Niobium in the Future

MANAGING SUCCESSFULLY IN NIOBIUM MARKETS OF THE 1980s

Thomas C. Barron

Ayers, Whitmore & Co.
950 Third Avenue
New York, New York 10022

Introduction

For years there have been two completely separate niobium "industries" - high quality and standard grade - separate at every stage from mining through processing and alloying to end use. In 1980, however, the industries joined, for the first time, at the raw material and processing stages of high quality (HQ) niobium. The high quality business has experienced a new situation. (Figure 1).

This new situation and a bright outlook for key market segments makes the HQ niobium business a very attractive one for the 1980s. Never before 1980 could HQ niobium be produced from pyrochlore source material. Now that it can, consumers' concerns over long-term availability should be effectively eliminated. The vast reserves and large processing capacity for pyrochlore will place downward pressure on HQ niobium oxide and alloy costs and prices. This can only foster development of alloys and other products containing niobium, and spur the expansion of new applications and markets. Somewhat in contrast, the standard-grade niobium "industry" will be much the same in the years ahead - very competitive for standard-grade ferroalloy producers, though ultimately healthy for the long-term usage of niobium and the development of applications.

Given these outlooks, different management approaches will have to be used in each of the two niobium "industries", to sustain satisfactory returns. In particular, HQ "industry" managers will need to be concerned with market segmentation strategies that carefully target resources by segment, while standard quality producers will need to emphasize manufacturing and applications.

The information given is primarily directed to managers from U.S., European, and Japanese companies involved in the processing and alloying stages of the two markets. However, the implications of these remarks for companies that consume alloys (e.g. steel or aircraft engine manufacturers) or for those that mine, concentrate, or smelt niobium raw materials should be fairly obvious.

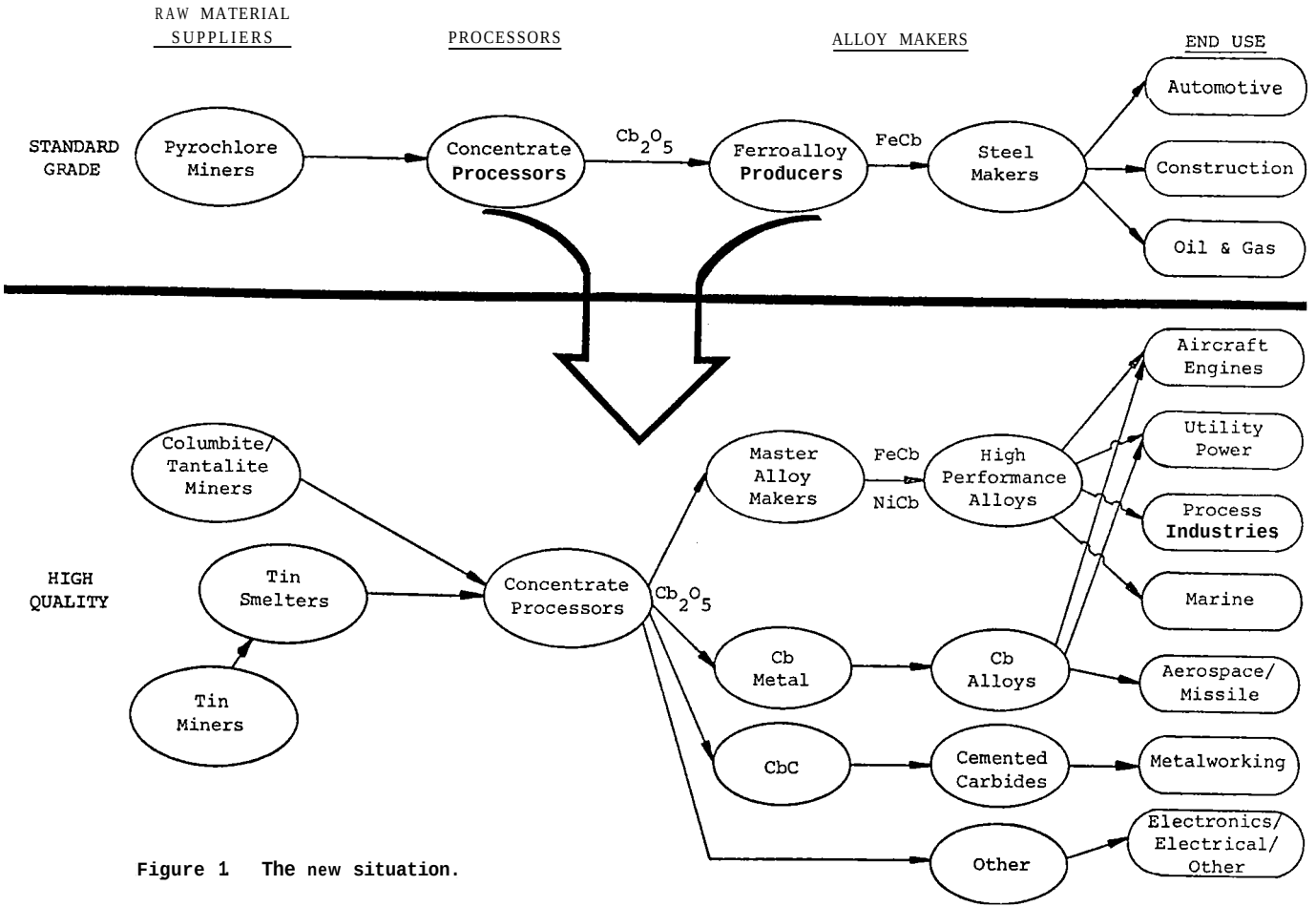


Figure 1 The new situation.

Niobium Success Factors

To be successful in the decade ahead, managers in the HQ niobium business will need to perform three tasks especially well:

(1) anticipate the market segments that will have the most attractive growth patterns and the timing of demand increases to fully participate in the growth;

(2) tailor business strategies - including manufacturing capacity, product research and development, sales force coverage, promotion, etc. - to capture market share; and

(3) find an optimum balance of raw material sources and costs - in other words to protect against the risk of supply interruptions while keeping a competitive cost basis.

Standard Grade Niobium

In contrast, managers in the standard grade industry will need a somewhat different emphasis for long-run success. First, managers will need to concentrate resources on applications development to counteract the slowdown in growth of several primary markets, e.g., oil and gas and automotive. Applications development effort should cover each major segment broadly and thoroughly. Second, it is essential that improvements in production efficiencies, based on economies of scale and new developments, be made 'to remain competitive in this modest-growth period. Finally, distribute the risk of supply cut-off or reduction, given that there is a limited number of available sources.

In summary, we are suggesting that marketing is the key factor for success in the HQ business, and manufacturing and applications engineering in standard grade. To explain the relevance of these conclusions each of the two "industries" will be discussed in turn, covering demand outlook, supply trends, availability and prices, and the key factors for success in the 1980s.

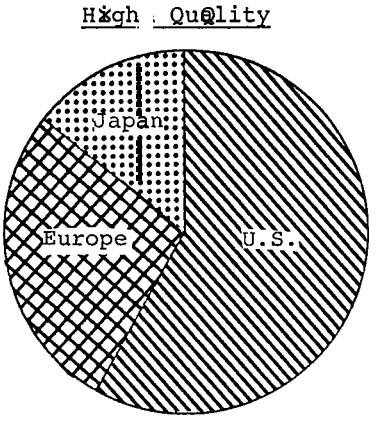
HQ Niobium

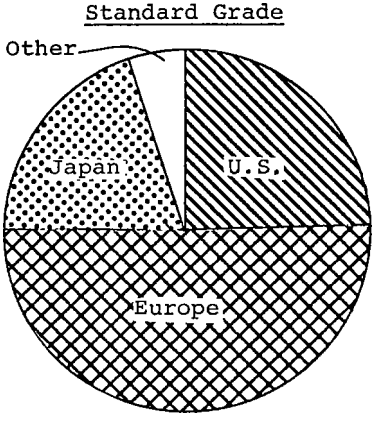
While HQ niobium is a much smaller market worldwide than standard grade - about 2.4–3.0 million pounds niobium content versus 19–20 million in the past two years – it offers attractive growth and margin opportunities to the well prepared company.

The United States accounts for about two-thirds of the world's HQ consumption, (Figure 2) primarily because aircraft engine manufacturing is *so* heavily concentrated in the U.S. Applications and markets in Europe and Japan are otherwise very similar to the U.S. Over the past decade,* the world HQ (and U.S.) market has grown at a compound annual rate of about 4 percent, although the demand pattern has been a volatile one.

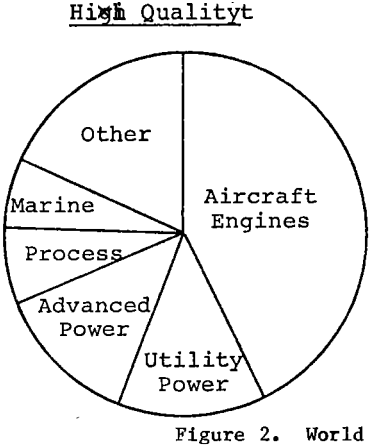
* 1970–1980

Geographic





Key Markets



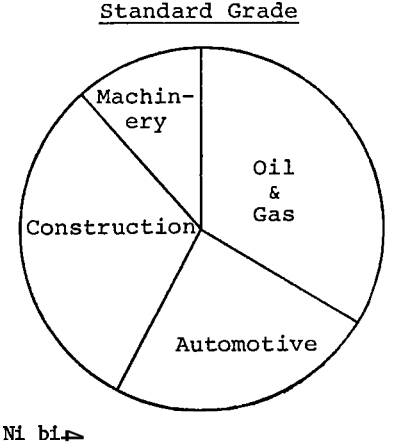


Figure 2. World Consumption of Ni by

The market segments where HQ niobium-containing products are used are a very interesting, distinctive combination. However, anticipating growth is difficult. Because there are usually many stages of processing and fabricating and few data are publicly available about production or sales at any stage, good market research is essential for sound decision-making.

Looking to the 1980's, overall demand growth for HQ niobium should average about 5 percent annually. Research suggests, however, that several segments should easily expand at rates above 7 percent per year, as shown in the matrix of segment size and forecast growth rate (Figure 3).

High Growth/Large Market

Perhaps surprisingly, the utility plant market for niobium-containing alloys stands out before aircraft engines as one of size and high growth potential in the future. About 300,000 pounds of oxide were shipped in 1979 for high performance alloys (HPAs) or so-called "superalloys" for use in pollution control equipment, gas turbine engines for conventional power plants, and components for nuclear plants. Pollution control equipment holds the real upside potential. For example, a single purchase of a stack gas emission control system for coal fired plants could require as much as a half million pounds of Inconel 625, equal to more than 20,000 pounds niobium in the final product. The long life and low maintenance costs of HPAs vs. stainless steels can in some cases offset their higher initial price tags. While it is possible that in the U.S.A., the government could take actions to reduce environmental standards and investment in pollution control equipment, the plant maintenance requirements of this segment should still be strong and sustain niobium demand. Also, any acceleration in converting oil-fired plants to coal would have a significant positive effect. Gas turbine engines for peak power loading will also see sales increases of about 7 percent per year and proportionately increase HPA requirements for such alloys as IN-738.

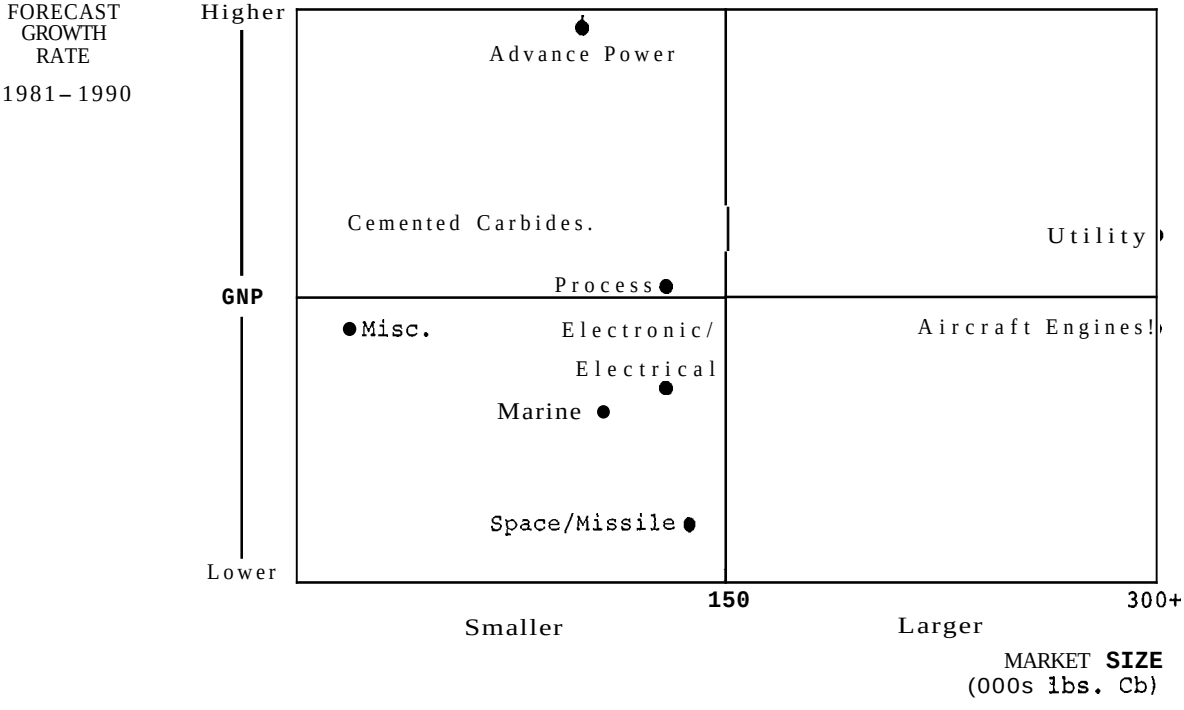
High Growth/Smaller Market

Three segments fall into this category, each for completely different reasons.

Advanced Power Research. Superconductor and classified U.S. Government nuclear research should increase at least 10 percent per year over the next five years, if not through 1990. In forecasting this, only small increases in the classified research area are assumed from a base of about 70,000 lb. niobium in 1980. It is superconductors which will provide all the excitement, albeit from a small base of only about 100,000 pounds in 1980. By 1985, the superconductor market should require at least 275,000-300,000 pounds niobium equivalent. The reasons are twofold:

- A strong initial push is coming from major government funded research programs at Fermi National Laboratory, Brookhaven National Lab and elsewhere. The research programs are directed toward six application areas: magnetohydrodynamics (MHD), fusion reactors, power transmission, generators, and magnetic separation. Of these, MHD and superconductive motors appear closest to commercial viability, sometime in the mid-1980s.

- A secondary stage of development is expected from private sector capital in the early- to mid-1980s to expand the applications of the technology.



Note: Nb equivalent ex works of processing companies.

Figure 3. Market size & growth by final market

The "arrival" of the superconductor market has been announced prematurely several times in the past, but it is now clear that commercial opportunities are finally emerging.

Cemented Carbides. Cemented Carbides have for the first time in the U.S. become an important growth area for HQ niobium in oxide or NbC form. As tantalum carbide prices increased from *$40* to $180 per pound, manufacturers have invested in R & D to design tantalum down and replace it with niobium. Prior to 1979 the tantalum:niobium ratio in American premium grade carbides was about **97:3.** Based on European experience, the average ratio can eventually drop as low as **70:30** - a substantial boost for niobium. We project that this substitution will occur and cause niobium demand to grow 8 percent annually in the U.S. and 5 - 6 percent in Japan and Europe.

Process Industries. Process Industries, like the utility industry, use HPAs such as Inconel 625 *(4%* niobium) for corrosion resistance application. These industries, e.g., sulfuric and phosphoric acids, are likely to respond **to** a restructured national economy and investment incentives to grow at GNP rates - *4.4* percent per year according to U. S. government forecasts.

Sub-GNP Growth/Large Market

Only one segment fits in this third group, aircraft jet engines, and it is by far the largest. In 1980, it was the ultimate destination of about 50 percent of all HQ niobium shipments; in 1970 that figure was very close to 75 percent.

The jet engine demand for HPAs containing niobium is projected to remain on a high plateau through the early 1980s and then, following the historical pattern, dip downward thereafter (Figure *4).*

- New engine production is forecast to remain between *14.4* million and 15.7 million pounds engine weight from 1980 through 1985. For comparison, engine weight shipped in 1977 was 10.9 million pounds.

- However, replacement parts demand - which typically accounts for more than 50 percent of demand for HPAs containing niobium (Figure 5) - will begin to enter the downward part of its cycle in the early 1980s. Heaviest replacement component demand occurs at 11–12 year intervals, and the most recent peak was in 1979–1980.

- The effect of substitution efforts by Pratt & Whitney and others to reduce their dependence upon cobalt alloys (in favor of niobium alloys) will soon be fully reflected in the demand figures. Additional substitution favoring niobium seems impractical and unlikely.

HPAs for aircraft engines is a very mature market segment characterized by long-term cycles at the engine manufacturer's level and violent, unpleasant swings for the alloy maker. Further, the future of HPAs containing niobium is not in the high temperature parts of engines for new generation aircraft. Newer technologies have been and will continue to supplant them gradually. Alloy development possibilities are therefore more limited in this segment as HPAs "move further back" in the engines of the future.

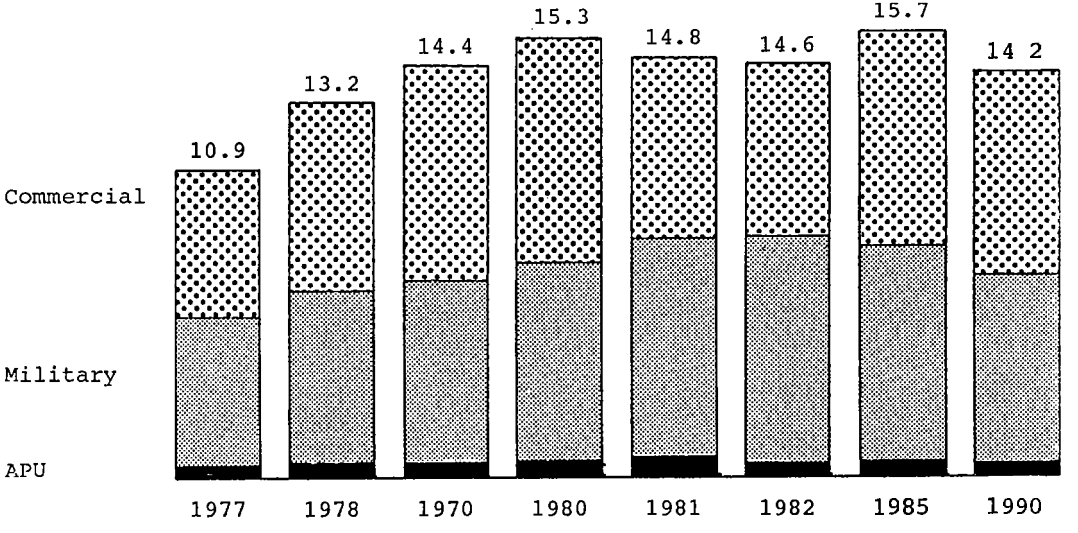
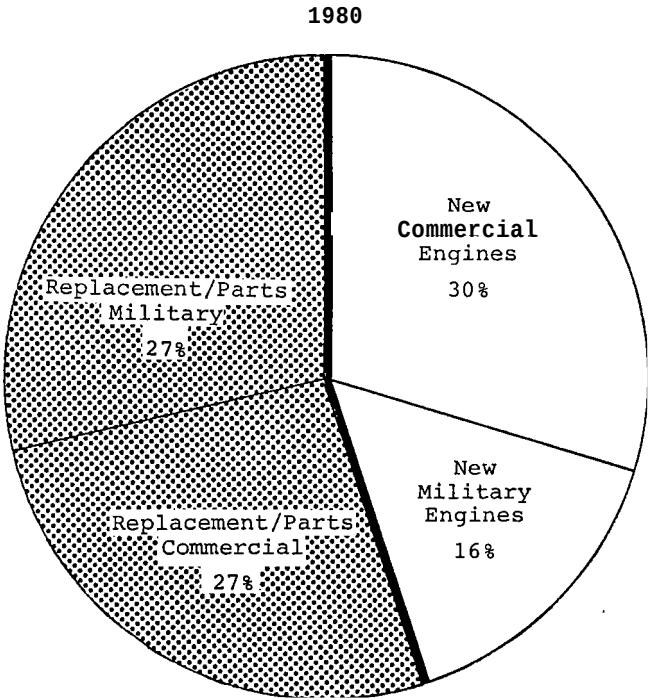


Figure 4. Historical and forcast U.S. engine weight.

(Millions Pounds Dry Weight)



Note: Demand expressed as percentage of total U.S. fly weight of engines and components produced.

Figure 5. Replacement part shipment weight exceeds new engine weight produced.

Low Growth/Small Markets

Finally, there are a number of low growth segments with attraction only for individual companies who might have already established a unique niche. These include aerospace/missile (e.g., the Trident submarine's hot gas steering system), electronics (e.g., ceramic capacitors), electrical (e.g., sodium vapor lamps), marine applications, cathodic protection systems, optical glass manufacturing, and other miscellaneous segments.

Tailor Strategies To Each Segment

Anticipating growth areas, or even the timing of increases in demand, is not sufficient for success. Managers need to tailor strategies to "win" in selected segments, because it is extremely difficult to succeed equally well in all areas. "Tailoring" in this context means to allocate resources to meet the key characteristics of each market segment targeted; the same approach cannot be used across the board (Figure 6).

For example, in comparing two important HPA-using segments (Figure 7) it is clear that different approaches to sales organization and training, product development and other areas would be in order.

Optimize Costs/Flexibility

Managers in HQ niobium will also have the important task of keeping unit raw material costs competitive, while not increasing the risk of supply interruptions. Pyrochlore source material is simply going to be cheaper than tantalum-related sources, and competitive economics will force alloy makers to use it. The question is what percentage of one's total needs should it represent?

While each individual company's situation differs, projections indicate that HQ niobium processors will eventually use about 45 percent pyrochlore, much of it Brazilian. Research into corporate metals purchasing indicates that 50 percent dependence on one supplier is psychologically and practically uncomfortable for most managements. Thus, a number of companies will find themselves facing difficult decisions. The trick will be to optimize cost and risk, rather than just minimizing costs.

Standard Grade Industry

In the 1980s the standard grade niobium (SG niobium) market should be healthy - with its usual cyclicality, of course - but it is unlikely to offer any exciting new areas of demand. An annual average growth rate of only about 3.0 percent to 3.5 percent is projected based on the long-term trends in oil and gas pipe and automotive uses in key market segments. Against this backdrop, the key success factors in the '80s are not startling: (1) production efficiencies and (2) applications engineering. Production efficiencies are one key because the overall demand trends in a slow growth environment favor the low-cost producers. An applications engineering focus will be key to obtaining higher margins under such demand conditions when low-cost raw materials are readily available. The steel producers and ferroalloy suppliers that are most aggressive and innovative should reap the best financial returns. Examine briefly the underlying demand, supply, and price conclusions that lead to these assessments about the standard grade industry.

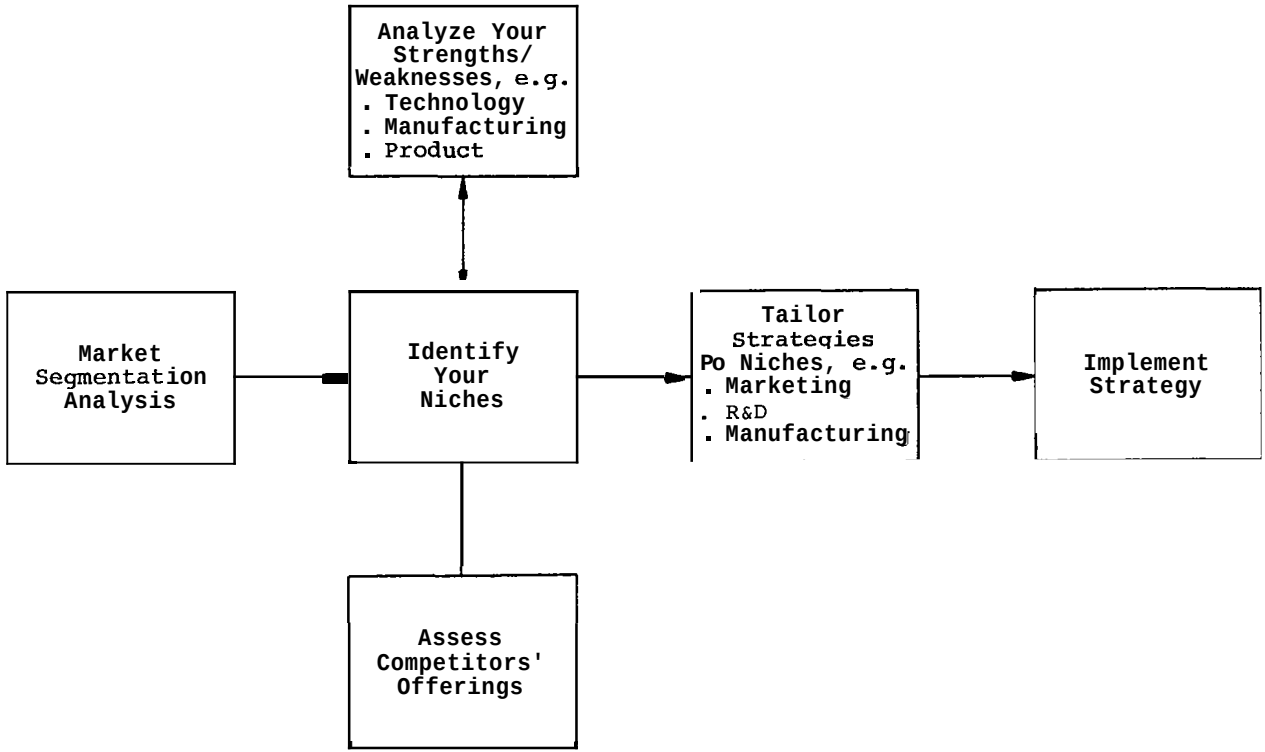


Figure 6. Strategies "tailored" to target segments.

	UTILITY POWER PLANTS	AIRCRAFT ENGINES
Know the Customer		
Number of customers	• Thousands	• < 20 worldwide
Buying factors	• Maintenance costs	• Alloy performance
	• Price - PSC/PUC	• Availability
	• Outside engineering firm	• Large in house R&D
Component design	• Operate cycle	• Very long cycle
Nature of Competition	• Newer game	• Mature
Engineering/Development Capability	• Applications need	• Product/alloy development

Figure 7. Same HPAs - different market characteristics.

Demand Growth Too Slow

It is forecasted that the world* SG niobium market will total about *30* million pounds annually by 1990, up from about 21 million in 1980. This *3.5* percent growth contrasts with a rate of about 7 percent per year since 1960 and 5 percent in the 1970s. Niobium usage has, thus, increased at a very impressive rate, but that is not likely to continue in the decade ahead. One reason is that substitutable materials, e.g, vanadium and molybdenum, are priced very competitively and will remain so. The other reasons are fundamental to the world energy situation and its effect on key market segments. The fastest growing and largest segments (Figure 2), oil and gas pipe and automotive, both derive their impetus from world energy economics.

Oil and Gas. Oil and gas activity probably will reach a plateau worldwide after the early 1980s because of (1) reduced oil consumption as a percent of world energy needs, and (2) increased energy supplies from other sources, especially coal. This plateau should coincide with a high level of drilling and transmission activity, certainly, **so** niobium-steel requirements will not decline, but rather show limited growth. This forecast is predicated on OPEC keeping prices up, at least in line with world inflation rates. High oil prices will in turn continue the momentum of conservation and movements to alternative energy sources.

Automotive. The same forces that brought "market share'' increases for HSLA steels in the last seven years, will conversely slow their growth in the future. Cars have become smaller and now use less steel in absolute terms. Further weight-reduction of automobiles is inevitable to reduce gas consumption, but other materials (i.e. aluminum, plastics) should take an increasing share from HSLA. Technological development of HSLA applications can help limit growth of competitor materials to some extent, but not a lot. The revitalization of U.S. automotive production would alone, however, serve to keep world niobium requirements from the automotive sector above the 1978–1980 level of *4.0–4.5* million pounds.

Construction. As one of the oldest applications of SG niobium as a steel alloying element, niobium requirements are affected most by the level of activity in the construction industry rather than by substitution for niobium. And the construction industry saw substantial ups and downs in the past 10 years. Even with sustained increases in usage of niobium-steels for offshore oil rig construction world requirements are likely to average less than *3* percent growth annually.

The net conclusion is that key segments will *see* slower growth rates while the overall rate will still be solidly positive.

Plentiful Supply

Looking at what sources exist to supply these markets we ***see*** no lack of phyrochlore reserves. When they are compared to annual worldwide demand, it is clear that more than *300* years worth have already been identified.

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* Excluding the USSR, Eastern Europe, and the People's Republic of China.

The issue in availability for many companies continues to be the degree of dependence on one source that they will accept. Particularly significant is the lack of U.S., European, or Japanese resources, and the fact that over 80 percent of standard grade material comes from Brazil. Even though there are two separate producers in Brazil and one in Canada, perhaps one or two major new pyrochlore producers could enter the market in the next decade. Consumers often become very uncomfortable if they are more than 50 percent dependent on one source, but this is inevitable in today's structure of the industry. If a new supplier comes along who can reduce this dependence for a reasonable price, the supplier should be able to sell his material and remain profitable even if his production costs are higher than those of existing suppliers.

Yodest Prices Increases Will Foster Development

The combination of solid demand growth and ready availability will mean a continuation of modest growth in price, e.g., at or below the rate of inflation. This moderation should serve to keep niobium competitive with other microalloying metals like molybdenum and vanadium. This should also enhance the long-term expansion of its applications in existing or new market segments,

Competitive Success

Logically, processors of niobium oxide and ferroniobium will continue, under these conditions, to endeavor to ensure their own basic raw material supply and reduce over-dependence on one source. The "winning" companies in standard grade will optimize this supplier risk/material cost balance better than competitors, and will concentrate managerial efforts on increasing production efficiencies and maintaining excellent delivery performance. Essentially, this is the same situation as in the past, but the level of competitive sophistication is increasing.

On the market side, the winning companies will pay more attention to shifts in growth of segments and their implications for customer product requirements and opportunities for highest returns. For example, the automotive industry's needs for materials will change in ways that even they cannot predict - due to international shifts in car market share and changes in the relative costs of materials over time.

Summary

Although the standard grade industry is the same - meaning success will depend on manufacturing and product development - the high quality industry's rules have changed. Marketing is now required more than ever for companies to achieve sustained financial success.