CAN YOU UNDERSTAND THE INDIVIDUAL PARTS IF YOU DON'T HAVE THE COMPLETE PICTURE?

In the corporate world synergy is a concept much used to try to justify why two companies should merge. That one plus one is not two, but three, four or even five. That combining knowledge, experience and contact networks creates a value that was not there from the beginning.

An analogy from the world of physics is fusion energy: the source of the Sun's and other stars' energy. Fusing two atomic nuclei converts potential energy into kinetic energy, generating more energy. But how is this possible? How do you do it? How can a whole be greater than the sum of all its parts?

How many people does it take to make the impossible possible?
When Neil Armstrong became the first man to set foot on the Moon, in a sense it required only one. On the other hand, without the other astronauts on the Apollo XI mission, it would have been a lot more difficult. And without the efforts of hundreds of thousands of people, working year after year to make it possible, it could not have happened at all.

At Saab it takes around 8,000 people.
What starts off as an idea in an engineer's head becomes an advanced system within the field of space, aviation or a related technology.

For instance, a separation system that ensures that satellites arrive at the right destination.

And computer, antenna and microwave systems that allow the satellites to communicate.

Navigation and positioning systems that use data from satellites to make the sky and sea safer places to be.

Radar-based level-gauging and guided weapon systems.

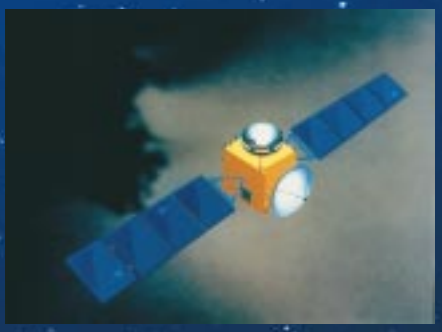
Extremely fault-tolerant real-time systems that control computers in aircraft, automobiles, in mobile telephones, satellite receivers, respirators and space launchers.

Subsystems for Airbus and Boeing. Laser and graphic-based simulation systems. And then Gripen. The world's only operational fourth-generation combat aircraft.

Being best in the world in any one of these areas is a tall order for any company. But being best in the world in all of them is almost an impossibility.

Brainpower has replaced brute force. For over 60 years, Saab has been stretching the laws of nature, pushing forward the limits of what is considered mentally and physically possible. From curiosity springs forth new products and companies. In every challenge there is a business opportunity.

Making ideas fly.



CHALLENGE NO. 1:

WHAT DOES THE UNIVERSE REALLY CONSIST OF – MATTER OR INFORMATION?

We usually think of the universe as being made up of particles of matter, and information as a derived phenomenon that describes the particular state of this matter. But perhaps it is the reverse. Perhaps the universe consisted initially of information and matter was a secondary manifestation.

Uncertainty abounds out in space. And distances out there are so huge that we have to put our trust in information. Making sure that this information gets back to us in a reliable way is one of the challenges faced by Saab Ericsson Space. Such as in the Rosetta project – a space probe equipped with our antenna, mass storage and data management system and that will rendezvous with a comet to provide us with some new clues as to how we got here.

We'll have some answers by July 2011.

Although we now understand the laws of physics that controls fusion energy, there is still no behavioral analyst or company accountant who can explain, in scientific terms, how synergy effects arise. Sometimes you can understand this intuitively, like when people meet and they "click". But how do you get 8,000 people to "click"?

A QUESTION OF CLIMATE

Compared to some of its peers and partners in the aerospace industry, Saab is a very small company. Going by the number of employees, that is.

When you try to explain how Saab has succeeded in producing something as advanced as Gripen, sooner or later you end up discussing the climate.

It's partly about a climate of cooperation and the symbiosis that Saab has developed with its customers over the years. Long-term relationships, enabling the free flow of experience and knowledge and letting it permeate the projects. Partly it's about a corporate climate distinguished by cooperation, openness, participation and security. It accepts that to err is human and part of learning. The decision-making process is informal and short. Feedback on activities are fast which leads to faster improvements.

"IS MORE PEOPLE THE SAME AS MORE HUMAN CAPITAL? DOES HAVING MORE COMPUTER POWER AUTOMATICALLY MEAN AN INCREASE IN STRUCTURAL CAPITAL?"

There are those who claim that all of this has created a corporate culture where nothing is impossible. It might just be true.

THE MYTH OF LARGE NUMBERS

Despite David having defeated Goliath, and not the opposite, opinion seems to be in favour of bigger being better and more being better than less. But just as more data do not equal more information, more resources do not equal more efficiency.

As the industrial society is gradually changing into the information and communication society, this view, albeit slowly, is changing. At the same time there is a shift in focus from real capital to intellectual capital. Instead of measuring how much we are worth in terms of machines and factories, our personnel's knowledge, experience and skills, together with their ability to work on systems, processes and methods, really decide how competitive we are.

But the question still remains: is "more people" the same as "more human capital"? Does having more computer power automatically mean an increase in structural capital?

CHALLENGE NO. 2: **RENDERING THREATENING RADIATION HARMLESS**

Our reliance on miniaturized and complex electronic technology is increasing, for example in aircraft, in mobile telephones, in portable computer systems and respirators. And in automobiles in particular, the next generation will contain so much electronics that they will begin to resemble aircraft. This all means that we are more vulnerable. The threats are many: cosmic radiation, lightning, radar and radio emissions, and other forms of electromagnetic radiation that can knock out electronic components or entire systems in a fraction of a second.

Ericsson Saab Avionics uses a highly sophisticated CRAY T3E supercomputer and unique, in-house developed measurement methods and advanced measurement and test equipments, such as the semi-anechoic shielded test chamber, to protect against these types of threats. These facilities are aimed both at systems developed by Saab and by other companies.

One example of the latter is Double Eagle MkII, an underwater robot from Bofors Underwater Systems, here flanked in the screen room by the customer's representative, Mikael Appelquist, and Åsa Pettersson, Mikael Berg, Ann Larsson, Nicklas Gustafsson and Göran Svensson, all from the Ericsson Saab Avionics Electromagnetic Technology Division.

One of the greatest challenges facing Saab today is to manage and develop its intellectual capital, whether it concerns the machines, methods or the people themselves. Especially given the rapid rate of change in the worlds of commerce and technology. Military is becoming civil. Swedish becomes international. Hardware is shifting towards software. Some of the people dealing with these phenomena on a daily basis are Åke Svensson, Head of the Future Products and Technology business unit, Billy Fredriksson, Head of the Saab Group Corporate Technology, Bengt Halse, CEO and President of the Saab Group and Bo Wass, Head of Technology at Combitech and responsible for spin-off activities at Saab.

PRODUCTS REPLACED BY METHODS

It might depend on how you use what you have.

Traditional industrial production and development is capital- and labor-intensive. The average time taken to develop a military aircraft is 13 years. Developments in information technology, however, follow "Moore's Law", which stipulates that computer power doubles every 18 months. Every 18 months new technology becomes yesterday's news.

The new industry works with virtual products. Instead of tying up capital in production, we are now investing it in technological developments. Real capital is being replaced by human and structural capital. Because they undergo constant development, virtual products are always state-of-the-art.

TWICE AS SMART, TEN TIMES FASTER

The fastest computer in the world has one-teraflop performance, meaning that it can make one billion calculations per second. That is more than a laptop will do in a whole year. But if computer capacity, according to Moore's Law, is doubling every 18 months, developments in the field of communications are even faster. Over the same period there will be a ten-fold increase in the performance of internal and external networks such as the Internet.

All this performance enables simulation and modeling that radically change our view of the real world and how we interact with it. Now, not only can we do these tests and analyze the results in a safe environment and relatively cheaply on the ground.

CHALLENGE NO. 3: **BREAKING THE SOUND BARRIER**

Stretching the laws of nature and pushing forward the limits of what is physically and mentally possible – this may sound pretentious, but let's just take an example of what could happen if we refuse to accept the limits of physics.

A lot of modern manufacture involves machining using a fully automated complex of tools that can manufacture components at a speed and with a precision that is far superior to labor-intensive manual techniques. But there are some jobs that even machines can't handle. New demands for lower weight, greater strength and better performance, combined with the ever-present and all-encompassing need to cut costs, mean that products have to be constructed from materials that cannot be processed using today's technology. So what do you do, particularly when the laws of physics seem to say that something is impossible?

The answer at Saab was – it has to be possible.

If you are machining a component, made of aluminum for example, and you increase the machine's speed, the heat and the cutting pressure also increase in the cutting zone until either the cutting tool or the component collapses. Or both. This was a "sound barrier" that could not be broken.

At Saab, they decided to surmount this obstacle.

When they increased the speed above the critical limit, the most peculiar phenomenon arose. Suddenly it was like cutting water. No pressure and no heat impact on the component. Where it had been impossible to mill walls thinner than 2-2.5 mm, it was now possible to make them as thin as 0.08 mm.

And that's just the start of it.

The technology, which used to be no more than a figment of the imagination, is called High-Speed Machining (HSM) and has considerable advantages. Not just the ability to manufacture finer components in a shorter time. It is also possible to manufacture far more complete solutions. Instead of 90 components requiring 90 construction drawings, 90 tool drawings, 90 tools, etc., you have a so-called integral bit – a component that uses a single drawing and a single tool. No need for riveted or bonded joints to hold the components together, and a better fit when the component is put in place.

The whole subject of physics is changing. The parts have become the whole. By asking "How?" instead of "Why?", the impossible suddenly became possible.

Mikael Karlsson, NC operator, Johan Björklund, NC programmer, Kristian Nielsen, Production Manager, and Kent Strand, Project Manager, at the department for Production Technology Development within the Collaborative Programs business unit. They are shown together with some of the products it used to be impossible to manufacture. Since they proved that high-speed machining was possible in practice, all textbooks on cutting technology have had to be revised.

CHALLENGE NO. 4: **DEVELOPING THE WORLD'S SMALLEST FOUR-WHEEL DRIVE SYSTEM**

It is a well known fact that four-wheel drive systems can improve roadholding qualities. All you have to do is ask a rally-driver. But it really depends on the electronic components reacting at lightning speed, e.g. to changing conditions between wheel and road surface.

At Combitech Electronics, electronic control systems are being developed and manufactured which are part of the four-wheel drive systems used by Audi and VW, among others. The system is based on so-called Multi-Chip Module (MCM) technology, which provides a high level of miniaturization so that the whole unit can be included as a distributed electronic component directly adjacent to the rear axle of an automobile. All for the sake of greater reliability and better performance.

Torbjörn Claesson, Kishori Couhan, Katarina Moberg and Marcus Hjalmarsson on the way into the clean room at Combitech Electronics in Jönköping, one of Scandinavia's largest and most modern clean-room facilities where products based on Multi-Chip Module (MCM) technology are manufactured.

We can also simulate certain phenomena in various conditions much faster than in real-world flight-testing, and so can study performance ahead of time.

Saab's engineers use these advanced digital modeling and computer simulation tools to construct, test and adapt many such products.

Another example is the PM (Presentation and Maneuvering) simulator that Saab uses to develop new aircraft and aviation systems. In a dome you project a pilot's-eye view of the outside world in all its "360 degrees". You can select the coast of the Baltic Sea, Kiruna in Sweden or Table Mountain in South Africa. All flight and technical characteristics and data – from engine performance to weapons and radar performance – are exactly the same as in a Gripen. And all the various technical and tactical scenarios can be played out in a frighteningly real environment.

Distinguishing between what is virtual and what is real is not as easy as it used to be.

"SURVIVAL OF THE BRIGHTEST"

The times we live in belong to those who have the right information, not the most information. What is true and what is false?

Success depends on our ability to quickly sort, understand and absorb huge amounts of data. This applies to companies and fighter pilots alike. It's about establishing very quickly what information is relevant to the activity to be performed. Equally important is being able to adapt immediately to the demands of the environment or the situation. And preferably a little faster.

Very soon, the word "virtual" will not adequately describe what is happening in the fields we work in. Sensors are becoming smarter and are being integrated in networks. Display systems are hyper-realistic and are being integrated with people, sometimes almost "in" them. We now have systems that not only present reality as it is now but can predict what will happen in the near future.

CHALLENGE NO. 5:

DESIGNING THE WORLD'S MOST ADVANCED REAL-TIME SYSTEM

It is incredibly complex. It has to be fast. And under no circumstances can there be any faults.

Gripen is probably the world's most sophisticated example of knowledge-based systems integration, bringing together 100 specialized technical fields into a system which the pilot can manage. It is also a prime example of advanced information technology systems integration. A flying computer-based information system, built on robust and super-reliable real-time systems, around a digital infrastructure with shared databases.

There are very few companies in the world today who understand all of this. And Saab alone has its fourth-generation aircraft in operational service.


FARA

CHALLENGE NO. 6:
BEING PART OF DEVELOPING THE BIGGEST COMMERCIAL AIRLINER IN THE WORLD

It is 73 meters in length, 80 meters from wing tip to wing tip, and around 800 passengers on two decks. And there is a further deck for freight and luggage that you could quite easily fit a Saab 2000 into.

We're talking about the Airbus A3XX which, when it according to present plans enters service in 2004, will be the world's biggest commercial airliner. And being part of the program means molding the future of the aerospace industry.

Saab brings its cutting-edge systems technology, aerodynamic and acoustic skills to the project. As well as calculation, simulation and production technology. The company that brings its skills not just to its own part of the project, but to the system as a whole, is indeed a valuable partner. And that's why a total systems integration capability is still so important.

If we are to be part of the program, we have to invest in competence. The exchange is multi-faceted. Counted in kilograms, it means that for every A3XX built, Saab receives a manufacturing volume equivalent to one Saab 340.

Saab has already proved itself as a skilled supplier to existing Airbus programs, mainly of structures for the Airbus A340-500/600. For example, the deal for the landing-gear doors, which are built of composite materials and are as big as a Gripen wing. Businesses worth hundreds of millions of US dollars.

By investing its skills, Saab gets skills in return. Today, developments in civil aviation are outpacing developments in the military sector. Cycles are shorter and the civil sector is pushing forward both products and production development methods such as digital modeling and assembly simulation. Knowledge which, for example, can later be used by the military to make Gripen a better and an even more affordable product.

Mats Palmberg, Ingemar Samuelson, Jonny Larsson and Sture Nordmark from Saab, with representatives from Airbus/Aerospatiale in Toulouse, France.

We operate in a Darwinian process, where companies who do not evolve will become extinct.

IS IT STILL RELEVANT?

A few years ago a South Korean electronic company decided to start making automobiles. A completely logical move, in the company's opinion, because it felt that what was critical for building the automobile of the future was not the combustion engine but knowing how to use computers to make automobiles safer, cheaper and more reliable. So, is that company an IT company or an automobile manufacturer?

At Saab, around 2,500 of our 8,000 people work in IT in some form or other. Not including all the people who use a computer in their everyday work for word-processing, logistics, aero dynamic simulations or even computer-aided design. Just those who are involved in developing and producing IT systems and products.

These could be self-repairing computer electronics for commercial communication satellites. Or extremely fault-tolerant, real-time systems which control the functions of a dialysis machine. Or complex algorithms for navigation systems. To name just a few. Most of these are what are known as embedded systems and end up in products that look nothing like a personal computer or mobile telephone, and therefore are not usually labeled as information technology products. Take Gripen, the world's first completely digital aircraft.

So the question becomes: is Saab an aerospace manufacturer, or an industrial IT company?

PHILOSOPHY AS DEVELOPMENT TOOL

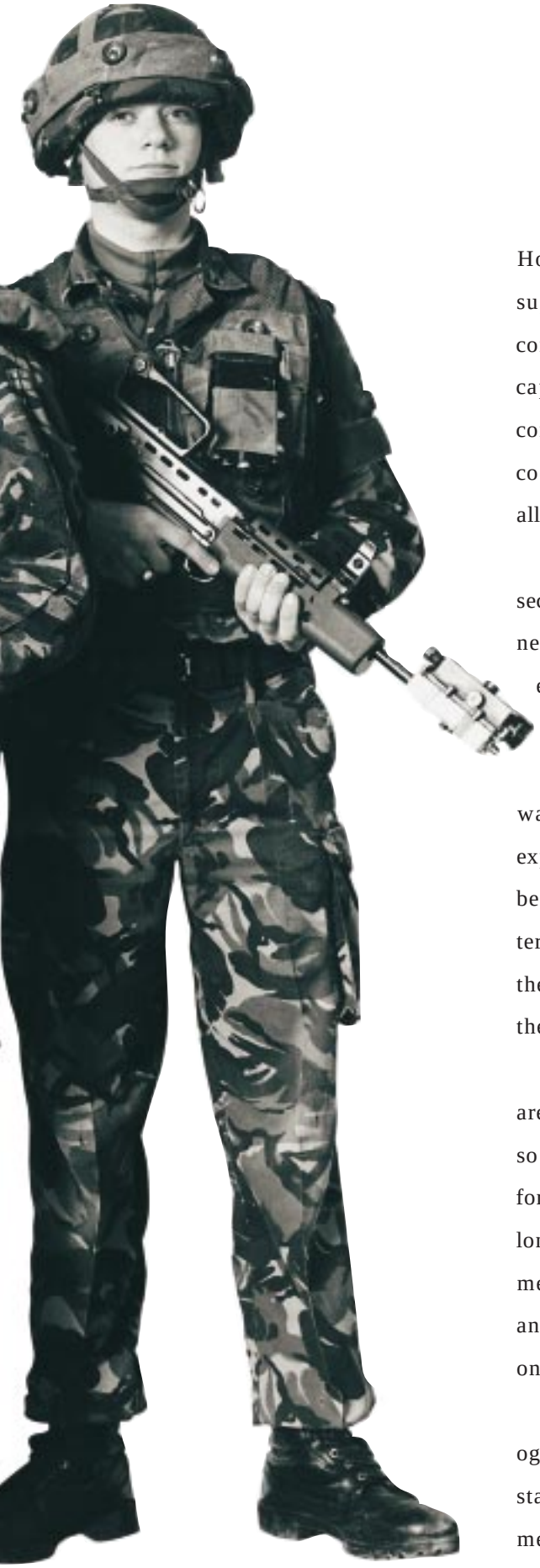
There is something strange about the so-called information society. Knowledge that can be easily put on a digital database and distributed over the Internet has taken precedence over knowledge that can not be put on a microchip, or that can not be printed.

CHALLENGE NO. 7:

THE BRITISH ARMY'S UNIQUE SUPPORT AND REPAIR CONCEPT

No, this is not about the laser-based firing simulator from Saab Training Systems, even if this is a unique product. No, this time it's about customer support and how Saab employees are available on site with the British Army, where they are responsible for maintenance, service and stock-keeping, ensuring that the training equipment is used in the best way – a competitive advantage that reduces customer costs and thus contributes to Saab's world-leading position in the field of military training material.

Claes Utterberg at Saab Training Systems in England assist the troopers 25051453 Davies and 25054623 Webb at B Sqn, 9/12 Royal Lancers.



However much decision-making support and artificial intelligence computers give us, we can never capture human experience and common sense in programming code. Because they just do not allow themselves to be packaged.

This is perhaps one of the secrets behind Saab's competitiveness. An ability to take care of the experts' skills and transfer them to new colleagues. There is a Swedish saying, "It's in the walls", meaning that this kind of experience-based knowledge can be felt but not explained. Long-term projects have given novices the time to observe and learn from the "masters".

But the fields of knowledge are becoming ever more complex, so that in systems development, for example, "the walls" are no longer enough. And if there is no method of transferring experience and skills, you have to develop one of your own.

Saab is thus the first technology company in Sweden to have started working with a unique method of transferring this silent knowledge, which can not be documented, be seen or heard.

Skill is a combination of precision and innovation, of science and intuition. By combining leading-edge research into linguistics philosophy with development methods for highly professional technical applications, you get a clearer picture of what an engineer's skills really consist of.

From being considered a most as a piece of hardware, engineers are taking on a softer dimension.

WILD BRAINS VERSUS STRUCTURED

A good team consists of different kinds of people. On the one hand it needs creators and innovators who are free to pursue creative tangents. On the other hand you need people to structure the work and take it all the way to being a business opportunity.

Somewhere in the middle you have the entrepreneur who sees the commercial potential of the innovator's idea.This is when the "It's in the walls" attitude can become an obstacle. Sometimes

CHALLENGE NO. 8: **REVOLUTIONIZING INTERNATIONAL NAVIGATION AND AIR TRAFFIC**

You hardly need to be an expert to understand the importance of keeping track of a vehicle's position, regardless of whether it's a supertanker or an airliner. But apart from the safety aspect, which is becoming increasingly important with growing traffic intensity, there are also other reasons for doing so, such as environmental monitoring and logistics.

The technology still used for this purpose, even though it is over 50 years old, is radar. It does, however, have several shortcomings. One is that it is difficult to identify vehicle types, another is that the captain or pilot needs the help of people on the ground. Yet another is that the technology is not sufficiently accurate.

In the 1980s, radar was complemented with the Global Positioning System (GPS), a satellite-based navigation system designed by the US armed forces. This enabled a pilot to see his own position in the air without the help of people on the ground, but he still could not see what was going on in the airspace around him.

This problem posed a challenge to the Swedish inventor Håkan Lans. The task was to create a datalink to the satellites that would send, receive and coordinate position data from different vessels. The solution developed by Håkan Lans is known today as SOTDMA (Self-Organizing Time Division Multiple Access), a system that enables ships, aircraft, ground vehicles and fixed land bases to exchange position information in an intelligent way by allocating timeslots on a radio link, since not everyone can transmit at the same time.

Together with Saab's expertise in the fields of complex systems, real-time programming, radio technology, navigation technology and applications know-how,

Nils Willart, Service Manager, Hans Svensson, Quality Controller, Rikard Kjellberg, Systems Engineer, Mikael Pettersson, Project Manager, and Marcus Gustafsson, Software Developer, proudly demonstrate a SOTDMA transponder, a datalink system that uses the satellite-based Global Positioning System (GPS) and VHF radio to transmit the position and identity of aircraft and vessels.

Håkan Lans's ingenious solution has resulted in the product known as LINCS. With an accuracy of less than a meter, this makes it possible for all users to monitor their own and other users' exact geographical location in real time, and hence their position in relation to each other. Via real-time links to other systems, it is also possible to see, for example, the names and call-signs of the vessels, where they come from and where they are going, in the event that they are on a collision course.

The first practical application of the system is in maritime navigation, where the UN's International Maritime Organization (IMO) are evaluating this technology for use on commercial vessels. A decision is expected in 1999 stipulating that all vessels over 300 tonnes must be equipped with datalinks. Together with Celsius, Saab has accumulated considerable, unique expertise in this field. There is already a comprehensive system in operation along the Swedish coastline. This system is also part of the Baltic Watch project, aimed at demonstrating how such technology can be used by all the states in the Baltic region to protect life, property and the environment.

The greatest potential for this technology, however, may be in aviation. If it becomes a world standard here as well, and there are several indications that it will, this will open up a market consisting of around 15,000 large passenger aircraft and 300,000 to 400,000 smaller aircraft.

If this were the case, it would be both technically and commercially possible to see on a computer screen where all aircraft and large ships l over the world are at any given point in time.

CHALLENGE NO. 9:
MAKING THE WORLD SMALLER

Placing products several thousand miles out in space can actually be the best way of bringing people closer. The Internet, analog and digital television, mobile telephony and ordinary, good old long-distance telephone calls. Thanks to communications satellites we can reach places that used to be alone in the world. And the world can reach us: news around the clock, live concerts and sports events – for instance a tennis match from the other side of the globe, where the match ball smashes into our livingrooms with a delay of only 0.3 seconds.

Saab Ericsson Space manufactures antennas that enable satellites to complete their assigned task. Here Mikael Petersson, Krister Ljungberg, Camilla Svensson and Jonas Karlsson demonstrate the reflector antenna from a telecommunications satellite.

there is an attitude of "this is the way we have always done it", inhibiting entrepreneurship and creativity. Some new ideas have to be taken away from the core business if they are to have a chance of surviving. And there are people who don't want to work for a big organization, even if it is a relatively small one like Saab.

So Saab doesn't experiment just with new products and methods, but even with new ways of working – the possibility of working for a small company in a "freer" atmosphere while still being a part of the "big" Saab.

By allowing its employees a higher degree of freedom, the company gets a "wild" side to fall back on when the competition gets fierce. If you plan everything down to the finest detail you run the risk of being a laggard when technological development takes an unexpected turn.

"IS THERE ANYBODY IN THERE?"

Let us re-formulate our opening question.

Which subsystem is the best? Subsystem A that was developed in isolation, without knowledge of the complete picture? Or subsystem B, that right from the start knows its place in a larger system?

Just by formulating the question differently the answer becomes patently obvious. And

"TO BE ABLE TO THINK OUTSIDE FRAMEWORKS YOU SOMETIMES HAVE TO GET OUTSIDE THE WALLS."

at the same time we begin to understand that the whole can be greater than the sum of all its parts. The difference between our subsystems is not made up of matter but of information. Subsystem B knows something that subsystem A does not. Subsystem B has got a meaning.

Now we're beginning to get a close to one of the oldest problems of existence – the duality between mind and matter. The brain, which is made of matter, creates thoughts or mental information. Nobody knows how.

Perhaps you understand but lack the ability to explain – that the human brain can think in more dimensions than we can formulate.

Or it could be that we cannot explain a system which we are part of. Just as cosmologists and quantum physicists cannot find one common theory for how the universe works.

If we really had all the answers we could all go home and leave it to the Computers. If we could explain why we can do what we can do, then it would no longer be so difficult.

Matter becomes information. Or information becomes matter. Somewhere in all of this there exists the magic that drives development forward. ◆

CHALLENGE NO. 10: **ELIMINATING THE PILOT**

Today's military aircraft are among the most advanced systems solutions you can think of, and their performance is mind-boggling. But even this is sometimes not enough.

So even if the structures, propulsion and control systems can withstand a force of 30 G, there's not much point if the pilot passes out at 10 – 12 G.

And even if the aircraft's information system has never been so sophisticated, with new avionics and sensor technology, artificial intelligence, decision-making support and a display system that uses the latest in man-machine interface developments, we are reaching the upper limits of the pilot's physical and mental abilities.

To meet new operational demands, we are studying various technologies for unmanned air vehicles. Not to replace the Gripen, mind you, but as a complement to it, particularly in situations where human life would be at risk. Despite this, unmanned aircraft are not just a military necessity, but can also be used for example in information systems designed to enhance civilian safety or to monitor the environment.

Some of the studies, mostly involving artificial intelligence, are being conducted within the framework of a research program. Most of them, however, are going on behind locked doors at Saab's Future Products and Technology business unit, which is coordinating the project.

These studies are an intellectual challenge to all the areas of skill within Saab, from navigation to autonomous control, simulation, modeling, manufacturing and production technologies. In simple terms, you could say that the unmanned air vehicle will be like a Gripen but minus the cockpit, the oxygen and environmental control systems, and the ejection seat.

But the man-machine skills still come in handy. Although the vehicle does a great deal of its own decision-making, there will be someone on the ground operating it. Not a pilot flying in a virtual world, but a supervisor who can give the aircraft orders to adapt rapidly to an unexpected scenario. There isn't a computer yet that can use common sense and improvise.

"WE NOW HAVE SYSTEMS
THAT NOT ONLY PRESENT
REALITY AS IT IS NOW
BUT CAN PREDICT WHAT WILL
HAPPEN IN THE NEAR FUTURE."