Scenario Planning in the Aerospace Business Environment – the VIBES Approach

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Abstract

Air transport has a considerable impact on tourism, trade and other aspects of society, and the industry that constructs and maintains aircraft is a major employer and wealth generator. Many nations have made substantial investments aimed at developing and retaining world-class aerospace design and manufacturing capabilities; if these resources are to be deployed to best effect, the aerospace industry needs a means of understanding, describing and analysing the future business environment, in order to formulate strategies that minimise risks.

To address this need, the VIVACE (Value Improvement through a Virtual Aeronautical Collaborative Enterprise) programme, funded under the European Union’s 6th Framework scheme, includes a work package that addresses business case modelling for the extended enterprise. The partnership for this task includes the University of Nottingham, Rolls-Royce and Volvo Aero Corporation. Based upon research conducted within the partnership, and taking into account supplier and customer needs at various stages in the supply network and the after-market sector, this paper presents a methodology to support and promote strategic thinking in the aerospace business environment, from a broad range of perspectives.

Introduction to scenario planning

The creation of scenarios is a qualitative approach to business planning that looks beyond the order book and numeric forecasting methods, offering a response to our inability to predict the future with accuracy. Forecasting methods typically attempt to estimate or calculate likely values for the metrics that are of interest, but scenario building is not limited to plotting only the most likely outcomes. Scenario development permits plans for multiple alternative outcomes to be considered simultaneously.

For each scenario, changes to the business plan can be considered, aiming to allow better exploitation of opportunities or to put contingency plans in place to limit the damage of an adverse environment. The approach can also be used to test the assumptions inherent in a company’s forecasting process, investigating the confluence of forces that characterise the anticipated future. Scenario modelling may also be instigated after a problem is encountered, providing a structure for rethinking a company’s views of the future. Where quantitative forecasting methods may fail after a discontinuous change because there are no clear trends, scenario techniques are potentially most valuable.

In one of the key sources on scenario planning, Ringland (2002) defines scenarios thus:

“Scenarios are possible views of the world, providing a context in which managers can make decisions. By seeing a range of possible worlds, decision makers will be
better informed, and a strategy based on this knowledge and insight will be more likely to succeed. Scenarios may not predict the future, but they do illuminate the drivers of change: understanding them can only help managers to take greater control of their situation."

[Ringland, 2002]

The market for air transport, and its enabling technologies and services, is one where understanding the form that possible futures might take is of particular value. Aircraft and engines continue to grow in complexity, driven by demands for improved safety, performance, fuel economy and noise reduction, etc. This increased complexity naturally leads to more expensive (and often lengthier) projects. The level of investment required in such projects exposes the manufacturer to a substantial risk that is magnified further by long project lead-times, since the business environment is more likely to change over time.

In response to this trend, manufacturers have increasingly sought to employ a collaborative approach, sharing expertise and sharing risk. Again, this demands that the business environment is well understood, since it will be necessary for interested parties to communicate unambiguously as they negotiate with the aim of forming strategies and viable responses to shifts in the business environment.

Mapping the aerospace business environment

The aerospace environment may be considered unusual for several reasons. While many manufactured items are subject to an increasingly short product life-cycle, an aircraft or engine can be in use for decades. Furthermore, commercial jet engines are often sold at a loss; discounting by up to 70% is done with the aim of increasing market share and thereby enjoying a continuing revenue stream when the engine requires spares and support. Strict type approval laws, plus a tremendously expensive initial investment, serve to delay the appearance of spares from rival manufacturers. There is also a political dimension, as nations use subsidies in an effort to retain a strong domestic aerospace industry, perhaps because aviation is seen as critical in defence.

Aerospace manufacturing must not be considered in isolation, however. The influence of the tourism industry, the environmental lobby, etc. must be taken into account. For this reason an extensive literature survey was conducted, examining technical, commercial, legislative and academic literature. The findings were presented in a graphical map, utilising a two-tier format that allowed the complicated interactions between influences to be shown [Bramham et al, 2004]. Figure 1 shows the top-level factors map, illustrating the major influences acting within the market for air travel (and its enabling products and/or supporting services).
Modelling the Aerospace Business Environment

The factors mapping exercise had identified many of the influences affecting the industry, but it showed that the construction of a macro-economic model of the market for air transport products and services would (a) be an extremely large undertaking, and (b) would be extremely difficult to validate if it could be brought to completion.

Of course, the individual businesses within an aerospace supply network conduct modelling of their own. Forecasting methods at Rolls-Royce and Volvo Aero Corporation were investigated, showing the complexity inherent in even a subset of the industry factors. To plan capacity levels for the manufacture of engines and spares, it was found, requires a detailed understanding of the amount of flying that is anticipated, including the routes that are likely to be operated. Total flying time, for example, can be misleading, since a large number of short flights involves more takeoffs, and hence more wear and tear on the engine. An added complication is the presence of a large fleet of aircraft that are not currently in use. They may return to use if circumstances (demand, fuel prices, etc.) permit; meanwhile, they are parked in desert locations that limit corrosion. Finally, individual businesses need to consider market share, whereas the industry factors map considered aggregate demand for a ‘global fleet’ of aircraft to meet overall demand.

Our industrial partners employ specialist staff who study this complex set of interactions and forecast likely customer requirements in a 3–5 year window. Given the level of expertise...
already applied by manufacturing businesses, creating a system that replicated this task would have been counterproductive. However, an opportunity arises if we consider the ability of the current approach to cope with discontinuous change. In recent years there have been unforeseen, substantial decreases in passenger demand. One occurred in the aftermath of the hijackings of September 11th 2001; another occurred when public concern over a potential epidemic of the Severe Acute Respiratory Syndrome (SARS) reached its peak. When mathematical models struggle to show the way forward after such a discontinuous change, scenario planning is much more useful. Ideally, business scenarios such as a sudden drop in passenger numbers will have been considered in a previous scenario planning exercise. Failing that, it can also be used in the aftermath of the problem, to explore alternative ways forward.

To aid in the creation of scenarios, the factors that had been identified during the mapping exercise were clustered into themed sets. For example, those that influence the availability of jet fuel, whether political, economic, social or technical, were aggregated to give a single scale. Each scale was defined by a pair of extreme scenarios. For fuel availability, one extreme is a future where aviation fuel is plentiful (perhaps due to oil exploration in new areas such as Alaska or Antarctica, or because some other present-day use of oil comes to an end). The other extreme shows a world in which the supply of aviation fuel is greatly constrained (perhaps by the environmental lobby, or simply because the oil fields now coming into use prove to be very poor in comparison to those that are now being exhausted). It is not necessary for the research team to comment upon which of these is likely, most lucrative or ethical; merely for each range of possibilities to be accommodated within the scenario planning methodology. Stakeholders will select the future event(s) that they wish to investigate.

With each pair of scenarios offering an axis along which the future business environment might diverge from the present day, a future business environment could be plotted as a point in a multi-dimensional space. Initially, a sample of eight dimensions were offered, based upon some of the stronger influences in the factors map. However, interviews with stakeholders caused the number of dimensions to rise steadily. At the time of writing, twenty-two dimensions are envisaged.

**VIBES**

Although this number represents a substantial reduction in apparent complexity, compared to the number of nodes and interconnections in the two tiers of the factors map, creating and communicating a set of possible future business environments is still a potentially lengthy process. For this reason, a software tool was created. The VIVACE Interactive Business Environment Simulator (VIBES) is a prototype that allows users to experiment with the scenario pairs identified in this research. This is presented with a graphical user interface (Figure 2); user-friendliness was important, since the wide variety of stakeholders within the aerospace industry gives us a broad range of potential users, not all of whom will be adept with the more complex computer-based tools that might have been employed.
Figure 2: Screen displays from the VIVACE Interactive Business Environment Simulator (VIBES)

For each dimension, VIBES has a screen showing a scale and a pair of opposite scenarios. These are explained with a paragraph of text, and are in some cases supported with graphics. Users are free to visit as few or as many of these scenario pairs as they wish. Each scale has a slider that begins in the centre, representing the present-day state of affairs. The user can drag the slider to any position that they wish; the greater the movement away from the centre, the more significant the shift toward the chosen scenario.

The earliest versions of the software included a feature whereby the user was invited to identify their role, i.e. their employer’s activity within the industry. The aim was to further limit the apparent complexity of the business environment definition task, and the time required. Based upon the role identified, dimensions that fell outside the area of activity of the user were disabled. This proved to be unpopular with users, who were interested to see all the dimensions of the business environment, even if they did not directly impact upon their own business. An option to choose whether the set of scenario pairs should be limited or shown in full was added, but users were happier experimenting with the full range of dimensions, so this software feature had been unnecessary. In fact, this is an encouraging finding, showing that those within the extended enterprise are interested in the issues that affect the industry as a whole, rather than concentrating solely upon their immediate concerns.

When the user has made changes on as many of the dimensions as they wish, a future business environment has been defined. The number of different environments that might be constructed is virtually infinite, but all can be represented as a simple array of data. Figure 3 shows a summary view, outlining the changes that a user has chosen to investigate:
Once a business environment has been modelled, VIBES provides the user with a rough-cut forecast, showing the net impact of the business environment on a number of industry metrics. Within VIBES there resides a matrix, cross-referencing each dimension against each industry metric, using a system of weightings to show the relative influences of each scenario. These weightings were initially proposed by the research team, and have subsequently been modified as a result of comments from industrial partners. For the present, it is not proposed to allow users to alter these weightings, although at some point in the future a ‘power user’ who understood the structure of VIBES’ underlying model might be able to customise the software to reflect more closely the particular circumstances of a single business. Furthermore, the open-ended nature of the model within VIBES means that additional industry metrics can be added with relative ease.

Figure 4 shows an example of the rough-cut forecasts produced by VIBES. The list of key metrics can be seen in the left-hand column; on the right is a prediction for future changes, presented in text and graphical form.
It was decided that VIBES should not attempt to quantify each metric, since this would be inappropriate to its role as a quick-to-use tool to promote scenario-based planning, and could set the software in opposition to specialists within the industry whose scenarios and forecasts are naturally more detailed. By allowing the impact of a combination of events to be explored rapidly and from a variety of different viewpoints, VIBES proves its value when looking beyond the 3–5 year planning horizon.

Discussion

It must be noted that the forecasts produced by VIBES are not totally dependable, since their generation involves a number of simplifications; in particular, all relationships within VIBES’ internal model are assumed to be linear. At some point in the future, it might be possible to incorporate a means by which VIBES could represent more complex relationships. For example, some metrics might exhibit a “cliff edge” relationship, where at some level a steady state is broken and the metric changes dramatically. Others might show a “square” relationship, where either extreme exerts the same departure from a central norm, and so on. Combinations are also theoretically possible, although the additional complexity introduced by complex curves for each dimension/metric grouping may be prohibitive.
When conducting long-term scenario planning, in addition to the magnitude of a change, there is also the question of rapidity of onset. It remains questionable, however, whether an increase in the level of detail in VIBES’ output is desirable, if it comes at the expense of an increase in the complexity of the software that limits its use to occasional experiments by expert planners.

The response phase

The construction of a business environment forecast, whether achieved manually or with VIBES is only part of the scenario planning process. The user may have identified a threat, or an opportunity; both demand that an appropriate response should be determined.

In the response phase, planners’ decisions will depend upon their knowledge of the specific strengths and weaknesses of their business. There are as many potential responses as there are business environments; cost cutting, acquisitions (vertical or horizontal integration), partnerships, new product or service development, retrenchment, diversification, liquidation... it is not appropriate for a generic modelling tool to suggest the best course of action. Indeed, no scenario planning software is able to support this phase fully, although it could perform clerical tasks such as storing recommendations against each business environment, and supporting the sharing of ideas between team members by facilitating communication.

As a prototype, VIBES does not perform these tasks. It can be seen to have added value, however, by promoting awareness of scenario planning, and by establishing an ontology whereby stakeholders in the market for air transport and its supporting industries – despite their differences in background – can discuss shifts in the common business environment. Furthermore, when working through a structured process of the kind that VIBES facilitates, it becomes harder for users to ignore issues unconsciously; all dimensions are shown within every VIBES model, clearly showing where a model anticipates no change from the present-day state of affairs.

One response to the business environment shown by VIBES may be to disagree with the forecast produced. It would be unreasonable to expect the prototype to produce accurate models, given that specialists may have access to detailed knowledge about technologies, customer buying behaviour, legislation, etc. Comments from such specialists, on the failings of VIBES to produce plausible future business environments are particularly welcome, since
this knowledge can then be captured and incorporated into future models. Of course, in such cases, the user can change the rough-cut forecast to show what they feel is a more likely outcome, and then conduct the response phase accordingly.

Investigation of key factors in greater detail

For the virtual aeronautical enterprise to be responsive, it must be able to evaluate conceptual environments quickly. In putting together a competitive product and service offering, speed may be highly important. Thus, the VIBES software aims to produce immediate rough-cut forecasts of future aerospace business environments, and some simplifications and assumptions have been necessary.

Although the rough-cut forecasts that VIBES produces may be adequate to promote discussions between stakeholders, these may reach a point where it is desirable to investigate the behaviour of the market to a greater level of detail than can be achieved with a system of matrices and weightings. In the next phase, VIVACE researchers at the University of Nottingham propose to use a system dynamics approach to investigate key industry metrics. Given that resources are limited, only areas that particularly merit closer investigation will be modelled with system dynamics tools. While VIBES has provided a way for stakeholders to experiment with a full range of scenarios, industry personnel have also been provided with a means of identifying and describing the set(s) of circumstances that, in their opinion, merit closer investigation.

System dynamics has increased in popularity in recent years [Sterman, 2000], particularly its application to the modelling of differences between capacity and supply in generic value chains [Spengler and Schroeter, 2003]. The approach may be of particular value when investigating the complex, cyclical nature of demand for aircraft, where there is a considerable delay between ordering a machine and putting it into service, with consequences for the value of orders and options.

Conclusions

This paper has described a methodology for the description of future aerospace business environments through scenario analysis, facilitated via a software prototype, ‘VIBES’. Research to identify the influences acting upon and within the industry indicated a great deal of complexity, including many factors that were not directly quantifiable. No single-viewpoint model would serve the needs of the collaborative aeronautical enterprises that are now in operation, or being considered for future projects.

By clustering factors into themed groups, future business environments could be defined as points along a series of scales, each scale having the present-day state as its midpoint and its extremes being defined by a pair of scenarios. Where a conventional modelling approach would have been a massive undertaking – requiring even greater manpower for validation – the generic approach described has allowed a great many possible futures to be constructed rapidly, prompting discussion and allowing strategic responses to be formulated. The generation of responses to possible business environments was assisted through the automatic generation of rough-cut forecasts, based upon the future business environment selected.

While there are clear limitations to the VIBES software, its simple approach allows those who are not familiar with business modelling approaches to play a full role in the creation of scenarios, and in the discussions that follow. Such people could include technical or commercial specialists whose input could be of considerable value, but who might not normally participate in business simulation work.
References


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