March 26th the VSV ‘Leonardo da Vinci’ has organized a symposium on the future of aviation; “Flight Forward”, the future of air transportation. The organizing committee invited several players in the aviation business to share their point of view on the subject. The spokespersons where Ir. Jeroen Fukken of the Dutch ministry of Transport and Public Works, Prof. dr. Ricky Curran of the TU Delft, Mr. Ype de Haan from KLM, Robert Nuttall of Rolls Royce, Drs. Sjoerd Vollebreght from Stork, Daniel Sallier of Aéroports de Paris, Cor Vrieswijk from Easy Jet and Jan Närlinge from Boeing. All of them playing important roles in (Dutch) aviation.

The CEO of the renowned airline Cathay Pacific once described the current view on aviation like this: Our passengers check in smoothly and will depart right on time to a destination thousands of kilometers away. Comfortably in their seats they will have a good time during their flights. Unaware of the harsh environment just centimeters away; air rushes by almost at the speed of sound and reaching temperatures way below anyone’s imagination. Only a few meters from them controlled explosions at temperatures half of the Sun’s take place continuously. Once the aircraft has reached its destination and touched down within centimeters off the middle of the runway the passenger will leave the airplane complaining about the poor sound quality of the in-flight entertainment system. Nowadays we take aviation for granted.

In the future the aerospace industry is facing several problems, states Jaap de Laat, president of the Symposium committee. “The most obvious one being that fossil fuels become scarce. Secondly, the aerospace industry has to deal with the growing environmental awareness, and the last problem is the competition from countries from the East. Asian aerospace companies are booming at the moment making it a challenge to compete with them.”

DUTCH AVIATION INDUSTRY
For the Netherlands it is important to stay competitive. “Our history is very important: we had a leading position”, ir. Jeroen Fukken says. “The Netherlands where the first country to open skies with the US. This improved the connectivity of Schiphol, but is lost its leading position.” Editorial staff Leonardo Times “For now sustainability is a unique selling point, which will bring the Netherlands ahead again.” This, however, is easier said than done, the so called ticket tax that was introduced by the Dutch government in 2008 proved to have a negative impact on both Schiphol and KLM. The industry had already predicted that it would do more harm than
good, but nevertheless the government only reversed its decision after its dramatic consequences for the Dutch aviation had already unfolded themselves. Since Schiphol has a small domestic market, so it mainly relies upon the transfer passenger, which then saw the Netherlands as unfavorable due to the tax. ‘It is important to realize that the government only makes decisions based upon the information that is made available to them, so it is a very strong responsibility of the industry to provide decision makers with the necessary information. If this is done correctly the government will not make such bad decisions’, Fukken says.

The government therefore took another angle of approach to steer the Netherlands to being a leading country in aviation. ‘There are a few problems to solve’, Fukken states. ‘We will have to tackle the so-called “poldermodel.”’ Schiphol is in a deadlock situation since it must be able to grow, but due to noise pollution and environmental issues it can’t. Hence a balance between growth and environmental dilemmas has to be found. One answer to this situation is the multi-airport system: Schiphol as the main hub while Lelystad and Eindhoven are used for point-to-point traffic. There are 250 airports in the Netherlands, from which seven have relevant size and importance for the Dutch economy. Fukken: ‘The task of the government in this is to create an environment for the industry to perform: industry does performance, government makes the environment for industry to do performance. So Schiphol does not raise rates for the airlines using the airport.’

Prof. Ricky Curran, lecturer at the Faculty of Aerospace Engineering of the TU Delft, emphasizes that aviation is a very important industry for the Netherlands, as he illustrates: ‘Ten percent of the Dutch economy is linked to aviation. We live in the age of aviation 2.0, where the aviation industry

**WHAT IS THE MAIN THREAT TO THE POSITION OF SCHIPHOL?**
Schiphol is an important hub airport, which makes point-to-point traffic a main threat. Also limited possibilities to increase its capacity in the future pose a threat, since the aviation industry will continue to grow. Currently, work is done on the optimization of traffic positioning around Schiphol in order to use the available airspace as efficiently as possible and to minimize the environmental impact. A good example of this is the introduction of continuous descent approaches and research on sound barriers to reduce the noise burden for local residents.

**WHAT ARE THE STRENGTHS OF SCHIPHOL AND HOW DO WE SAFEGUARD ITS CURRENT POSITION?**
Despite the lack of a large domestic market, Schiphol is one of the largest airports in the world. This has all to do with the vision, inspiration and strong entrepreneurship of those that made the Royal Dutch Airlines the major passenger carrier it is today. A good example is that KLM was the first airliner to sign an open-skies agreement with the USA in Europe. In other words, as long as KLM remains a strong and large hub carrier Schiphol will pick the fruits.
drives the economy. For young engineers the question is how to step forward to aviation 3.0 which is called the Sustained Value Age where the aviation industry is integrated efficiently into the need for sustainable operation. A lot of issues occur at the economical, social and environmental field. For new engineers the question is to match these three issues."

**DUTCH AIRCRAFT PRODUCTION**

Sjoerd Vollebregt from Stork presents the state of economy as having a positive effect on the aeronautic industry. "The current strong economic downfall is not that bad, because it ensures continuous growth for the coming fifteen years."

A less optimistic message from Stork is that it states that defense expenses shouldn’t be limited. In the future the world will continue to face challenges that will rise the level of tension between countries. The dangers of climate change, scarcity of food and resource depletion are imminent. Due to these situations defense spending is expected to grow.

In the future development times in the aerospace industry are expected to become even longer as it will require more and more work to realize improvements or develop entirely new concepts. This means that more resources both in time and money will have to be available in order to stay at a competitive level. On an international level the rise of China is actually good news. It will provide new market opportunities and push the current level of technology even further by putting more pressure on the already very competitive aerospace industry. For Stork this effect will undoubtedly be challenging since it is expected that countries like China, Japan and Russia will develop their own aeronautic industry. The Brazilian company Embraer is a good example of how this has happened in South America. This means that we will face new competition with strongly subsidized companies. This new competition also implies that the industry will become more fragment-

**NEW AIRCRAFT HAVE VERY LONG DEVELOPMENT TIMES. CAN WE EXPECT EXTENSIVE UPGRADE PROGRAMS FOR EXISTING AIRCRAFT? OR WILL WE SEE THE DEVELOPMENT OF AIRCRAFT WITH AN UNCONVENTIONAL LAY-OUT?**

The development of a new aircraft is extremely costly, time consuming and the existing platforms still provide the most revenue. That makes it unattractive for aircraft developers to experiment with new ones. The current projected revenues of unconventional commercial aircraft are simply not enough to justify the tremendous development work and investments that would need to be done. Competition will grow when new markets like Asia, that have all the necessary resources and capabilities, enter the aerospace industry. These new competitors are not bound by their past work, more flexible and can develop new ideas more easily. This new competition will lead to more innovation.

The new development of the Fokker-100 is an example of an aircraft manufacturer that combines existing and proven technology into a new product. It will therefore only compete in price. It is expected that the F-100NG will be competitive for about ten to fifteen years. It will enter an already crowded and very competitive market segment. Stork Aerospace is involved in the development process but doesn’t do it herself because it is considered too risky.
ed, thereby also increasing the complexity of supply chains.

‘Since Fokker has disappeared, Stork Aerospace has focused on the supply chain since it shows that complex products are about fifteen percent more costly per element in the supply chain,’ Vollebreght says. ‘Stork has a unique position in which it is able to connect five cornerstones in the industry giving us a very strong competitive position.’ This gives Stork Aerospace the ability to do all the subcontracting themselves. Another very important business for Stork is maintenance. ‘The company workers feel as if they actually own the Fokker aircraft themselves and lend them to KLM and other operators,’ according to Vollebreght. ‘The experience and expertise from Fokker when it was still constructing the aircraft has enabled Stork to become very competitive on the maintenance market. Today Stork Aerospace is able to perform maintenance on aircraft of for example Bombardier cheaper than Bombardier itself.’

Sjoerd Vollebreght states about today’s challenge that it is not the end, not the end of the beginning, but it is the beginning of a new beginning.

ENVIRONMENT
As the world faces the challenges of a sustainable future, the airlines are in survival mode and not in an easy position to look forward. A disadvantage is that the aviation industry gets disproportional attention to its CO₂ production, although it only contributes to 2% of the world’s emission. The cement industry for comparison is already responsible for twice as much. Although this percentage is low, Boeing keeps developing new products to reduce this load. In view of the 787 Dreamliner, Jan Närlinge from Boeing explains the latest developments: ‘Our new Boeing 787 Dreamliner is a revolutionary aircraft. We changed everything, including the supply chain. However, Boeing has currently lost 4.8 billion USD on the project, for example due to design problems and troubles in

IT IS FEARED THAT THE RELATIVELY SMALL INCREMENTS IN AEROSPACE TECHNOLOGY THAT APPEAR TO BE HAPPENING THESE DAYS WILL DEMOTIVATE STUDENTS. THEY ARE SCARED FOR THE LARGE AND COMPLEX INDUSTRY OF TODAY. WE HAVEN’T SEEN MAJOR BUILDING BLOCKS THAT CAN REDUCE CO₂ EMISSIONS BY CONSIDERABLE AMOUNTS. AND IF INNOVATION GOES TOO SLOW AND TAKES TOO LONG THE INDUSTRY MIGHT LOSE GOOD ENGINEERS?

In the pioneering days of the aviation industry progress was much more rapid and visible than today, but companies still do a lot of very interesting and challenging research and development work. Periods in which major advancements were made and clearly noticeable are the Second World War and the Cold War. These periods are characterized by a great sense of urgency for the development of aerospace technology. Such a period is coming again. Shortages of rare metals and the depletion of fuel reserves threaten the continuation of the industry.

Good examples of very innovative, but not very visible progress in the new Boeing 787 is the extensive usage of new thermoplastics and the replacement of all hydraulic systems by electrical ones. Also on the area of engine reliability large improvements have been made. A former pilot on a Boeing 707 has had to deal with at least ten involuntary in-flight engine shutdowns. While piloting a newer plane, the Boeing 757, he hasn’t experienced any of those. Nowadays we take a very reliable engine for granted, but a lot of work still goes into ensuring this.
the supply chain. But important milestones in the project have been achieved, most visible being the current test flights. Four aircraft are currently flying and two more will be added to the test-fleet. A very good backlog of 786 aircraft worth about 250 billion dollar ensures that there are still good opportunities for Boeing to get revenue from the project. To ensure this and prevent future problems Boeing has added four engineers to its staff with the sole task to keep oversight on all projects.

Boeing is currently researching what it will do with the successful B737 and B777 series. It may develop new successors or do further upgrade programs. Närlinge: ‘A Boeing 737 engine refitting program would be a very serious option for the last.’

BOLTS
With the lack of fossil fuels in the future, the engines are a great player in the sustainable future. ‘We won’t discuss the level of innovation of the cement industry, but

the technological level of the aerospace industry is astonishing’, Robert Nuttall of Rolls Royce says. ‘A turbine blade in the brand new engine that powers the Boeing 787 Dreamliner is worth its weight in gold. It is grown from a single crystal and incorporates a laser drilled cooling network, so efficient it would be able to sustain an ice cube in your oven.’

More overlooked components such as the thirty bolts holding the fan and turbine together answer to equally impressive specifications. ‘Let’s just say that one single bolt can also be used to suspend two A380’s if they were hanging on a single cable’, Nuttall illustrates. ‘The latest Rolls Royce Trent engine contains more than seventeen thousand of these precision engineered components that each have been through years of careful individual development and attention. The Trent 1000 for the B787 and the Trent XWB for the both push one ton of air forward per second. These engines are per kilogram worth their weight in silver. The level of worth is illustrated when using the same comparative scale on a car which results in a cost of one hamburger per kilogram. And you might not realize it, but in all one third of the entire periodic table is present in one engine.’ Rolls Royce is capable of developing such an engine in only six years. ‘To make this possible it has a continuous and thought through investment strategy and is careful to optimize the right things.’

Major advancement in the industry nowadays comes from the summation of many smaller individual improvements, according to Nuttall. ‘But let’s not forget the progress that has already been made. Rolls Royce monitors all its engines 24/7. It gathers half a billion bits of information about their status every year. In doing so, it has been able to further increase reliability by 30% and drastically decrease the chance of an unexpected engine failure, every airline’s nightmare. Rolls Royce invests twenty billion euro a year in environmental research and development and

WOULD IT BE A NICE IDEA TO MAKE CONCEPT AIRCRAFT, AS IS COMMON PRACTICE IN THE AUTOMOTIVE INDUSTRY?
Boeing, for example, only shows what is marketed. A lot of research is being kept in-house and is not very visible for the rest of the world. The aerospace industry is a very large and diverse market. Will there be more specialization in the future?
Being in the aerospace industry requires you to do continuous and major investments. The business model must be in such a way that these investments can be earned back. This means that although it is exceptionally expensive to develop a new aircraft, the aircraft must be cheap enough to be affordable. But in principle a lot of gain can be acquired by a higher degree of specialization.

SHOULD THE UNIVERSITY PARTNER MORE WITH INDUSTRY?
One has to realize that the industry is always on the cutting edge. It does its own research and development, has its own information distribution and in a way defines by itself what cutting edge actually is. So for universities it is very important to partner up with industry.
another ten billion a year in the reduction of CO₂ emissions. These investments are incomparable to other sectors. These massive and consistent investments not only push engine technology forward by about one percent per year, they also result in considerable spin-off technology that finds its way to numerous other industrial sectors.

‘We strongly believe that these continuous long-term investments are the root of the solution for the future,’ says Nuttal. ‘It is important that people know the unique position of the aviation industry. Besides facilitating the magic of heavier than air flight, it is also at the root of new developments. It provides new connections, communications and horizons and does its own share of development for the future. For Daniel Sallier of Aéroports de Paris here is the problem for solutions of the future. ‘We see the future as we like to see it today,’ he says. Sallier thinks people do not look far enough in the future. ‘One must know what travelers want in the future, one must be able to look further than today. Don’t wait for the future to show what it will be like. Decisions you make today will make the future. One can decide what the future will look like.’ But there is another problem. When an airport is built, over the years more and more people start living around that airport resulting in restrictions of airport capacity. With increasing aircraft movements, airports could become the bottleneck in the future air transportation.

‘Aviation used to be something special, but in these days people seem to notice mainly the negative side effects,’ Sallier states. Flying brought people to places they could only dream of before. It made holidays far away possible and it brought medical care to remote areas. At the same time, it also has a large environmental impact (although small compared to other industries) and causes stacked beaches and aircraft full of people on their holiday. ‘There used to be magic in flying and we need to bring that magic back,’ Sallier says. ‘Otherwise aviation could become a prey to all the negative opinions about flying.’

Next to the psychological challenge of changing the image of flying more concrete matters are present in the economic situation. The difficulty in this is matching supply and demand. Sallier: ‘You can lower prices and improve comfort to attract more passengers, but that is of no use when this results in the airline losing money because the extra passengers don’t make up for the increased costs.’ Questions about the economics of aviation have become more difficult in the past years; the aviation industry now deals with an unstable economic situation. Ype de Haan from KLM agrees with Sallier: ‘There is an overcapacity in the market which forces prices to stay low. The load factor is currently only 80%. Some airlines will go bankrupt clearing the market for the successful ones and provide KLM possibilities to buy other airlines and to form more alliances. The traffic decline has already stopped, but recovery is expected to be slow. Airlines try to delay the delivery of new aircraft and to reduce the costs of flying to save money on the short term. Improvements for the future are expected to be a new environmental friendly fuel and a single European sky agreement.’

PAIR OF JEANS
Although some Low Cost Carriers (LCC) appeared to be high costs low fares airlines and went bankrupt, easyJet is one of the few airlines to make a nice profit in these times of economic crisis. The ‘sell tickets cheaper than a pair of jeans’ strategy appears to be working quite well. Statistics show for example that the market for network airlines has matured while the market for charter flights is declining, but the LCC become more and more popular. EasyJet started as an airline within the UK but has increased its network to the whole of Europe, flying from and to primary airports. With 1100 flights and 135000 passengers a day easyJet is a big player in the European aviation market.

‘LCC and network carriers will go side by side’, according to Cor Vleswijk from easyJet. ‘LCC are positioned in-between high speed trains and network carriers. These days, people plan and combine their own flights through the internet. They can for example fly with a LCC from the airport closest to their home to another airport where they transfer to a flight of a network carrier to their final destination. This is often a lot cheaper than a direct flight or a transfer via the network carrier. Because easyJet does not offer transfer flights, it can utilise its aircraft in a more efficient way than network carriers. Easy-Jets’ aircraft fly for example eleven hours a day, compared to the average eight hours of KLM aircraft. LCC’s can grow as point to point carriers and as feeders for network carriers.’

The profits easyJet makes are invested into new aircraft, resulting in a fleet of on average only 3.5 years old aircraft. These new aircraft use less fuel leading to lower costs. But it also makes the aircraft are a lot more environmentally friendly by means of less CO₂ and NOₓ emissions due to better engines. Because of all the benefits of new aircraft, easyJet is looking forward to the arrival of next generation aircraft.

The future of air transportation is still vague. But somehow, with effort from all market and government players, aviation keeps existing over the whole world. It will proceed to play an important role in economics. How? That is not known yet. What is it that people want in the future and how will different aviation markets develop? That is to be determined when the time has come. For now, educated guesses and developments will do.