THE ENGINE INDUSTRY - NEW AVENUES TO A NEW CENTURY

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Ladies and Gentlemen:

Outsiders may well envy the engine industry its strong financial showing. Understandably enough, for the engine community has indeed scored impressive bottom lines especially these past several years of continuous boom. What is not so well understood, though, is that these fat years resulted from strategic decisions that were made decades ago on a handful of high-margin engine programs.

For the strategic decisions needed now, however, the engine industry will have to reexamine its past business models in light of changing market realities and adopt new approaches if it wants to maintain its profitable course and unlock new markets in the years ahead.

Let me therefore please attempt a brief rundown of our industrial past; I believe it will help our understanding of the new directions we ought to take.

Gas turbine engines and gas turbines are products that require heavy investments in terms of technology and capital. These are formidable barriers for new entrants; small wonder system and subsystem manufacturers remain a small select group globally. That group, while closely cooperating in various constellations, simultaneous sees some fierce infighting. Operating further down the food chain is a highly-specialized component industry that provides the necessary raw materials and parts.

Since aircraft engines were considered—and are to this day—crucial operational assets economically as well as technically, many nations in the days around World War I began setting up their own engine industries, side by side with the airlines. These engine industries initially performed military repair work and, depending on the respective nation's industrial policy, engaged in engine manufacturing at subsystem or system levels. Global cooperative ventures, too, soon sprang up in the time between the two World Wars, when mostly U.S. engine manufacturers licensed overseas subsystem manufacturers to produce their own engines and occasionally reverse-engineer them, as perhaps typically reflected in the 1928 licensing agreement between Pratt & Whitney and BMW. The engine industry's basic structure has survived largely unchanged into the years after World War II.

At the time, the engine industry generally attempted to migrate technologies from the military engine world to civil applications, hoping to share in the blossoming civil market and so reduce its reliance on military procurement projects.

Today, the global engine business is split 70/30 between nondefense/defense markets, with the nondefense fraction still growing. Germany's first foray into the commercial engine market came in the late sixties, again through an international

cooperative venture, when General Electric (GE) brought MTU, alongside Snecma, in on the production of the CF6, the civil TF-39 derivative, initially under a license agreement and later as a risk and revenue sharing partner. Once the big systems integrators saw how these cooperative approaches helped pay for upfront engine development and production costs and aided regional marketing efforts, they set up a wide, mostly transatlantic network of cooperative relationships. In the process, some companies also entered into one-on-one alliances, such as Snecma with GE, MTU with Pratt & Whitney, and Spain's ITP with Rolls-Royce, while others again preferred to play the field, entering into cooperative relationships with partners that varied from one program to the next, as did Fiat and Volvo.

The primes thus were in a position to offload some of their immense development costs that might amount to fully $1 billion for an engine developed from scratch, as well as share the cost of price concessions to lure new business, even if foregoing some of their profits from subsequent spare parts sales; these were now divvied up proportionately among the various stakeholders.

War for market share

In the seventies, large-bypass engines emerged that brought drastic reductions in fuel consumption and noise levels for widebody transport. But also the smaller aircraft serving shorter routes stood to benefit from the large-bypass engines. Engine builders coming late to the recognition of those advantages, or foregoing them so as not to jeopardize their conventional markets, would later have to learn the hard way.

While around 1980, almost 80% of the Western world's commercial transports were still powered by Pratt & Whitney engines, the GE and Snecma CFM consortium, once it overcame its teething problems, soon hotly contested Pratt's market dominance.

The nineties were marked by the battle for market share. While in the short- and medium-haul aircraft markets, airlines could choose among propulsion offerings only on the Airbus A320 family and the Boeing 757, the widebody sector saw lethal price wars between two engine makers and even in three-on-a-wing competitions.

The heated sales campaigns of the nineties severely hurt the prices new engines fetched in the marketplace. Aircraft customers soon got very comfortable with the idea that when they bought a transport, its engines were just about thrown in. Regrettably, the airlines were peeved also that they could not extract the same concessions on engine spare parts, and so they devised strategies to put the squeeze also on this last remaining profit bastion of the engine maker's business model.

While the consistently improving reliability of the new engine generations took an ever greater bite out of spare parts revenues, the airlines clamored for guaranteed caps on engine repair costs. In all, the hope to recoup development and production launch investments in no later than 10-15 years faded into the sunset.

Things are currently being aggravated by the PMA aviation parts phenomenon. PMA (Parts Manufacturer Approval) parts are non-OEM items approved by regulatory agencies. These pose a dual threat in that they squeeze OEM (Original Equipment Manufacturer) parts prices and simultaneously permit upstarts to develop technologies they can subsequently leverage in new roles as suppliers to engine manufacturers, so lowering the previously mentioned barriers to new entrants in the manufacturing sector. Keen on heating competition to bring down spare parts prices, the airlines are entering into long-term deals with PMA manufacturers.

To find a way around the dilemma of increasingly jeopardized pay-out, the engine industry is trying to launch out in new or redefined directions. Their thrust is fivefold:

1. Drastically reduce new engine development and production costs.
2. Revise the value-added chain.
3. Consolidate the industry and enter into cooperative programs.
4. Differentiate its products through novel technologies.
5. Diversify.

1. Cost reductions

For the engine industry, cost reductions are an ongoing battle. They have been achieved to this day through streamlining classical development and production operations through drastically curtailed cycle times, increased process reliability and improved per capita output. In many cases, however, these measures could do little more than offset general price escalation or revenue erosion. But to appreciably reduce its program launch risks, the engine industry needs to go further. What it needs, soon, is another at least 30% quantum leap.

To that end, methodical approaches suggesting themselves are to a) aggressively unlock global development and production sources, mimicking the automotive industry, b) extract the last scrap of value out of costly engine materials in an all-out 'buy-to-fly" effort–presently, only about a one-seventh fraction of the raw materials purchased actually finds its way into the engine–and c) devise new engine architectures with fully matured aerodynamics and an up to 40% reduced number of stages and parts count of its turbocomponents. The latter approach is vigorously being pursued by Pratt & Whitney, for one, in its current determined push to regain lost territory.

It is clearly apparent that globalization, helped by electronic channels of communication, will dramatically revamp the engine development landscape as well. Prompted by a dwindling pool of engineers to draw from at home, the prevailing cost pressures and the emergence of capable computing centers in threshold countries, engine companies tend more and more to pursue projects through a global network of distributed centers of excellence. Development targets such as thermomechanics, stress, and increasingly also aerodynamics, all safely amenable to the use of CAE tools, are the easiest to farm out to any location across the globe. Your traditional development department then preferably retains system integration, verification and project management functions, while the sunrise development locations devote themselves to the analytical and also design portions of the work. The GP7000 stands as a typical example, its development already involving GE and Pratt & Whitney computing centers in areas as remote as India.

2. Expanding the value-added chain

Back in the fifties, when on transatlantic flights the shutdown of an engine still appeared to be the norm, not the exception, the airlines never thought twice about running their own engine repair operations, a need now obviated by the great reliability and longevity of today's engines; powerplants will often stay on-wing for the first seven years of their lives, and the engine maintenance, repair and overhaul (MRO) effort is planned over long horizons.

Many airlines have therefore shuttered their engine repair shops and outsourced their engine MRO work. Which in turn triggered new developments: while in the past, engine MRO was the exclusive domain of the airlines and some independent MRO providers like MTU, the engine OEMs, too, have these past several years been making a major push into the MRO market, often merging the airlines' engine shops

with their own repair operations and turning them into autonomous joint ventures or simply gobbling them up wholesale.

Then when spare parts prices escalated and the carriers during the last U.S. recession were cutting costs with a vengeance, some of the airlines and dedicated MRO shops started developing techniques to repair defective engine parts rather than simply replace them. The repair approach grew into an increasingly common MRO practice and, in conjunction with the engines' enhanced reliability, began to become a drag on the OEMs' projected spare parts business. The OEMs then were quick to turn to the MRO sector as an additional means to expand their earnings opportunities.

As the engine OEMs aggressively expanded into the MRO market, they began to tighten their technical support and licensing policies. Today, the three big OEMs—Pratt & Whitney, General Electric and Rolls-Royce—practically own a substantial chunk of the MRO market. Presently, they seem willing to forego profits on engine sales in favor of unlocking and controlling new segments in the value-added chain and winning broad access to the aftersales market for their own and their rivals' engines alike.

While increasingly moving into MRO services, engine OEMs are in their manufacturing activities focusing on their systems integration capabilities, going out to external suppliers like MTU for complete subsystems or modules and allowing them to become firmly entrenched in the primes' supply chain. In the process and amidst all cooperative efforts, subsystem manufacturers like MTU are well-advised, as are the OEMs themselves, to retain access to existing aftersales markets and through the OEMs, ensure such access is maintained also in new aircraft sales, regardless of any total-care package deals that may be struck.

Much the same tendency, albeit not quite as advanced, is noted in defense markets. Time was when the customer, or the military procurement agency, largely controlled the progress of projects through phased funding, where contracts were let and funds committed separately for concept analyses first and development and production phases thereafter. Today, tight military budgets tempt the military to offload more of the risk on the backs of its industrial partners. International rivalry is making military markets as cost-sensitive as the toughest among civil programs.

Industry aims to open up additional value-added opportunities also in its military business. This endeavor suits military customers fine, happy as they are to see more economy and flexibility in their dealings with industry. Typically,

- MTU seeks a larger repair and overhaul role through its joint industry-military model of cooperation in maintenance with the Luftwaffe, and
- the U.K. is leasing its U.S. C-17 airlifters rather than buying them, and
- in the military market, GECAS is seen aggressively leveraging its financial clout to promote GE engine sales.

3. Consolidation and cooperative programs

In the U.S. engine industry, consolidation has been in full swing for years. Allied Signal bought Textron Lycoming and later merged with Honeywell. Rolls-Royce in 1995 bought the U.S.' veteran Allison Engine Company, adding helicopter engines to its portfolio and moreover improving its access to the U.S. defense market and the technology sponsorship enjoyed by U.S. defense companies.

Unlike the big mergers and acquisitions among airframers, the pace of consolidation in the engine community was somewhat dampened by GE's fruitless attempts

to acquire Honeywell, although Honeywell's future is still clouded in doubt. The European Commission's decision nevertheless leaves a question mark hanging over GE's ability to join the ongoing consolidation fray in the engine industry; there are too many EC eyebrows raised about the market clout of GECAS, GE's formidable financial arm.

Consolidation makes progress also in Europe, albeit at a slower-than-expected pace. Rolls-Royce, which assimilated BMW Rolls-Royce two years ago, is now making noises about beefing up its present, very nearly 50% stake in Spain's Industria de Turbo Propulsores (ITP).

In France, engine activities had already been bunched together last year through Snecma's acquisition of Labinal (Turbomeca and Microturbo). Snecma additionally holds 51% in Belgium's Techspace Aero. Snecma itself is still 97% state-owned (the remaining 3% being held by UTC), which is the No.1 obstacle in the way of further private-sector consolidation of Europe's engine industry. Accordingly, the French government wants to rid itself of its stake in the company, or at least of 25% of it for openers.

To get further consolidation options sorted out, distinction must be made between defense and nondefense operations. In the civil sector, ties are mostly lasting and transatlantic, while on European government programs, European engine manufacturers are cooperating in changing constellations:

On the EJ200 for the Eurofighter, MTU partners with Rolls-Royce, FiatAvio and ITP, while Snecma competes with them with its M88.

On the Tiger engine MTR390, MTU, Turbomeca (now Snecma) and Rolls-Royce are partners, while Rolls-Royce and Turbomeca (RTM322) are vying with GE/MTU/FiatAvio (T700) for the NH90 propulsion business.

For the engine to power the emerging A400M European military transport, MTU/Snecma/FiatAvio had originally been competing against Rolls-Royce until finally, bowing to a gentle pursuasive push from the customer, the contestants amicably agreed on a solution that has MTU, Snecma, Rolls-Royce, FiatAvio, ITP and Techspace Aero jointly launch Aero Propulsion Alliance (APA). Whereas in the civil sector, European engine makers for the most part have their transatlantic ties:

- MTU and Pratt & Whitney have formed a strategic alliance, cooperating on a plurality of engine programs
- MTU, Rolls-Royce and Pratt & Whitney are partnering in the IAE consortium
- Snecma and GE jointly operate the CFM consortium, cooperating also on a number of other engine programs
- MTU and Snecma both have a stake in the GP7000, a joint GE and Pratt & Whitney program, and also in GE's CF6
- ITP, on practically all of its engine programs, partners with Rolls-Royce,
- While FiatAvio and Volvo Aero selectively cooperate with either Pratt & Whitney, GE or Rolls-Royce on various engine programs.

Contractual arrangements underlying these cooperative ventures are long-term and laced with noncompetition clauses. A pan-European civil combine patterned after EADS would directly jeopardize existing transatlantic ties and hence the potential partners' civil operations.

Nothing short of a mega-merger between two of the three big engine integrators General Electric, Pratt & Whitney and Rolls-Royce would seem to be able to rock the boat of these established cooperative patterns.

The spectre of fierce three-on-a-wing competitions, such as had left the big three exhausted in the nineties, is increasingly banned through interlocking cooperative relationships:

- In the upper thrust range, GE and P & W cooperate on the GP7000 program.
- Whereas the IAE consortium (P & W, RR, JAEC, MTU) has positioned itself in the lower thrust range.

Neither cooperative venture gives cause for anticompetitive concern, considering that there are viable competing products in both ranges.

Closer cooperation ultimately leading to the marriage of the partners involved would for MTU as the would-be suitor–and for Snecma and Rolls-Royce at that–appear conceivable at this time only with Volvo Aero and FiatAvio as potential brides. Now while conceivably it might be possible for European engine makers to separate their nondefense from defense operations to jointly launch an integrated military engine entity, the desirability of completely divorcing military from civil activities would appear questionable in that it is bound to zap technological synergies between the two.

Instead, MTU has for some time now been plugging for a European system coordination and management company that makes all European engine manufacturers stakeholders and conceivably uses the recently founded APA as its nucleus. While in this system house, as it is called here, the stakeholders would each focus on their respective specialty, the European system coordination and management company would in toto possess full military engine system integration capability. Subsystem contracts would then be placed according to the technological and economic capabilities of the various engine makers, with national offtakes loosing some of their relevance. Specialization of the various engine makers would reduce duplicate capacities in Europe and appreciably improve competitiveness with U.S. rivals.

What type of consolidation will ultimately emerge depends largely on what the European defense policy will be. Two typical scenarios suggest themselves:

- emergence of a common European standard for the next aircraft generation, or
- emergence of a common NATO standard

While in the former case, European consolidation along the lines of a European system coordination and management company would be needed to compete on a level playing field with U.S. rivals, the latter scenario would indeed allow of competing transatlantic partnerships.
Present developments, however, seem to favor the type of European consolidation described in scenario 1.

4. Differentiation through new technologies

The present commercial engine price war evidences a high degree of product maturity that makes it increasingly difficult for engine manufacturers to differentiate their products by function or quality. Performance measures such as thrust-to-weight, specific fuel consumption and reliability are fairly mature and would not improve much with new engines. So competitions are now mainly being won on price. If the past is any indication, the advent of high-bypass engines, i.e. a leap in technology, brought on lasting high margins, and it will take similarly sweeping innovations do the same again. First attempts in that direction are the geared-fan and recuperated engine presently under study. Either technology affords sufficient potential for a quantum leap in fuel burn improvement, especially when used jointly in a new engine design. The time such technologies make it to market, however, largely depends on their financial feasibility and then again on a conducive environment, such as government funding.

5. Diversification

Diversification, too, provides opportunities to capitalize on aircraft propulsion investments, as with industrial gas turbines (IGT) for power generation or turbomachinery for again other applications. These IGTs can often be derived from aircraft engines with relatively little effort. As it stands, power generation in the 20-60 MW range, for instance, is dominated by aeroderivative engines. The power crunch in California, deregulation of the power markets and and also the trend toward smaller-size distributed power generating units are currently triggering a veritable boom in nonaviation gas turbines. Every third 70-klb. gas turbine presently coming off MTU's production line is an aeroderivative unit for the power market.

Marine propulsion, too, offers tremendous opportunities. The all-electrical ship, for instance, will boast on-deck recuperative gas turbines fitted with electric motors driving directly to the ship's propellers. This arrangement provides a high degree of efficiency, excellent maneuvrability and low weight, banning all propulsion equipment from the ship's interior.

It is generally assumed that in dollars and cents, the market potential of nonaviation gas turbines will in the decades ahead grow to 50% of the overall gas turbine market.

Diversification may be achieved also in the form of engineering services. MTU, for instance, three years ago launched its Atena engineering consultancy company for greater flexibility in its core business. Its objective is to apply the company's technical core capabilities in nonengine areas to cushion capacity fluctuations and get the most bang from its technology investment buck. Today, some Atena 250 staff are working in Europe and the U.S. on exclusively high-end engineering projects in the automotive, mechanical engineering, aircraft construction and aerospace areas. The popularity of the services and capabilities provided also goes to show what tremendous significance engine technology has for the national economy.

Summary

Please bear with me as I recapitulate the major avenues the engine industry will have to follow:

1. Drastic cost reductions in the development and production of engines
2. Changes in the value-added chain
3. Consolidation and cooperative programs
4. Differentiation through new technologies
5. Diversification

While some of the wording here may not have sounded overly optimistic, it was by no means intended to express pessimism. It couldn't be, for in so short a space as the next ten years ahead, the overall market for gas turbines will be worth in the vicinity of $350 billion. That's a hefty potential market sufficient to offer incumbent manufacturers all the promising prospects they are currently used to.