A Case Study of Early Supplier Involvement in a Radical Innovation by a New Venture - The Eclipse 500 Very Light Jet

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ABSTRACT

The Eclipse 500 Very Light Jet (VLJ), developed by Eclipse Aviation, is a new type of personal jet that is expected to revolutionise the market. Its sale price and operating costs are historically low and a very low time to market and high number of advance orders were achieved; furthermore, it is an example of a radical innovation developed by a new venture. This paper is organised as a case study of supplier involvement in the development of the Eclipse 500. It assesses hypotheses concerning supplier involvement and time to market, development cost savings, suppliers’ specific investments and qualification of supplier abilities. A research question about other effects of supplier involvement is also answered.

Selected employees from Eclipse Aviation responded to two questionnaires; a number of relevant press releases from this manufacturer were also analysed through a framework of supplier involvement. It was concluded that a negative relationship exists between supplier involvement and time to market and that a positive one is present between supplier involvement and development cost savings. The qualification of supplier abilities and supplier specific investments have had a positive relationship with the extent of supplier involvement in this case. Eclipse Aviation was more involved with the suppliers chosen for the quality of their products and supplier involvement was important in reaching final product quality goals. Further research is possible by performing a multiple case study of Eclipse Aviation and its main competitors and see if the conclusions reached in this work still hold.

Keywords: Supplier involvement; Radical innovation; New venture; Eclipse 500; Development cost savings; Time to market.
INTRODUCTION

This paper is a case study inspired by the successful development and introduction of the Eclipse 500 Very Light Jet (VLJ), a very light business jet built by Eclipse Aviation. The company, founded in 1998, started in 1999 the development of an aircraft that intended to change forever the market of personal jet transportation. The Eclipse 500, seating in standard configuration 6 persons and with a range of 1300nm (assuming 4 persons on board) has a purchase price of 42% less and a total operating cost per hour 35% lower than the Cessna Mustang, an aircraft very similar to the Eclipse in terms of technical specifications, but not yet in the market (Eclipse Aviation, 2007a, 2007b).

These characteristics are part of a broader set that enable the Eclipse 500 to be classified as a radical innovation. Radical innovations are for a multitude of reasons very important for the long time success of companies, and require specific management skills to be successful (O'Connor & McDermott, 2004; Song & Benedetto, 2008). Their development has been associated mostly to new ventures, such as Eclipse Aviation, while established companies have strived to foster radical innovations in their contexts (Martin, 1995; Pavitt, 2003).

One of the noteworthy aspects of the development of this product is the short time to market achieved, while still keeping costs historically low to achieve the desired reduced sale price. In parallel to the fast development process, sales have also been high; by 2004 Eclipse Aviation already had orders in excess of 2000 aircraft (Eclipse Aviation, 2004a). This figure shows that this product is aiming for a deep change in the market of private air transportation, and in the broader market of air transportation in general. Eclipse Aviation’s relationship with its suppliers may have been a factor in achieving this development performance.

Early Supplier Involvement (ESI) is a feature in the development of a product in which the suppliers actively participate in the design stage of a product that will be commercialised by the manufacturer. It aims to achieve cost and time savings namely through parallel development and design agreements (Weele, 2005). Based on earlier research (Boavida, 2008), the author’s thesis is that supplier integration must have been strongly present in the development process to meet the requirements set by this manufacturer.

A large body of research exists on the topic of radical innovation in established companies (e.g. Henderson & Clark, 1990; McDermott & O’Connor, 2002), and also of early supplier involvement (e.g. Weele, 2005; Wynstra, Weggeman, & Weele, 2003). However, much less exists about the use of early supplier involvement in the radical innovation by new ventures, with the most relevant source being Song & Benedetto (2008). The present work aims to address this knowledge gap in literature.

The research problem is precisely formulated in the following section, together with the hypotheses and research questions that will be used to tackle it.
RESEARCH PROBLEM, HYPOTHESES AND QUESTION

The research problem this paper addresses may be formulated as:

To study the supplier involvement in the development process of the Eclipse 500 VLJ, by Eclipse Aviation, as a case study of supplier involvement in a radical innovation carried out by a new venture, and attempt to validate hypotheses as well as extract lessons from that project that may be useful for future research and managerial practices.

To allow this research problem to be studied it has to be divided into more specific research questions and hypotheses that are to be addressed individually. The hypotheses used in the present work are of the one-tailed type, meaning that they predict the direction of a relationship between two variables. Logically, by defining one hypothesis one will always be defining the null hypothesis, that will be valid on all the possible outcomes that do not validate the original one (Trochim, 2005).

The variables used in this paper are represented in Figure 1 as boxes, with the hypotheses being shown as arrows in the same figure. A further explanation and formal phrasing for each hypothesis then follows.

![Figure 1 – Research variables and hypotheses.](image)

One of the main goals of companies getting involved in supplier involvement projects is to achieve reductions in the development time of their products, namely through parallel development of components and assemblies (e.g. Petersen, Handfield, & Ragatz, 2005; Wagner & Hoegl, 2006; Wynstra et al., 2003). It was mentioned that Eclipse attained an outstanding and unprecedented performance in the time-to-market of the Eclipse 500. The first hypothesis may then be phrased as:

\[ H_1: \text{Supplier involvement has had a negative relationship with time-to-market in the Eclipse 500 development project.} \]

Eclipse 500’s low operating costs, together with its market leading purchase price suggest that a low cost base has been achieved for the development and production of this aeroplane. A commonly stated goal of supplier involvement is to reduce costs (Weele, 2005); this suggests the following hypothesis:

\[ H_2: \text{Supplier involvement has had a positive relationship with the development cost savings in the Eclipse 500 project.} \]
The third hypothesis is based on conclusions of both an empirical study about the activities present in the development of radical innovations (Song & Benedetto, 2008) and previous research done by the author that hints that supplier involvement was present in the development of the Eclipse 500 (Boavida, 2008). Supplier specific investments are the ones that have reduced or no value at all for the supplier outside the relationship with Eclipse Aviation. The hypothesis is phrased as:

\[ H_3: \text{Supplier specific investment has had a positive relationship with the level of supplier involvement in the Eclipse 500 development project.} \]

The fourth and final hypothesis to be analysed in the context of the development of the Eclipse 500 is also based on a prediction done and validated by Song & Benedetto (2008) in their study about the development of radical innovations, that connects qualification of supplier abilities done by Eclipse Aviation and level of supplier involvement.

\[ H_4: \text{Supplier qualification has had a positive relationship with the level of supplier involvement in the Eclipse 500 development project.} \]

Since the present work is a case study it aims to gather a deep and detailed understanding of the specific reality of the development of the Eclipse 500 VLJ. The hypotheses can only be formulated as predictions that stem mainly from previous research mostly of adjacent fields. In order to represent the commitment of keeping the results open for other possible conclusions not related to the hypotheses, the following research question is formulated:

\[ Q_1: \text{Which other outcomes and results of early supplier involvement in the Eclipse 500 development program were there detected other than the ones predicted by the hypotheses?} \]

**METHODOLOGY**

The option for a case study was made due in a large part to the performance achieved by Eclipse Aviation and also to the innovativeness of this particular development project, significant in a field where not much research exists. With the case study it is possible to delve deep into the understanding of the complexity of a single case, rather than aiming to achieve externally valid conclusions.

Since the supply chain management of the Eclipse 500 is too complex to be entirely analysed it was decided to look carefully into four assemblies present in the final product, regarding them as nested cases of the larger case study. The four selected nested cases were:

i. **Avio NG Avionics Suite**: the avionics package integrated by Eclipse Aviation featuring individual components by a multitude of suppliers (Eclipse Aviation, 2007e);

ii. **Landing Gear Assembly**: the landing gear assembly was produced and delivered to Eclipse Aviation by Mecaer (Eclipse Aviation, 2004d).
iii. *Engines*: the engines powering the Eclipse 500 are PF610F turbofans developed and produced by Pratt & Whitney Canada, created specifically for this aircraft (Eclipse Aviation, 2003).

iv. *Nose Assembly*: this component was built specifically for this aircraft by ENAER (Eclipse Aviation, 2004b).

The next step in the methodology is to decide how the information is to be gathered. This process was divided into two broad areas: Direct Contact and Public Information.

Direct Contact concerns two questionnaires answered electronically by selected employees of Eclipse Aviation, working in the area of supply chain management. Most of the questions featured in the questionnaires had Likert 5-point response formats and had to be kept as short and easy as possible, in order to obtain the highest possible response rates (Trochim, 2005). The only significant exception to this was an open ended question featured in the end of each questionnaire so that respondents were encouraged to add any further comments that could have been suggested by the previous questions.

Public Information comes mainly from three different sources: selected press releases made available by Eclipse Aviation in its website (Eclipse Aviation, 2008a), the information in the website itself, and information given by the company to its customers. Despite not being as specific as the information coming from the questionnaires, the information from the public sources complemented and expanded the insight gathered from the answers to the questionnaires, and enabled a triangulation of data sources to be made, therefore increasing the validity of the study (Guba & Lincoln, 1995).

However, one of the biggest challenges of this work remains to be how to effectively use the information of diverse types and coming from a multitude of sources to assess the hypotheses and answer the research question. Qualitative methods were used due to the limited amount of available data, that was not enough for a statistical study. The questionnaires are likely to provide information for the assessment of all hypotheses; the public sources are more likely to be useful in the study of $H_1$ and $H_2$ due to their more general character when compared to $H_3$ and $H_4$. A framework of supplier involvement (Wynstra et al., 2003) is to be used to systematise and streamline the information gathered from the public sources, in an attempt to maximise their usage in the present study.

**LITERATURE REVIEW**

The present section presents relevant information from available literature that shall be used to address the hypotheses and question; it is divided into two subsections, the first one dealing with radical innovation and new ventures, and the second one devoted to early supplier involvement.

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1 Selection was done based on date of release (December 10, 2003 to March 31, 2008), availability on website, and the presence of certain keywords on the title.
Radical Innovation and New Ventures

Innovation is a familiar term, but also one that is difficult to define. The term in itself contains the notion that something new and unique must be achieved; Pavitt (2003) states that innovation involves exploration and exploitation of opportunities for a new product, service, or process and that it is inherently uncertain.

It is broadly recognised that innovation is required in order for companies to attain and sustain a competitive advantage, and thus succeed (Porter, 1985). Recent studies reflect that, in line with this, innovation is still among the high priorities of corporate leaders around the world as a key growth driver (Scanlon & Jana, 2007). However there are many types of innovation that must be distinguished.

Several innovation classification systems have been developed by researchers (e.g. Abernathy & Clark, 1985; Green, Gavin, & Aiman-Smith, 1995; Henderson & Clark, 1990; McDermott & O'Connor, 2002), both two and one dimensional, and characterising innovation based on different items. For the purpose of this work a dichotomous classification of innovation with incremental innovation in one end of the scale and radical innovation in the opposite end is appropriate. This choice is motivated by the focus of the present paper on radical innovation, and not on innovation classification systems, and has already been made in literature by other authors addressing the same topic (e.g. Song & Montoya-Weiss, 1998).

Many definitions of radical innovation exist in literature. Green & al. (1995) describe it as corresponding to a high degree of technological uncertainty and inexperience, business inexperience and technological cost. Song & Montoya-Weiss (1998) define these products as relying on technology not previously used in the industry, producing and impact or causing significant changes in the market and being completely new to the relevant market. Consequently, these innovations require a high level of learning, when compared to incremental innovations. The same authors tackle the risk characteristic of radical innovation, stating that considerable risk is involved because not only product requirements are unarticulated but also they require targeting emerging markets. O'Connor & McDermott (2004) claim radical innovations stand out by the promise of reward they offer, with a broad scope and a high strategic relevance, and also the aforementioned characteristics of risk and uncertainty. In their study these authors operationalise the definition of radical innovation a performance improvement of over 5 times the existing products, or that achieve a reduction in costs superior to 30%. The final definition to be addressed is the one of Leifer, Salomo and Gemunden (2007): radical innovation has the power to transform relationships between customers and suppliers, restructure marketplaces, and even displace current products or create new product categories.

Some of these characteristics make clear that succeeding in developing and managing radical innovations may be determinant in the success of companies. New ventures are often entrepreneurial efforts initiated with the intent of bringing into the market an innovative new product (Lodish, Morgan, & Kallianpur, 2001); they are frequently extremely dependent on the success of the new product for their very survival (Song & Benedetto, 2008).
Research has yielded several reasons for which new ventures are more likely to be successful in radical innovations. These companies, due to their small initial size, have much larger flexibility with low associated costs than large established companies, and this factor is a significant advantage when dealing with the frequent twists and turns in the development of a radical innovation. One of the most common causes of failure of radical innovations derives from companies managing them as incremental innovations (McDermott & O’Connor, 2002); this problem occurs most frequently with established companies.

Corporate inertia, based on managers being generally unwilling to change methods after a successful period, and fear of hurting established work posts are other reasons for established companies being less successful than new ventures when dealing with radical innovation (Pavitt, 2003). Finally, it was discovered that radical innovations thrive on informal networks (O’Connor & McDermott, 2004, p. 23). This is due to the fact that radical innovations frequently need to draw knowledge from unconnected fields, with the informal networks playing a role in increasing the efficiency of this process. Informal networks are much more likely to occur in small, new companies than in large corporations with a departmentalised structure, representing once more an advantage for new ventures in the development of radical innovations.

Now that the definitions of radical innovation and its connections with new ventures have been clarified, it should be assessed to which extent the Eclipse 500 VLJ may be seen as a radical innovation developed by a new venture.

Some sources (Li, 2001; Tsai & Li, 2007) describe new ventures as companies created less than 8 to 10 years ago. Created in 1998, Eclipse Aviation may be on the border of being classified as a new venture by this definition. However, considering the long development times that characterise the aerospace industry and the fact that the Eclipse 500 is its launching product (Eclipse Aviation, 2007c), Eclipse Aviation may be seen as a new venture under this definition. Eclipse Aviation is also a new venture under the definition used by Song & Benedetto (2008), stating that new ventures are companies launched with the purpose of exploiting an opportunity or commercialising a specific product.

Several of the previously mentioned characteristics of radical innovation may be detected in the Eclipse 500 VLJ. Firstly, it relies on technology previously unused in the market; that is easily seen in the patenting of proprietary technologies developed by Eclipse Aviation for the Eclipse 500 (Eclipse Aviation, 2004c, 2005). The registration of these patents implies a high level of learning present in this development process, which is also a characteristic of a radical innovation. Since it is creating a market of its own, it can be said that the high risk characteristic is also present. Other authors mention a high strategic relevance for the company and promising rewards. The Eclipse 500 also matches this definition, being the launching product of Eclipse Aviation and having received a very large amount of advance orders early in its development process (Eclipse Aviation, 2004a). By being targeted at owner pilots, an unprecedented feat in jet aviation, this product transforms the relationship between
The customer and its supplier; finally it also creates a new line of products, and an example of such is the unveiling of the Eclipse 400 jet (Eclipse Aviation, 2008b).

The last two paragraphs showed that it is legitimate to see the Eclipse 500 VLJ as a radical innovation developed by a new venture. The remainder of the literature review section deals with the subject of early supplier involvement.

**Early Supplier Involvement**

It has been mentioned that risk and uncertainty are inherently present in radical innovation projects. One of the ways used to deal with them is to engage in early supplier involvement projects. These projects are also used to achieve namely time and cost savings in new product development (Weele, 2005), through the leveraging of supplier specific knowledge and also parallel development. This involvement is a fairly complex process in which several firms attempt on the one hand to relate on the best possible terms in order to achieve a successful partnership while on the other hand each company keeps closely in mind its own interests, that may collide with the partner’s ones. The framework of Wynstra et al. (2003) provides very good insight into supplier involvement in new product development. While its thorough analysis is out of the scope of this document, a broad description shall be made since this framework is to be used to analyse the information gathered for the assessment of the hypotheses and of the research question.

This framework divides supplier involvement into four management areas, developer, product, project and supplier interface management, with the latter one being central to the other three. Each area consists of sets of generalised activities that shall take place from the point of view of the manufacturer in a successful supplier involvement project. Then five key processes are defined. A key process is an attribute that can be used to classify each of the activities that constitute the management areas. It is through the identification of particular cases of the general activities present in the development of the Eclipse 500 that this framework will be useful for the data analysis.

Only one source delved into the impact of early supplier involvement in radical innovations developed by new ventures (Song & Benedetto, 2008). These authors claim that more and more small firms are leveraging their suppliers’ abilities to increase their own chances of survival and success. Their industry-wide empirical study of radical innovations by new ventures led to the validation of several hypotheses, namely connecting supplier involvement and success of the radical innovation of the new venture, influence of both suppliers’ specific investments and efforts of the new venture to qualify suppliers on the extent of supplier involvement.

**ANALYSIS**

Before proceeding to the analysis itself a brief reference to the response rates shall be done. Both questionnaires featured a general section about the development process as a whole, and then a specific section asking questions about each of the nested cases mentioned before. Five employees
were involved in this study; one of them had a leading role in supply chain management, while the other four were specialised in each of the four nested cases. The response pattern is the one shown in Table 1, resulting in the availability of 4 answers for most questions in the general sections, and 2 for each question in the specific sections.

Table 1 – Response rate in both questionnaires.

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<thead>
<tr>
<th>Positions</th>
<th>First Questionnaire</th>
<th>Second Questionnaire</th>
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<tbody>
<tr>
<td></td>
<td>General</td>
<td>Specific</td>
</tr>
<tr>
<td>Leading Role</td>
<td>Replied</td>
<td>Replied to All</td>
</tr>
<tr>
<td>Avio NG</td>
<td>Replied</td>
<td>Replied</td>
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<tr>
<td>Landing gear</td>
<td>Replied</td>
<td>Replied</td>
</tr>
<tr>
<td>Engines</td>
<td>Replied</td>
<td>Replied</td>
</tr>
<tr>
<td>Nose Assembly</td>
<td>Replied</td>
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Hypothesis H$_1$ proposed a negative relationship between the level of supplier involvement and time to market. From the answers to the relevant items of the questionnaire it is seen that supplier involvement was largely present in all the nested cases except for the nose assembly. Regarding the process as a whole, respondents considered supplier involvement very important in achieving the time to market targets. In the press releases, hints of parallel development and consequent time saving potential exist for the aforementioned components, with general activities of three of the four areas of the framework of Wynstra et al. (2003) being likely to be present (Eclipse Aviation, 2003, 2004d, 2007e). It can then be said that the available information points to the confirmation of H$_1$.

The second hypothesis suggested a positive relationship between the level of supplier involvement and the development cost savings in the development of the Eclipse 500. Replies to the questionnaires pointed to high cost savings due to supplier involvement with the nested cases sporting high levels of supplier involvement, and low cost savings in the only one with low supplier involvement. Only one indirect mention at cost savings was made in the press releases (Eclipse Aviation, 2004b) when Eclipse Aviation expresses its desire of changing the economics of private air travel with the signing of two suppliers. Consequently hypothesis H$_2$ is validated.

Hypothesis H$_3$ involved the prediction of a positive relationship between supplier specific investments and the level of supplier involvement. Most respondents considered that, considering the development process as a whole, suppliers have made extensive specific investments in the relationship with Eclipse Aviation. When asked about the relevance of supplier specific investments in achieving higher levels of innovation in the nested cases, a positive correlation was observed between high levels of supplier involvement and high levels of contribution of supplier specific investments to the level of supplier involvement. No relevant information was found in the press.

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releases to assess this hypothesis. It was then decided to validate $H_3$ solely based on the above quoted answers to the questionnaires.

The final hypothesis predicted a positive relationship between qualification of supplier abilities and the level of supplier involvement. Respondents consider that in general Eclipse Aviation has been making large efforts in quantitatively qualifying the abilities of its suppliers. Regarding the nested cases, only the supplier of the nose assembly received a rating less than the maximum possible pertaining to the efforts of Eclipse Aviation to qualify its abilities. Similar answers were observed in the question asking about the relevance of qualification of supplier abilities in achieving higher levels of supplier involvement. As expected no relevant information was found in the press releases for the assessment of this hypothesis. It was then decided to validate $H_4$ based only on the conclusions from the questionnaires.

The remainder of the analysis section is devoted to the answering of the research question $Q_1$ formulated above. Firstly, the combination of several answers of the questionnaires pointed out that supplier involvement was exceptionally important in achieving the required performance of each product in the development of the Eclipse 500. Information contained in the press releases (Eclipse Aviation, 2007d) also claim that the superior capabilities of suppliers allowed Eclipse to meet the required quality standards, through long and successful relationships.

By correlating answers to two different questions of the questionnaires it was observed that higher involvement was obtained with the suppliers chosen for the quality of their products. This particular conclusion had not been expected from previous literature. Finally, it was concluded that the respondents did not consider the involvement with suppliers a significant driver of advance orders in this project, contrarily to what was expected from results of previous research that did not comprise direct contact with Eclipse Aviation (Boavida, 2008).

**CONCLUSION**

This paper presented a case study of supplier involvement in the development of a radical innovation by a new venture: the Eclipse 500 VLJ, by Eclipse Aviation. More precisely, hypotheses were formulated based on previous research on adjacent fields. These predictions concerned relationships between supplier involvement and time to market, development cost savings, suppliers’ specific investments and qualification of supplier abilities. A broader research question was also addressed, about the general outcomes of early supplier involvement in the product development process.

The methodology was based on the qualitative triangulation of information both from direct contact with Eclipse Aviation and public sources. The research hypotheses used in this paper were presented in Figure 1, and the data analysis process led to the confirmation of the totality of the hypotheses.

The confirmation of the first hypothesis connected the level of supplier involvement to reductions in the time to market of this product. Parallel development is likely to have been an important driver of
these time savings. This conclusion agrees with the available literature on supplier involvement, that states time savings as one of the main reasons for engagement in early supplier involvement (Wagner & Hoegl, 2006; Weele, 2005; Wynstra et al., 2003). The same sources quote cost reductions as another of the main reasons for companies to enter early supplier involvement; the validation of H2 confirms the occurrence of these cost savings in the development process of the Eclipse 500. Furthermore, in the specific field of radical innovations by new ventures, Song & Benedetto (2008) state supplier involvement gains particular importance due to the more limited set of financial resources available to new ventures.

H3 and H4 were both based on predictions that had already been validated by Song & Benedetto (2008) in an empirical study of radical innovations developed by new ventures, so their confirmation for the particular reality of Eclipse Aviation was likely. Specific investments from the suppliers may encourage involvement since suppliers are motivated to become more involved for financial reasons, as these specific investments are by definition of reduced value outside the relationship they are made for. In what concerns qualification of supplier abilities, high qualification of a particular supplier may give further confidence on that specific company to Eclipse Aviation, being therefore a driver of higher levels of involvement.

From the research question it was firstly concluded that supplier involvement was positively related to the performance of the radical innovation; this conclusion agrees with available research in this field (e.g. Danilovic, 2006; Song & Benedetto, 2008; Wagner & Hoegl, 2006; Weele, 2005). The fact that Eclipse Aviation was more involved with the suppliers chosen for the quality of their products was not expected, and sheds light into a new field that can be the object of further research: the study of the reasons for supplier involvement in each particular component or assembly. The fact that the respondents did not consider supplier involvement an important driver of advance orders suggests that another aspect of the relationship with the suppliers may have been; one possibility is the usage of the brand names of the suppliers, but further research is also needed to validate this suggestion.

DISCUSSION

The main limitation of the validation of the hypotheses is the fact that time savings may have caused an unknown level of costs savings by itself, rendering the validation of H1 and H2 not completely independent. Further research statistically determining the drivers of development costs would be adequate to tackle this limitation.

Concerning the study itself, the most limiting factor was the amount of available data. The physical location of the company made a personal visit impossible to conduct, where personal interviews would have been possible that would deeply improve the validity of the conclusions.

Finally it should be reminded that as a case study the results reached herein are valid only for the specific reality of the development of the Eclipse 500 by Eclipse Aviation, and further research is necessary to extend these results to other situations.
REFERENCES


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