

# The WINDEX 1200: Aircraft Development<sup>1</sup>

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The product development process in small firms is a complex process highly charged with emotions, personal expectations, and anticipations from the market. Frequently, the decision-makers have strong convictions about their product's design, performance, and market position. These convictions may differ dramatically from what the market perceives in terms of design, performance, and market position. When these differences become difficult to resolve by the managers responsible for the product development process, the process may proceed endlessly without any tangible results. This case involves many issues regarding the product development process in a small firm that competes on an international market. RADAB is a privately owned firm focusing on the development of the Windex 1200 motorized glider.

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<sup>1</sup> This case was developed by Jan Bodin of INC Graduate Business School, Nancy, France for instructional purposes only. Any similarity to an actual managerial situation or an actual firm is coincidental. The case was prepared as a basis for classroom discussion rather than to illustrate either effective or ineffective handling of a business situation and cannot be used without the written permission of the authors or be reproduced in any way.

## Company's Dawn

Three owners, Harald Undén, Sven-Olof Ridder, and Lars Bergström founded RADAB in 1964. RADAB is an acronym that stands for Research and Development, AB. The owners have known each other for a long time. Harald Undén and Sven-Olof Ridder met while they were still in an elementary school. Sven-Olof Ridder and Lars Bergström also knew each other for a long time, perhaps before they were 20 years old. All three had a strong interest in building and flying model airplanes. All three were also avid sailors. During the 1960s, they used their free time to restore boats and try to improve their sailing skills. While restoring boats they recognized a need to improve some of the tools and equipment used on a sailing boat. Because of lack of resources, they made some of the tools and equipment themselves at the Royal Institute of Technology in Stockholm where Ridder and Bergström were engineering students.

Their products were very successful — other sailors begun to ask if they could make similar products for them. They agreed since it gave them an opportunity to finance their own hobby. After some time they decided to start a company and do business in a more formal way. They did not start the firm with specifically planned objectives or projects. In recent years, RADAB employed between two and seven employees.

Today, Harald Undén is an acting CEO, and the only owner, who has continuously been receiving a salary from the company. Sven-Olof Ridder is the dominating force when it comes to generating ideas. He is the innovator and a competent engineer. His ideas are seldom questioned and everyone within the company is aware of his competence, especially in the field of aerodynamics.

Lars Bergström is the least active owner within the firm. In the beginning of the 1970s, due to a health problem, Lars moved to Sarasota in Florida where he and Sven-Olof Ridder also have their own company, B&R Design, which specializes in products for the sailing industry. Lars stays in contact with his two partners by telephone, fax, and by visiting Stockholm and RADAB's home office couple of times each year. He is an undemanding person, an engineer, interested in selling and marketing the products developed within RADAB.

## Earlier Products

In the mid-sixties, Ridder came up with an idea of a new accessory for their sailing boat, a wind-direction indicator. In 1964, he gave a prototype as a Christmas present to Bergström. They saw a potential market for the product and started to produce it under the Windex trademark.

Initially, the wind-direction indicator was made of aluminum. It was primarily Bergström who promoted the product by making presentations at sailing-clubs. In 1972, they invested in necessary tools to make the wind-indicator using plastic material. The mould was actually taken as payment against one of their invoices. Since the manufacturing process had become more effective and cheaper, the company was making steady profit. As a result of improved manufacturing they were able to keep the same price for 15 years during the 70s and the first half of the 80s. Competitors have tried to copy their product. At one time they could count over 30 copies of Windex being sold worldwide. Windex was a cash cow.

In the beginning of the 1970s, a new project was started. This focused on a sailing boat available as both a kit or ready to use. Many new gadgets were featured in the design, including a folding wing-keel, safety-ladder, and bathing-platform among other innovations. When the boat, named Windex 92, was finally ready, the market had shifted its preferences from sailing boats to motorboats. There was a surplus production of sailing boats and the second-hand market was large resulting in low prices.

Windex 92 faced many obstacles — high price tag, production difficulties, and additional problems in distribution. Windex 92 never became a success. During the development stages potential customers and journalists were very much interested in the prospective product, but when RADAB finally had a commercially viable product to offer, the market did not respond. They saw the market launch of Windex 92 as a failure at RADAB but still, regard the product as a good internal success. Windex 92 represented the first attempt at RADAB to design and market the “home-builder-kit” and introduce it in the “do-it-yourself market”. The outcome was a financial failure.

In the mid-1970s, Ridder developed a variant of the wind-indicator suitable for wind-surfers. The product failed. Subsequent investigations determined that wind-surfers did not want any help in determining wind directions, or any technical gadgets predicting natural conditions.

## The Development of the Motorized Glider

At the end of the 1970s, the owners were ready for a new commitment. Ridder, now a professor in aeronautical engineering at the Royal Institute of Technology in Stockholm, had the idea to design and build a revolutionary motorized glider. It is hard to pinpoint the exact date when the idea emerged. Ridder started to sketch on an aircraft 30 years ago and he held lectures at the local Experimental Aircraft Association<sup>2</sup> (EAA) Chapter 222 about his idea during the second half of the 1970s. This idea resulted in the first blueprints of an ultra-light glider with an eight h.p. engine and a total weight of only 64 kilos.

The glider started to take the form in the beginning of the 1980s. Ridder and Undén worked on the concept during their spare time. The aircraft, engine included, was planned to have the equivalent performance of a regular glider without an engine. From the beginning, their plan was to present an aircraft kit to presumptive buyers. The rationale was to keep a low price by simplifying the manufacturing process as much as possible. The owner's main interest has always been to develop new designs since they find the administrative and manufacturing parts dull and uninteresting. Bergström even suggested

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<sup>2</sup> The *Experimental Aircraft Association* was founded in 1953, in the United States. It is an organization spread all over the world. EAA is divided into different chapters or groups. In the United States chapters can be found in different regions. Outside the United States, the common way is to have only one chapter in each country. In Sweden, the local chapter number is 222 and was founded on 20 January 1965. It is an idealistic organization that works for the members' rights to build and fly an amateur-built aircraft with the minimum of restrictions. They work with information and education, and act as the amateur builder's spokesperson toward the Swedish Civil Aviation Administration and other government agencies. They have a close relationship with the Flight Safety Department since EAA is responsible for preparing the application, including giving a suitability judgment, for each person who applies to build an aircraft.

that they would sell off the project when everything was worked out and they had a stock of orders.

The first sketch of the aircraft had a wingspan of ten meters. Ridder developed a new wing-profile that was tested at the Royal Institute of Technology. The wing-profile did not match the glider's performance profile. A second profile was developed, tested, and was found suitable for the glider. Ridder is explicit and up front with the fact that the project had been almost impossible to carry out without his connection to the Royal Institute of Technology. External organizations and individuals have supported the idea in various ways. The Aeronautical Research Institute of Sweden and the Royal Institute of Technology have made certain constructional tests possible. Another important group that has had some input to the process is Ridder's colleagues at the Royal Institute of Technology. In addition to the wing-profile, the stabilizer has been wind tunnel tested. An aerodynamic engineering student at The Royal Institute of Technology, as a degree project, carried it out. Ridder, based on his skill and experience in the area, designed the fuselage.

The formal start of the project was on 31 December 1982, when Ridder and Undén sent an application to EAA for permission to build an ultra-light glider with self-launching capability. Their application was approved and resulted in building permit number 354. About the same time a decision was made to incorporate the project into the firm. As they realized that the development would demand a larger workshop area, they also rented some additional space next to their present office. In 1984, they renewed their EAA application, this time changing category from *ultra-light* to an *experimental* glider with self-launching capability.

They worked on the technical aspects and developed a prototype, Windex 1100 that had its premiere flight on 15 March 1985. In most aircraft projects, the dominating episode during the development is the premiere flight of the prototype. Although most of the construction's specification can be calculated in advance, the flight test will give the final judgment on a design. Everyone involved noted with satisfaction that one "phase" that went smoother than expected was the flight-testing and evaluation.

The Windex 1100 prototype was built and cut out of foam with a laminated shell. It is a method used for short series of test-planes and prototypes, but is not suitable for the production of longer series. Ridder's urge for refining the construction, to make it optimal, resulted in additional adjustments after input from the test flights and development of a second prototype called Windex 1200. Modifications included a longer fuselage, extended wingspan, and T-formed stabilizer. In Windex 1200, the materials were no longer regular fiberglass and plastics but a structure of honeycomb and epoxy molded in an autoclave.<sup>3</sup> After they developed a flying prototype, they applied for additional funding from the Swedish National Board for Industrial and Technical Development<sup>4</sup> (NUTEK) to develop a commercially viable product. Requested by NUTEK, RADAB produced a marketing plan.

RADAB searched for, and found, a manufacturer in Sailcenter of Sweden AB, located in Ätvidaberg south of Stockholm. After completing each part, they sent the moulds (set number one) to the manufacturer. On 21 March 1988, when most of the moulds were completed and at the manufacturer, Sailcenter's factory burned to the ground. All parts were destroyed and a weakness in the development process emerged. When they started to reconstruct each part, they had difficulties finding the proper blueprints. They found different versions but had a hard time sorting them out. Questions emerged: Which version was the latest? Why had they done the adjustment? They had to backtrack and start over again. Naturally, they took the opportunity to make some additional adjustments to the concept, when they had the chance, and sent the moulds (set number two) once again to Sailcenter of Sweden AB.

Windex 1200 finally had its premiere flight on 27 April 1989. It is an interesting fact that although the constructions from Windex 1100 were supposed to just be refined in the final construction, no parts are interchangeable between the 1100 and 1200. A second pre-series kit

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<sup>3</sup> An autoclave is a sealed and airtight confinement, with the composite material covering a mould and "baked" under both high temperature and high pressure. The method imparts a very high and solid quality to the manufactured parts.

<sup>4</sup> Known today as the Swedish Business Development Agency.

was built parallel to the W1200 prototype in the RADAB's workshop. The three external builders, among them the technical chief at EAA in Sweden, implemented additional modifications to the construction based on the prototype's flight evaluation. Their modifications included air brakes of new design, a larger main wheel, retractable supporting wheels in the wings, and additional fuel tanks in the wings, among other things.

Parts of the Windex 1200 prototype's flight evaluation were carried out in Florida. While there, they got in contact with Steve Coan, a professional aerobatics glider pilot. He tested the Windex 1200 and wrote a flight evaluation. Coan was so impressed that he ordered three ready-to-fly planes certified for aerobatics. RADAB did the additional calculations and when they found that the difference between the normal and aerobatics version was minimal, they decided to certify all planes according to JAR 22 A<sup>5</sup> (Aerobatics Category). The second set of the Windex 1200 moulds that was sent to Sailcenter of Sweden AB included most of the modifications presented above. In addition, the wing spar was modified from all-glass to carbon fiber. The design capable of +9G/-7G even exceeded the demands for the aerobatics category.

At first, Sailcenter AB did not receive a general manufacturing permit from the Civil Aviation Agency (CAA). As a result, people from CAA needed to inspect each part on-site before signing an acceptance certificate. Since it was not practically possible to let the CAA representatives inspect all parts at the same time, the process was considered too costly for RADAB. In 1991, NUTEK raised questions regarding the potential sales volume and money invested in the project. Over time, new people entered the decision group at NUTEK. Some of them entering in the later stages, raised questions why NUTEK invested money from the start. At that time RADAB was financially overextended. They let go of their employees in order to shrink the organization, thereby minimizing their costs due to a drop

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<sup>5</sup> 1 G is the normal earth drag-coefficient. Gliders that are built for normal use according to JAR 22 (Utility) have limits of +5.3 and -2.65 G. The aerobatic version is limited to +7 and -5 G. As a reference, a normal person can handle +3 to +5 G before they lose their vision and start to become unconscious.

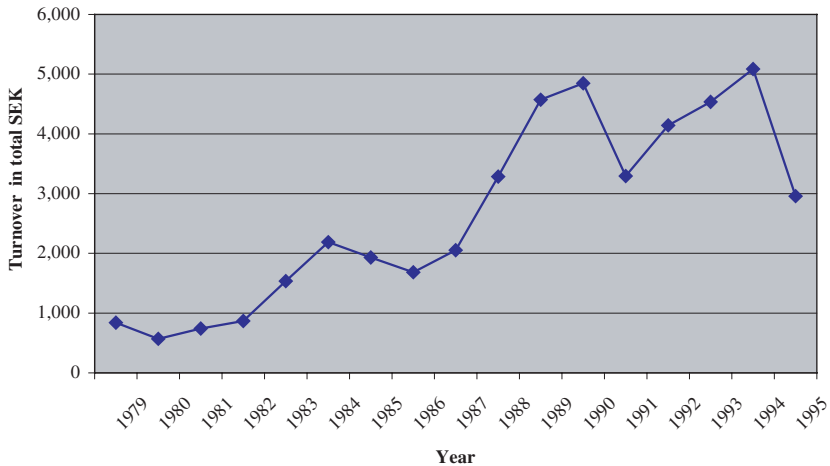


Fig. 1. RADAB's turnover in total SEK between 1979 and 1995.

in turnover, as can be seen in Fig. 1. (The yearly profit margin is of little interest since the owners have decided to reinvest most of the money in new ideas and projects.)

After downsizing, the CEO, Undén, was the only one still formally working at RADAB. The same year RADAB delivered 4–5 Windex 1200 kits, thereby raising new capital. They also applied for an additional 500,000 SEK loan at NUTEK for the development of the wing coupling and additional adjustments to the construction. Over time they have also worked at making the kit easier to build for the prospective buyer by applying new technical solutions like abrasive water cutting and drilling.<sup>6</sup> The adjustments have mainly involved refining the cockpit module thereby simplifying and shortening the building time for the buyer. It is notable that even if the motorized glider was an idea that Ridder had nurtured for a long time, he kept his regular job as a professor at the Royal Institute of Technology throughout the project.

<sup>6</sup> Abrasive water cutting uses a beam of water under such an enormous pressure that it can cut through metal. Since the method is using plain water there are no residues. Another advantage is that the method is “cold”. The part will not be heated in any way that might cause additional labor in later stages of processing.

## International Movements

Bergström's relocation to the United States in the early 1970s due to medical reasons has probably helped all parties at RADAB to see things in a more global context. They have, throughout the process, been looking for solutions to their problems — both domestic and international.

Their reason for involving companies in other countries in the development process can be derived from numerous factors. First, the way the Swedish CAA wanted to examine and test all parts would cost too much, they had to work around the problem. Second, due to economic constraints, NUTEK forced them to manufacture ready-to-fly aircraft. The reason behind this was that it would get the aircraft out on the market faster (no building-guide necessary) and they could aim at a higher profit margin. Third, it was not possible to find a company in Sweden with either skill or equipment suitable for this kind of production. Since the certifying-process, JAR-22, is accepted in most countries, including Sweden, they could bypass the certification problem by going abroad. They contacted *Szybowcowy Zakład Doswiadczalny (SZD)* in Poland, mainly for three reasons. First, SZD is a large glider manufacturer with a vast experience in certifying gliders. Second, when the gliders are certified in Poland the planes together with all parts are also certified in most Western countries through a rather simple transfer process. As a result the kit, as well as the ready-made plane, would be approved in Sweden by CAA/EAA. Third, Poland holds, relative to Sweden, a low salary level thereby making the total production costs lower.

After negotiating a contract with the Polish manufacturer they started to experience vast communications problems. No one answered the faxes they sent. When they phoned and asked about the progress in testing and manufacturing, the answer was “good” and “looking fine”. When they later visited the factory, they started to realize that it was not true. When they demanded all the facts about the process from the SZD personnel, they were asked for more money. Returning to the written contract to find support for their claim of negligence and not fulfilling the original intentions, they

found that no stipulated deadlines were included. After additional efforts to bring the cooperation back on track without success, RADAB decided to terminate their business with SZD. No legal actions were taken and RADAB solved the dispute by buying back their parts for, as the CEO put it, “a rather small fee”.

In 1990, RADAB started to focus on setting up a suitable sales organization for the Windex 1200. They established ARACO — a sales company in United States managed by Bergström. This was done for two reasons. First, the US market is the largest in the world for this kind of products. Second, due to liability reasons, they decided to separate the marketing and selling of the Windex 1200 from RADAB. Their problem with the certification process still remained. Due to their international recognition in the 1991 Aerobatics World Championship where the glider took bronze-medals in two categories, they had some prospective partners, this time in Austria. A former engineer at one of the Austrian glider manufacturers wanted to start his own firm, and saw the production and certification of Windex 1200 as an interesting part to his business concept. The venture was never carried out. Others were interested in becoming an agent for the Windex 1200. In 1992, they started to negotiate with a representative in Great Britain. During 1994, the Briton started building his own kit to have as a demonstration plane.

## The Engine

Parallel to the development process of the glider, RADAB was searching for a suitable engine. It turned out to be a long and difficult endeavor. The market for small efficient engines in the area of 25–35 h.p. seemed to be almost nonexistent. In addition, the concept of applying an engine in the back of the plane added many constraints to the engine-construction. It had to be a very light and effective engine. It also had to have a sleek design, to uphold a good aerodynamic performance. Their search led them to the König engine from Germany, a three-cylinder star engine with an output of approximately 20 h.p. The star configuration was not a suitable design in this case, and the performance was not enough to get the plane off the ground

made inquiries in Czechoslovakia about future production facilities for the engine.

Ridder's theoretical background and Jonsson's background in racing and tuning motorcycle engines resulted from different opinions regarding the engine design. Ridder wanted a sleek design with no excess weight. Jonsson argued for a more traditional and robust construction. Their different viewpoints resulted in not only Ridder, but also Bergström, objecting to RADAB paying S&T Verkstads AB.

### **The CEOs Problem**

At the next board meeting at RADAB, the question was raised whether or not to continue to financially support Jonsson's engine development. What should Undén do?

## **Appendix A**

### **Technical Note**

The development of an aircraft can follow different certification procedures. For those aiming at producing a complete and ready-made aircraft, you have to certify the aircraft according to some of the Joint Airworthiness Regulations (JAR) or equivalent; JAR-22 for gliders, JAR-23 for motorized aircraft, etc. These regulations state how things should be done and how it should be documented in order for the Civil Aviation Agency (CAA) to give their formal approval.

Another way is to build the aircraft as an ultra-light or experimental aircraft according to the regulations of the Experimental Aircraft Association (EAA). By doing that you agree upon the fact that the future customer will build more than 51 percent of the aircraft him or herself and that you as a producer only can deliver a kit that the builder has to complete. By doing so the builder is also accepting the responsibility of liability of the product. Due to the increased liability problems in the US, manufacturers like Cessna and Piper have experienced huge problems. This situation has made it possible for a number of new manufacturers with new ideas and new technology to

enter the market. It is reasonable to say that it is the kit manufacturers that have been the driving force within the industry during the last 20 years.

## **Materials**

An aircraft can be made out of traditional materials like wood and metal, but over the years the dominating material have been some sort of composite material. This have made it possible for more advanced and complex designs since the shape of the part is formed in a mould and gets the final form straight away instead of carved or hammered into the right shape. Performance has as a consequence been increased in a radical way.

Among the different techniques of building an aircraft out of composite material, the use of an autoclave is among the more extreme, since not many companies have the equipment needed for large aircraft parts. In this case, the production process is based on Prepreg, a pre-impregnated glass fiber with epoxy resin and Nomex honeycomb (a polymer similar to Kevlar). The Prepreg and Nomex honeycomb is applied in the mould and on top of the carbon fiber material a plastic film material is located. This film has vacuum air canals, which facilitates vacuum being established between the film and the laminate. The mould, including the laminate and plastic film vacuum bag, is entered into the autoclave and is cured in 90 min at a temperature of 120°C with a pressure of 2–6 bar to the outer side of the plastic film.<sup>8</sup>

## **Aircraft Engines**

The aircraft engine can, as well, be divided into two categories. The first would entail reliance on engines equipped in small commercial planes such as the Cessnas, Pipers, or others. These types of engine have different back-up systems like parallel ignition systems, the use of low rpm and horsepower compared to engine volume, etc. This type of engine has to be serviced by a certified aircraft-engine engineer at

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<sup>8</sup> <http://www.sailcenter.se/info.htm>. October 2001.

certain intervals in order to keep the aircraft airworthy, but one is allowed to use the aircraft commercially and take passengers.

The other category of engines entails those that can be serviced by the owners. This category of engine is not allowed to be used in commercial flights, and when it comes to motorized gliders, the engine should always be looked upon as a support function. The pilot should still behave as if he was flying a pure glider. Even if that is what is stated in the regulations, today's engines have proven to be highly reliable. Many of them are, in fact, converted car engines.

### Technical data of the Windex 1200<sup>9</sup>

A complete 3D view of the Windex 1200C can be found on the next page, Appendix B. A complete Windex 1200C kit with costs of 39,300 Euro divided into following subparts:

Fuselage kit	14,600 Euro
Fast built wing kit	16,300 Euro
Engine <sup>10</sup> and propeller unit	8,400 Euro

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<sup>9</sup> <http://www.windex.se>, October 2002.

<sup>10</sup> The König SC-430, 3-cylinder engine has a displacement of 430cc and delivers 20 h.p. at 4200 rpm. The weight is 13.8 kg (30.4 lbs).

on high altitude and in warm climate. They took the strategic decision to develop their own engine, a major undertaking by itself. Undén even acknowledged that it would probably demand at least 50 million SEK<sup>7</sup> to “do it right”. Ridder found it interesting to experiment with a new engine design, but in the end the new concept did not work satisfactorily. The representatives at NUTEK had doubts, and tried to talk them out of the idea. They even gave them support and advice through consultants on engine construction.

Through common interests in aircraft and composite materials, RADAB got in contact with Bertil Jonsson at S&T Verkstads AB outside Stockholm. Bertil Jonsson has a history in tuning engines for racing and renovating motorcycles. He has worked with a variety of things like ultrasound as a tool for cleaning parts, different types of painting techniques like thermo, electrostatic, plasma painting, and diamond coating. Since 1955, Jonsson also holds a glider pilot license. His first contact with the Windex aircraft was when he and his wife, in the beginning of the 1980s, attended a fair named Älvsjömassan, where the Windex 1100 prototype was exposed. The comment to his wife was “I’m going to have one of these!”

Jonsson had a mutual understanding with Ridder and when he heard that RADAB worked with carbon fiber, he contacted them. He met with Undén and Ridder and they started to talk about the specifications for an engine suitable for the aircraft. Jonsson found that they needed a special kind of engine and realized that it would involve certain problems. After the first meetings, the contact was mainly upheld via Undén. Jonsson started working on the project on pure interest, and helped RADAB develop a more conventional three-cylinder engine. After a while RADAB started to partially cover him for his costs, but their mutual understanding was that the major part of the development costs would be paid as a commission fee on each engine sold. The three-cylinder 300 cm<sup>3</sup> engine produced approximately 26 h.p. With larger cylinders that later were introduced on the market they planned to improve the performance to at least 30 h.p. During the same period they also

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<sup>7</sup> Fall 2002: 1 Euro equals approximately 9,20 SEK.

## Appendix B. A Complete 3D view of the Windex/200.

