalum carbide. A combination of slower recovery of the cutting tool industry and reduced use of tantalum carbide in the cutting tools is considered to be the cause of reduced tantalum carbide consumption.

The proportion of consumption for oxides and carbides compared to metal products, as shown in the chart, has decreased from a 3:2 ratio in 1972 to a 3:1 ratio in 1976.

TANTALUM PRODUCTS CONSUMPTION IN JAPAN 1972 - 1976
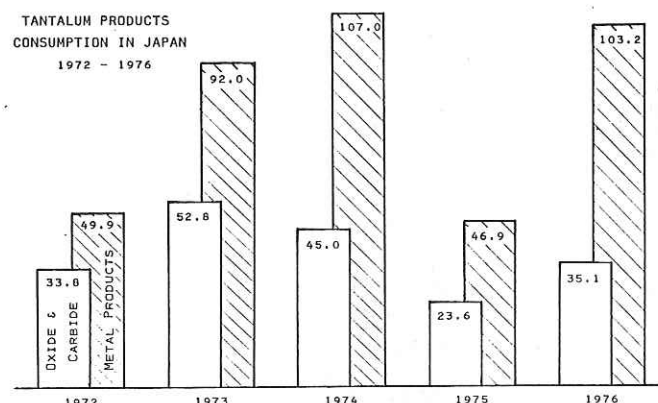
Imports of source materials for 1974, 1975 and 1976 compare as follows :

SOURCE : (Unit : m.t.)	1974	1975	1976
Ore and concentrates	109	62	62
Potassium fluotantalite	137	22	118
Tantalum scrap	22	1	9
Approximate Ta content	126	34	87
% of products produced	134 %	70 %	92 %

The approximate tantalum content of the source materials, amounting to only 92 % of the weight of domestically produced products, indicates a significant reduction of the source material inventory built up in 1974. New imports, after making allowance for unrecoverable losses in processing, supplied only about 85 % of the material needed.

The New Metal Association has forecast that in 1977 the total consumption of tantalum products will be about 130,000 kg., a drop of about 6 %. A reduction in the consumption of capacitor powder is expected due to the trend toward smaller units. Capacitor powder requirements have reduced from 240 grams per 1000 capacitors in 1974 to 160 in 1976. The forecast for 1977 is 120 grams per 1000 capacitors.