To drone, or not to drone?

An exploration by potential end-users of the possibilities for unmanned flight within the 3i project.

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To drone, or not to drone?

Remotely piloted aircraft are often referred to in the media as "drones". There is often an association with military applications. Organisations concerned with remotely piloted aircraft often talk about a UAV or a UAS: an Unmanned Aerial Vehicle or System. The vehicle is the aircraft itself, while the system also includes the ground station. However the term increasingly used across the sector is the acronym RPAS, standing for Remotely Piloted Aircraft System. This is also the term used by the government in the new legislation.

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3i project: Background and objectives

Illegal discharge of waste at sea, a disturbance at a busy beach, a reported drowning or a fire on board a ship. All examples of situations where the rapid deployment of remotely piloted aircraft systems (RPAS) can be valuable in rapidly collecting accurate information. Information that can be used to optimise the deployment of manpower and resources, leading to improved safety, the saving of lives or the (speedy) arrest of crime subjects.

But is all this really true in practice? And are unmanned aircraft really more economical and/or quicker than traditional equipment like helicopters or ships? Questions like these were the motivation for the participation of Kent Police, Politie Rotterdam and Havenbedrijf Rotterdam in the 3i Project Consortium.

General project objectives

The general objective of the project is to create development capacity by bringing together parties with an interest in the use of RPAS in the maritime environment (ports and coastal environments). The primary concern here is with potential applications of RPAS with the capacity to create a safer environment. Universities in France, England and the Netherlands are bringing their expertise to bear on the research problems raised by the project. SMEs are developing new products and services to meet the requirements of the end users. Read on to find out how this all comes together.

Specific project objectives

The 3i Project is concerned with the use of RPAS above coastal areas and ports, with the aim of improving maritime safety. The central specific objectives of the project are:

- research into and development of potential applications for remotely piloted aircraft, including search and rescue operations, border control and environmental monitoring;
- research and (continuing) development of technology for use with unmanned aircraft, for example flight controls, data communication and the man/machine interface;
- the demonstration of the operational capabilities of RPAS by means of computer simulations;
- the sharing of knowledge and expertise and the development of innovations and new technology;
- the development and production of a joint prototype;
- testing of existing and new technologies on the prototype;
- demonstration of the operational capabilities of the RPAS in preselected scenarios by means of real life flights with the project aircraft and equipment;
- evaluation of these demonstrations with recommendations for follow-up research;
- the sharing of the outcomes with the 2 Seas countries and the EC RPAS working groups.

Knowledge and experience

The knowledge and experience accumulated during the project will cover operational requirements and possibilities, costs, limitations and the quality of the end result (the camera images). Knowledge of the usability of the end result to replace or support existing information gathering techniques and of the potential for selling this type of information provision or setting it up as a shared service.

An understanding has also been gained of the various roles, responsibilities and liabilities related to the use of RPAS, but also about barriers and bottlenecks, for example the lack of harmonisation of the legislation in the different European countries and the implications of this for the timescale within which unmanned flight could become a realistic option. Efforts have been made to expand our understanding about the usability of RPAS in the circumstances encountered in ports and their approach areas and about such practical matters as take-off and landing, refuelling, the legal and other restrictions and the risks.

The goal of the project partners in publishing this document is to share the knowledge acquired. We wish to thank all the project partners for their contributions, their effort and their enthusiasm.

Politie Rotterdam	Paul de Kruijf
Havenbedrijf Rotterdam N.V.	Ingrid Römers

3i 2seas project

3i is an acronym for Integrated Coastal Zone Management via Increased Situational Awareness through Innovations on Unmanned Aircraft Systems. The project has been made possible by a financial contribution from the European Union's INTERREG IV A 2 Seas programme.

INTERREG IVA 2 Seas

The INTERREG IV A 2 Seas Programme falls within the objective "European Territorial Cooperation" set out in the Cohesion Policy for the period 2007-2013. It is a cross-border collaborative programme co-financed by the European Fund for Regional Development (EFRD). The Programme supports cross-border collaborative projects involving organisations in England, France, Flanders and the Netherlands and dealing with a number of themes including economic development, the environment and quality of life.

Project participants:

<u>The Netherlands:</u> Technische Universiteit Delft, ROC West-Brabant/Aircraft Maintenance & Training School, Digital & Media Solutions BV, Politie Rotterdam Rijnmond, Havenbedrijf Rotterdam, NV REWIN West-Brabant.
<u>France:</u> ENSTA Bretagne, Technopôle Brest-Iroise, Deev Interaction S.A.S., Institut Telecom/Télécom Bretagne.
<u>United Kingdom:</u> Kent Police, University of Southampton.

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Integrated Coastal Zone Management via Increased Situational Awareness through Innovations on Unmanned Aircraft Systems

Scenarios as the basis for technical specifications

The radius of action and airworthiness (safety) of RPAS are significant factors affecting their use, together with the quality of the sensor (camera) and the data connection. The potential end users Havenbedrijf Rotterdam and Politie Rotterdam together with Kent Police have developed a number of user scenarios with the aim of establishing the requirements which will need to be met by the aircraft, the sensor and the data connection. These scenarios provided the starting point for the technical specialists involved in the project.

It's not so much about flight, but more about what you can do with it. A brainstorming session involving the police and the harbour authorities threw up a substantial number of potential applications. Four of these operational scenarios were then selected as the starting position for the 3i project. Havenbedrijf Rotterdam Policy Staff member Reinout Gunst: "Could we use unmanned aircraft for situation monitoring and in responding to incidents? And could RPAS improve our response to incidents and increase efficiency?" Politie Rotterdam Innovation Broker Paul de Kruijf: "Police forces have similar questions in relation to our monitoring, detection and enforcement activities."

A supplement

The use of RPAS is considered for the time being as a supplement to existing resources. The police and the harbour authorities would be primary users of this technology, as a sensor which could be sent quickly to a specific location to carry out targeted observations, to direct the emergency services from the air, or as a patrol vehicle (or more accurately, as an extension of the visual range of patrol vehicles). There are consequences for the way the camera images are created and used. "Real time" images are not required for the inspection of infrastructure for example, however it would be important to identify the precise location where the image was taken. De Kruijf: "Real time images can be very useful to the police, and we have therefore provided a lot of input relating to the technical specifications for the camera." Face recognition from the air would be great, but it isn't a possibility with the cameras we have today. They do however have the capacity to identify a vehicle's colour, shape and type or a person's clothing. Image resolution is a significant factor here. De Kruijf again: "Good real time image resolution needs sufficient bandwidth in the data connection. We need to know how much is enough, what do you need as a minimum." Gunst adds: "The control and positioning of the camera is also important, for example the ability to quickly zoom in and out. And we can also use different sensors, infrared cameras for example, or odour detectors."[1]

Business case

It is possible that the use of RPAS may result in cost savings. For example the images collected might indicate that it isn't necessary to send out an expensive rescue vessel, there might also be savings from increased efficiency in the use of manpower and resources, or from the avoidance of risk. Gunst: "In essence the end user needs clarity about whether the use of an RPAS will bring benefits without excessive additional costs, and whether it might indeed be a cheaper option." De Kruijf: "During the summer it is necessary to deploy police manpower on our beaches. Monitoring with RPAS could reduce that burden. It might however lead to an increase in operational costs, because the more you look, the more you find."[2]

Test flights

A number of test flights based on four selected scenarios were proposed with the aim of investigating whether the use of RPAS would meet expectations. The test flights also had an important role in demonstrating the safety and operational reliability of the 2SEAS20 system. The stringent legislation currently in place in the Netherlands meant however that it was not possible to obtain the necessary

1 You can find more information about the sensors and their operation in the relevant articles.

2 You can find more information about the business case in the relevant permissions within the period of the project. Looking back, De Kruijf sees it as something of a Catch-22 situation: "You need to carry out testing to demonstrate safety and added value, but we were not given this opportunity. A missed chance I think." It's worth pointing out that all the flight systems are carried out redundantly to ensure safety. So for example if one motor fails there is another available so that the flight can be completed safely.

International collaboration

Both interviewees had positive things to say about international collaboration during the project. De Kruijf: "There was really quite a lot of work involved in this. But it was not my primary role, and I had to fit it in as and when I could. On your own you wouldn't always have time to respond or make adjustments." Gunst: "The great advantage of international collaboration was that each of the universities involved could make contributions drawing on their own particular research interests. A good collaborative atmosphere was also created among the group of end users, putting down a sound foundation for the possible future joint deployment of RPAS."

The 2SEAS20 has a cruising speed of 100 kph and a top speed of 150 kph or around 95 mph.

With a full tank of fuel the aircraft can remain in the air for as much as three and a half hours.

Unlike many other RPAS the 2SEAS20 has a petrol engine rather than the electric motor found on many other unmanned aircraft. Electric motors are battery powered, but the capacity of the batteries used for unmanned flight is still pretty limited.

User scenarios

Three scenarios were developed at the outset of the 3i project to serve as the basis for:

- the technical specifications for the aircraft, the control systems, the payload (sensors) and the power unit;
- an application to the relevant authorities for a waiver allowing flights over a specified location, at a specified height and for a specified time;
- research into the potential legal implications of the demonstration flights;
- gaining an understanding of the capacity and resources required to carry out the demonstration flights.

Scenario 1:

Seaside recreation

People visit the dunes and beaches for recreation throughout the year. The nearest police station will monitor the situation, carrying out surveillance on horseback as well as from cars. Unusual occurrences and incidents will be reported to the local station, and there will then be an interval before officers can attend the scene. There is often a lack of clarity about the urgency of the situation, and it can happen that the situation is already resolved before anyone arrives. In these circumstances a rapid observation from the sky can be of great assistance.
Three different situations were developed for this demonstration: a kite surfer in difficulties, an incident in the dune area and a fight breaking out on the beach.

Scenario 2:

Places of interest

Dit scenario kent twee subscenario's:

This scenario was made up of two sub-scenarios:

Anchorages

The aim of this scenario was to demonstrate the detection of illegal activities, like the illegal dumping of waste materials. The RPAS would take images of the location and send these in real time to the land-based monitoring post.

Inspection flight

An inspection flight passing over five previously identified points of interest. Illegal activities were said to be taking place at one of these locations. The RPAS would take images of the location and send these in real time to the land-based monitoring post. High quality images would be required to allow the identification of the vessels involved.

Scenario 3:

Protestors board a ship

A group of activists board a ship at anchor. The authorities need information about the number and location of the activists on board. It is not possible to establish this from the water. The use of the RPAS makes overhead images available.

Note: *the stringent legislation in place made live testing of these scenarios impossible during the period of the project. Nevertheless the requirements derived from these scenarios were used as the basis for the technical requirements set down for the project, for example: a flight duration of three hours, the ability to fly a previously determined route and the ability to deliver high quality images. Although it was not possible to determine during this project whether the use of RPAS would indeed deliver added value, a number of test flights were carried out in England in order to establish the design quality and resilience of the aircraft, and the camera was exhaustively tested in a land-based simulation.*

Unmanned aircraft: a new eye in the sky above the port

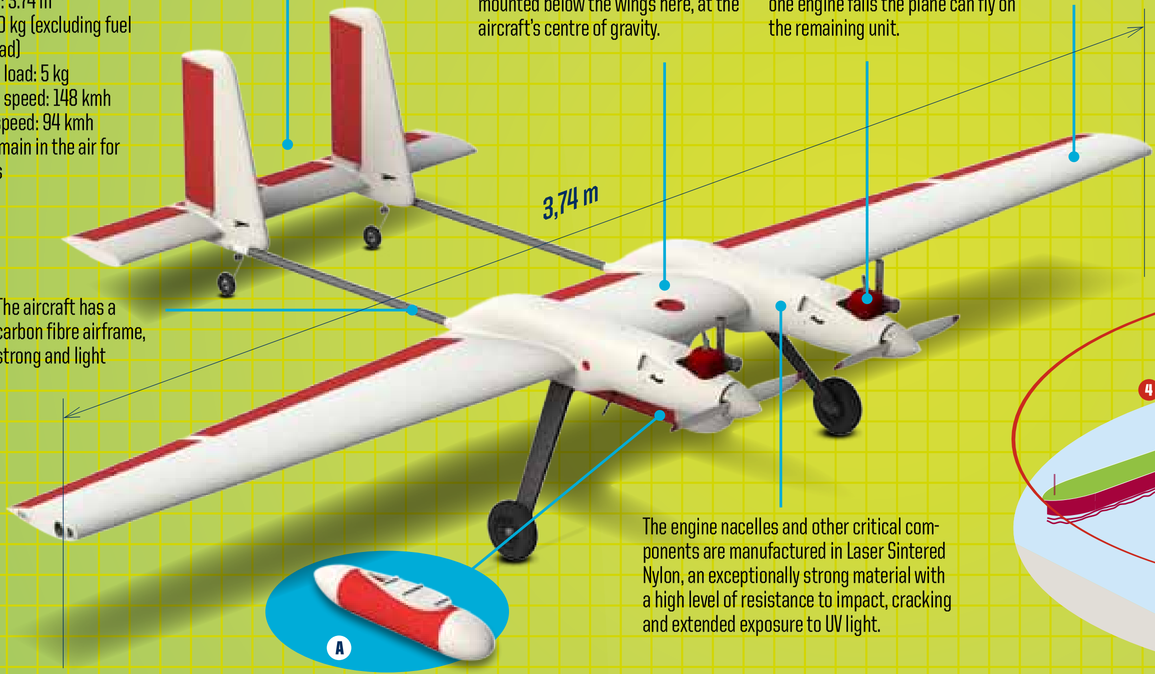
*The best view is often from above. The **2seas20** is an unmanned aircraft, specifically developed for tasks in and around the port, including rescues and inspections of infrastructure. So how does this self-piloting technical marvel work?*

- Type: unmanned, twin-engine aircraft with automatic pilot
- Wingspan: 3.74 m
- Weight: 20 kg (excluding fuel and payload)
- Maximum load: 5 kg
- Maximum speed: 148 kmh
- Cruising speed: 94 kmh
- Able to remain in the air for 2.75 hours

The central portion of the wings holds 5 litres of fuel. (A) camera can be mounted below the wings here, at the aircraft's centre of gravity.

Twin two-stroke petrol engines (28cc, max. 8000 rpm, 3.35 hp). If one engine fails the plane can fly on the remaining unit.

The wings are in polystyrene clad with fibreglass.

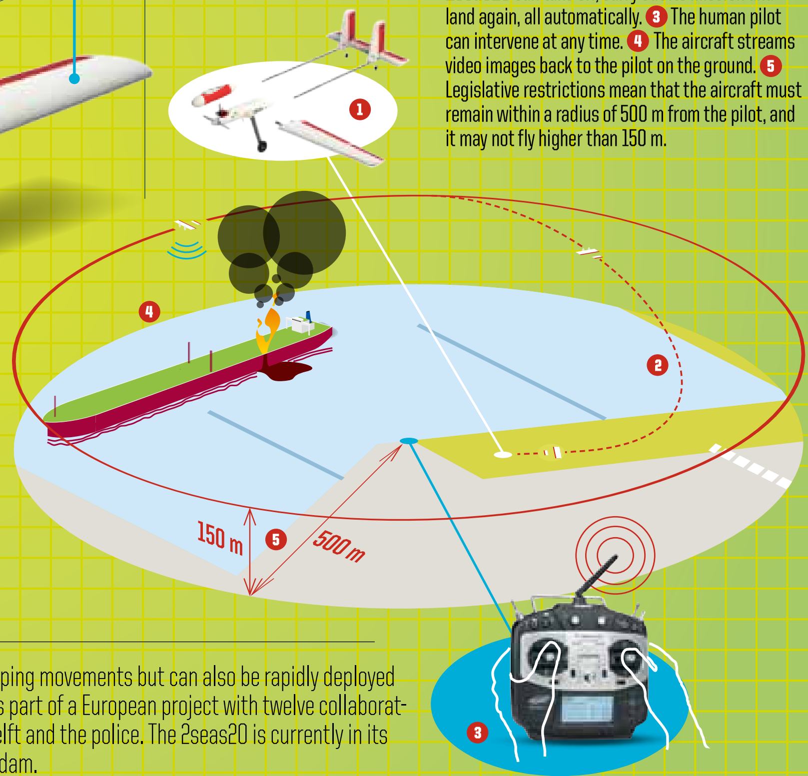


The aircraft has a carbon fibre airframe, strong and light

The engine nacelles and other critical components are manufactured in Laser Sintered Nylon, an exceptionally strong material with a high level of resistance to impact, cracking and extended exposure to UV light.

THE 2SEAS20 IN ACTION

(1) The dismantled aircraft is taken to the launch location by the ground station vehicle. (2) The **2seas20** can take off, carry out its mission and land again, all automatically. (3) The human pilot can intervene at any time. (4) The aircraft streams video images back to the pilot on the ground. (5) Legislative restrictions mean that the aircraft must remain within a radius of 500 m from the pilot, and it may not fly higher than 150 m.



The **2seas20** has been developed with the aim of improving **maritime safety**. It is able to monitor shipping movements but can also be rapidly deployed in the event of emergencies to gain information on the extent of the problem from the air. The 2seas20 is part of a European project with twelve collaborating partners. The Dutch participants include Rotterdam Harbour Authority, the Technical University at Delft and the police. The 2seas20 is currently in its test phase. It is not yet known when the aircraft will be operational in the skies above the port of Rotterdam.

infographic: Jan Peter Hemminga

Design and manufacture using 3D printing technology

The 2SEAS20 aircraft was mainly built on a 3D printer. This not only had advantages during design and manufacture, it also made it easier to implement modifications later. This advanced manufacturing technique also makes the assembly and stripping down of the aircraft quick and easy. Further research into this production technique will however be required.

RPAS designer Mario Ferraro of the Computational Engineering and Design research group at the University van Southampton has extensive experience in the design and building of RPAS. He was involved in the design of the first 3D printed RPAS aircraft in 2011. In the 3i project he was responsible for the design and fabrication of the aircraft.

Redundant design

Ferraro holds an MS in Aerospace and Astronautics Engineering. In his view his university was an obvious choice to take part in the 3i project. "We're very active in the field of RPAS and we are world leaders in the 3D printing (more formally "additive manufacturing") of airframes." The airframe is one of the crucial components of an RPAS says the designer. "It has to be capable of carrying the sensors, it needs to stay in the air for relatively long periods and it has to be extremely reliable." There's a difficulty here which doesn't affect ordinary aircraft, due to the lack of demonstrably reliable components. It was therefore decided that the principle of redundancy should be adopted for all the crucial flight systems in the 3i aircraft, the 2SEAS20.

Exceptional

The test model is therefore equipped with two motors, two generators connected to the motors and a second autopilot. The same "doubling-up" philosophy was also applied to the airframe, while the wings feature four ailerons. So if one of these fails there will still be adequate control to get the aircraft safely back on the ground. Ferraro: "Doubling up everything like this is pretty exceptional; you generally want to keep the weight and the costs as low as possible." The effectiveness of this approach was clearly demonstrated during the test phase when an engine failed. "A plug connection separated, but with the other engine to fall back on this didn't present a problem."

Straightforward

One advantage of the 3D printing technique is that improvements to the design can continue to be implemented without incurring excessive costs, and this method of manufacture also means that the machine can easily be taken apart, transported and reassembled. The capacity of the fuel tank was increased to allow longer missions to be flown. The 3D printing method means that it is relatively straightforward to implement these and other modifications.

Rapid adaptations

The use of the 3D printing technique offers particular advantages to designers and manufacturers, but end users also benefit because any modifications to the equipment can be carried out in a matter of a few weeks. There are also advantages where repair and maintenance are concerned as a defective component can be replaced with an improved, more robust alternative.

Further research required

While 3D printing offers all these advantages it also throws up questions, for example about replicability: is a new printed component of similar strength, or is it stronger? And how can this be demonstrated? What about the quality of the powder used? What is the residual strength of the material after (for example) one hundred hours of flight? These are topics that demand further research.

The aircraft can be assembled in as little as five minutes, but Ferraro urges caution: "This isn't something you should rush. But the aircraft can be operational within 15 to 20 minutes, including the pre-flight check."

Stable, high-quality camera images

The camera system is crucial in obtaining accurate information. Are we interested in capturing rapid movements, or in object recognition? And what level of detail is required? Do the images need to be high quality, or is that unnecessary?

There are a number of initial basic requirements for the camera system. The camera must be as light as possible (a maximal 5 kg payload below the aircraft) while still delivering high quality results. The dimensions are critical: the camera must be able to fit in the gimbal mounted on the aircraft. Energy consumption must not be excessive and the camera must come in within budget.

Basic principles

The scenarios developed at the start of the project (see page 6) provide the starting point for the technical specifications for the camera system. Tommaso Mannucci, a post-graduate researcher at the TU Delft has investigated which camera system will be most suitable. According to Mannucci the objective is for the end user to be able to view a situation and see what is taking place. "If there's a disturbance for example you want to be able to see how many people are involved, the colour of their clothing and similar details. If people are running off in different directions you need to be able to zoom out instantly while retaining image quality."

Zooming in and out without loss of quality imposes demands on the camera.

Mannucci refers to this as "filter view": the facility to image a specific part of the observed area. This demands a good optical zoom function capable of enlarging the filter view up to ten times without deterioration in quality. Mannucci: "You need to be able to zoom in on a specific point, but also to zoom out to monitor a larger area. Both without loss of quality. This is done by increasing or decreasing the focal length." A sensor within the camera corrects for the motion of the aircraft, so the camera is always stable and will make its images from the correct position. A GPS connection is used to ensure that the position on the map is known with precision. Face recognition using a camera continues to be problematical and is at the limits of what is technically feasible at this time. The availability of infrared imaging is an obvious requirement when flying at night.

Testing

A number of tests were carried out with three different cameras in order to establish what level of detail was visible with each camera. The quality of one of the cameras tested left something to be desired, and this type also had fewer control options. The other two delivered the desired quality at around the same price. The eventual choice was for an Australian camera weighing 700 grams, together with a gimbal to suspend it from the aircraft and a range of additional components such as a recorder and converters to allow switching between HD and analogue signals.

Camera controls

Two camera control systems have been developed. In one system a line is drawn on an interactive map on a touch screen in the ground station. The RPAS will then fly a linear route and the camera will follow that line. The other method involves steering the camera manually using a joypad. This allows free operation of the controls, for example zooming in and out. It is possible to fly using one of three configurations: in a line from point A to point B, in a circle around a point of interest, or following a preprogrammed surveillance route. Control of the camera and of the aircraft itself are separate tasks.

Data connections for controls, camera operation and safety pilot

The quality of the data connection between the aircraft and the ground station is crucial both for control purposes and to allow reception of the correct images with the optimal quality. The 2SEAS20 can continue to provide good images in real time up to a distance of ten kilometres.

The mobile ground station and the aircraft are in continuous communication. One modem is built into the ground station housing for this purpose, with another in a pod beneath the aircraft. The ground station has a mast with two antennas. One connection is used to control the automatic pilot. The ground station transmits data to the aircraft and receives feedback about its position, height and speed. The second data link is used to control the camera. There is also a radio link between the aircraft and the additional pilot on the ground. This “safety pilot” can take over the controls if necessary and control the aircraft manually.

Image quality

The aircraft transmits real time images to the ground station. This streaming data is not of HD quality as that would make the data files excessively large. The images produced are therefore first stored on board at HD quality. The quality of the streaming data also depends on the distance between the aircraft and the ground station and the weather conditions. The frame rate at which the images are received also plays a role. Extensive testing was carried out to determine what frame rate within a specified bandwidth would be acceptable to the end user. The tests revealed that the preference of the end users was for a frame rate of twenty frames per second. Although this delivers a relatively low image quality it was nevertheless good enough for the end users.

Distance

Depending on the weather conditions the data connection is still capable of transmitting good quality images at a distance of ten kilometres. This was successfully tested using motor vehicles on the beach. The aircraft is capable of flying beyond that distance, but in that case the images taken would be stored and then transmitted once it was back within the range of the ground station. The cameraman can read out the images once the aircraft has landed.

Over Ramsgate

The camera was also tested in the air above Ramsgate, an English port comparable with Rotterdam, with many objects manufactured in steel such as cranes, shipping containers, ships and freight vehicles. This large amount of metalwork did not lead to problems with the control or camera signals. The camera can anticipate the motions of the aircraft, keeping it focused on the desired point. TU Delft developed the algorithms used to achieve this. The aircraft is equipped with GPS, an accelerometer, a rotation meter, a barometer and a magnetometer. The information collected is brought together in the equipment and the system then picks out the information required to fix the correct position.

Operating the mobile ground station is as easy as playing Angry Birds

A pilot on the ground controls a remotely piloted aircraft. This is already possible using a relatively simple handset, but this was not satisfactory for the end users in the 3i project. A mobile ground station was developed, based on the user scenarios. The pilot, the cameraman and three or four personnel from the " operational agency" (the police, the harbour authority or the fire brigade) work together in the ground station.

There are individual workstations for these different roles in the mobile ground station, a customised van built on the chassis of a VW Crafter. The layout of the ground station is designed to promote collaboration between the pilot, the cameraman and the end user or client. The operators each have their own screen and keyboard and operate independently.

Fully automatic

Instructions from the user about the flight path and the use of the camera will be sent fully automatically to the autopilot system. The pilot monitors operations to see that everything is proceeding correctly and in the interests of safety does not get involved with the content of the mission. The pilot takes ultimate responsibility for the flight as required by law. There is also the legally mandatory reserve pilot outside the ground station with a hand transmitter, on stand-by in case the ground station should develop a fault. The cameraman controls the camera from his workstation using a computer. The camera will then focus automatically on the designated location. The cameraman can also switch on the recording function.

Switching

The loss of the connection is not something that is expected to happen often according to Engineer Marcel Mattheijer of Oud-Gastel-based D&MS. This project partner is a specialist in the construction of video and direction vehicles, primarily used by broadcasting companies. This expertise proved invaluable in the outfitting of the 3i ground station. The desired functionalities were determined by means of the user scenarios. The equipment was provided by TU Delft while the software was developed by French partners Deev Interaction S.A.S. and Télécom Bretagne. "Our knowledge and experience were critical when it came to the layout of the vehicle, ergonomics, location of the screens, the folding tables and the facility to reverse the co-driver's seat," says Mattheijer. Each user can log in to a different computer from any screen, a concept borrowed from the world of TV. "So if the sunlight is shining on the pilot's screen he can quickly and easily switch to a different monitor."

Angry birds

Ease of use and intuitive operation were guiding principles in the design of the control of the camera and aircraft controls. The starting point was that anyone should be able to control the equipment, without any additional training. Or as Marcel Mattheijer puts it: "It's easier than playing Angry Birds." The user indicates the flight path by drawing a line on an interactive map using a touch screen. The software then passes this on to the pilot. The pilot confirms this and the signal is sent to the aircraft. The interface was subjected to intensive testing in France, using simulations rather than actual flight. "It worked brilliantly," says Mattheijer.

Individual workstations

The pilot and cameraman sit at the front of the vehicle and each has his own workstation. The users sit to the rear at a range of monitors. There's a touch screen for control and two monitors connected to a computer with another two screens above these showing the live images and any replays. The vehicle has a seven metre telescopic mast carrying the antennas for the flight connection and for transmitting real time image data and GPS positioning data. The WiFi connection has a range of 150 kilometres, as long as the aircraft and the ground station can see one another.

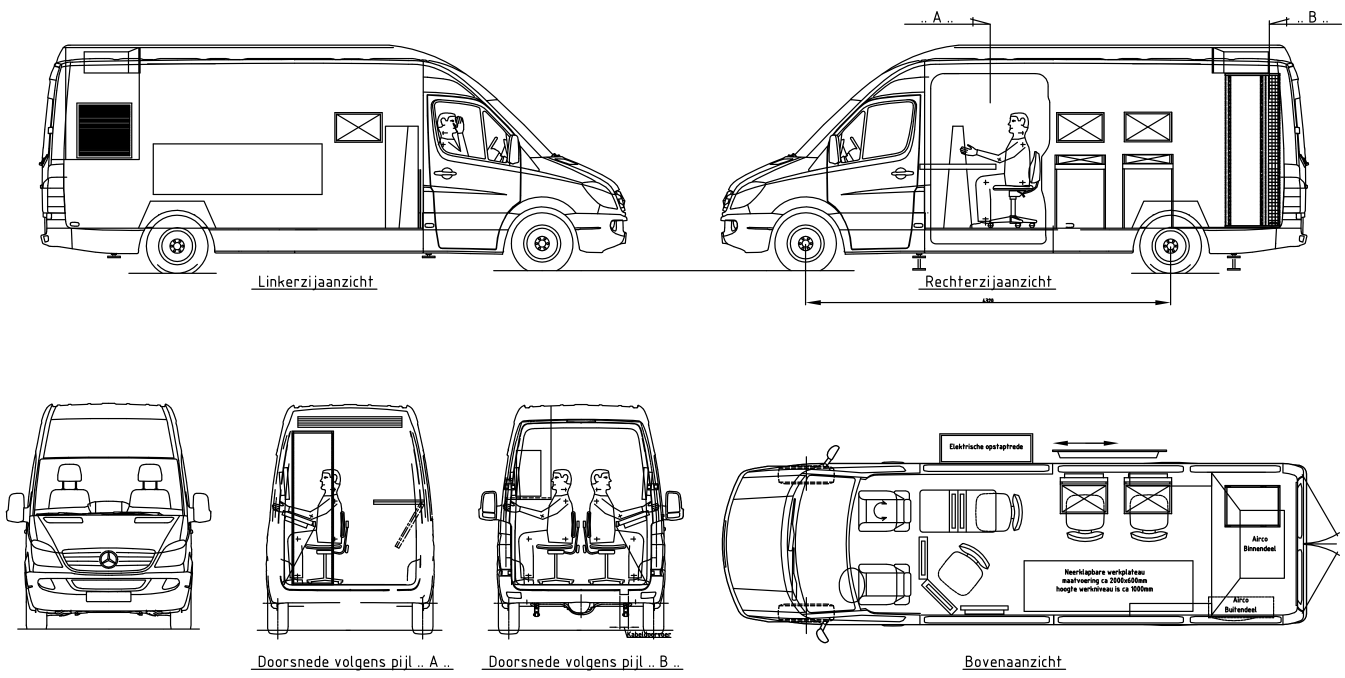
Software

The control software runs on the open source Paparazzi platform. The code for the autopilot and the hardware diagrams are available from the Paparazzi website. The 2SEAS project office were pleased with this says Mattheijer, as sharing knowledge is one of the conditions for the provision of finance.

"The advantage of housing the system in a vehicle is that you are out of the weather," he adds. The van is also used to transport the 2SEAS20, as it is a little too big for the average car. The end users can be located in the ground station vehicle, but this is not essential as they can look on and give instructions via a secure internet connection, so that their operational environment is the same either way.

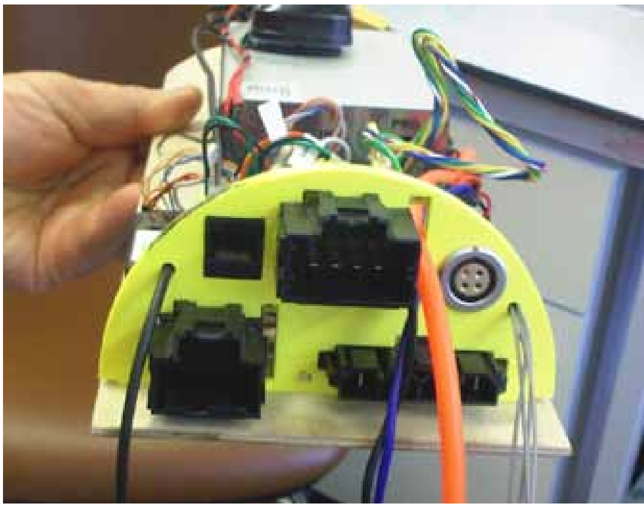
A new market for ground stations

The brief for the construction of the ground station was unusual says Mattheijer. "Normally when we start on the build of a broadcasting vehicle we already know how the final result will look. But that wasn't the case here. There were plenty of changes and additions along the way." Mattheijer was very satisfied with the project and sees new market opportunities for D&MS. "We have built up a lot of valuable experience."



Legislation prevents scenario test flights

In the original plans for the project the intention was that the flights described in the scenarios would actually be carried out. The objective was clear: to test whether the use of RPAS actually delivered in line with expectations. But the stringent waiver-based legislation in the Netherlands meant that the test flights could not be carried out.



Test flights were carried out in England however, involving general testing of the control systems, the automatic pilot, the safety systems (what would happen if the engine failed?) and an endurance test (how long can the aircraft remain in the air?). It was decided on the basis of the test results that all important components should be twinned.

Erik-Jan van Kampen, Assistant Professor in the Faculty of Aerospace Engineering at TU Delft was involved in the test flights, which were carried out at the University of Southampton. He explains how a number of altimeters were used for landings using the automatic pilot: "A GPS system on its own was not accurate enough for this purpose, so we carried out further tests with sonar and a laser ranging system." This revealed that the sonar system does not perform well over soft substrates like meadowland. So that option was off the list. We therefore incorporated the laser ranging system in the test rig. Van Kampen: "We carried out more than thirty automatic take-offs and landings in Ramsgate, a port with similarities to Rotterdam. The tests showed that we could fly safely."

A new waiver application after every modification

Unlike the situation in the Netherlands, universities in England are able to carry out test flights. They fall under the Hobby Regulations, for aircraft up to 20 kg. Dutch universities must apply for a waiver before they can carry out flights, but because the Environment and Transport Inspectorate need to issue a new waiver following any modification to the aircraft, van Kampen says the Dutch system is unworkable for research institutes. "Carrying out modifications so that they can be tested is the essence of our work." The university had a test site at the Woensdrecht air base up to 2012, but permission for that was withdrawn and the effect has been that the university is unable to carry out any further flight tests. Woensdrecht had also been the planned location for the 3i test flights.

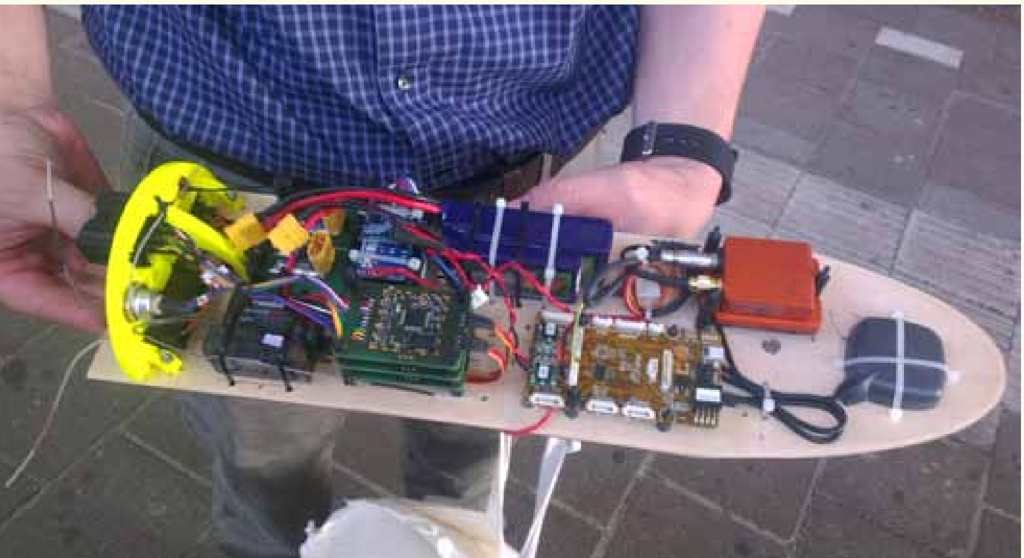
Hear and avoid

TU Delft were keen to take part in the project because of the research work it would facilitate. The university's primary interests are in automatic pilot systems for RPAS and "sense and avoid" systems, which allow the aircraft to avoid not only fixed objects but also other manned and unmanned aircraft. "This will be among the requirements if you want to extend the length of flights to carry out so-called "beyond visual line of sight" flights." Research into workable sense and avoid systems is ongoing. "It looks like "hear and avoid" with a microphone fitted to the aircraft will work better than using a camera," says van Kampen. "It's possible to identify a sound signal much more quickly than a camera image."

Following on from this the university investigated the best way to fly the RPAS to avoid an object. Should you go left, right, over or under the object? And what would you do if you wished to fly five RPAS to a single destination? A research project looking at this was successfully completed by a postgraduate student at the start of this year.

CTR Rotterdam

Because of the proximity of the Rotterdam-The Hague Airport, part of the area above the port is a so-called Controlled Airspace. Flying an RPAS in a controlled airspace is prohibited in any case. Potential solutions might be found in a demonstrably reliable sense and avoid system and by flying only to a specified limited maximal height in the area. According to a spokesperson from the Ministry of Infrastructure and the Environment work is going on to find a solution to this problem. The expectation is that the matter will be resolved before the end of 2015.



Legislation: “Can I fly my RPAS please?”

The Civil Aviation Act means that you may not simply fly as and where you like in the Netherlands, not even with a remotely piloted aircraft of relatively small size.

Flying “beyond visual line of sight” with an RPAS is not permitted. “In technical terms it is certainly possible, but the technique has not yet been adequately demonstrated in accordance with the aviation standards,” says Rob van Nieuwland, Chair of Darpas, the Dutch Association for Remotely Piloted Aircraft Systems. “This is a recurrent problem in the development of appropriate legislation on RPAS.”

Hobby or business?

Someone who acquires an RPAS as a private individual and only flies it as a hobby will fall under the “Model Flight” regulations. But where the use of the aircraft is commercial, as part of a job or profession and/or for payment, then a waiver is required from the Environment and Transport Inspectorate (the Dutch agency overseeing the enforcement of the aviation legislation, known as IL&T). There is something of a grey area here however, as IL&T regard practice, training and tuning flights as commercial flights, as well as flights used to take photographs or videos for one’s own purposes, including advertising.

What can a hobbyist do?

There are regulations covering hobby and model flying as well as professional use, with the aim of ensuring the safety of third parties and their property, and to prevent any contact with civil and military air traffic. Breaches of the regulations can result in fines of €7,800 for each breach.

A model aircraft may be flown:

- in daylight;
- in the vicinity of civil and military airports, provided appropriate agreements have been made;
- with a continuous good view of the aircraft;
- up to a maximum of 300 metres Above Ground Level (AGL);
- provided the aircraft does not fly over continuously built-up areas;
- but not above roads, railway lines, waterways, ports or large structures (bridges and the like), with the exception of 30 and 60 km roads.

Commercial flights: RPAS waivers

The following conditions must be met in order for a business to obtain an RPAS waiver:

1. A theoretical basic training course must be taken with a recognised training company, including theoretical exams;
2. Flight training with examinations must be taken with a recognised training company familiar with the type of RPAS the candidate intends to fly;
3. An approved Operations Manual must be available;
4. A Safety Management System (SMS) must be in place;
5. Air traffic insurance must be arranged, covering both the machine and third party liabilities;
6. The aircraft must be approved;
7. A final test must be carried out by an approved agency, with practical testing of the business/pilot/aircraft triangle against the requirements for the procedures described in the Operations Manual, including emergency procedures.

Once these five conditions have been met and the technical information on the aircraft are known to the government agencies, then a project waiver for specifically described projects may be applied for. The aim is partly to assess how the applicant deals with all these issues, which may play a role in the granting of a Commercial Waiver.

Waiver for the carrying out of a flight by an organisation with an RPAS waiver

Once the organisation has received a project waiver or a commercial waiver from IL&T, every flight with the RPAS must meet the following conditions:

- A Temporary and Exceptional Use (TUG) permit from the Provincial authorities is required for each flight. This is because an aircraft may not take off or land outside an air traffic site without permission. Some provinces do not require this.
- The permission of the owner of the land where the aircraft will take off and land must be obtained.
- A Notice to Airmen (NOTAM) must be submitted via the Airspace Manager five days prior to the flight.
- A notification must be made to the Mayor of the Local Authority where the flight will take place, as well as to IL&T, one day prior to the flight.

This is to relate to the specific combination of responsible organisation (the applicant’s organisation or one hired in) the specific aircraft (serial number etc.) and the named pilot. Where an aircraft has no type recognition (meaning that it has not been designed by a DOA certified organisation and has not been built by a POA certified organisation), then aircraft of the same type but with a different serial number must have been submitted separately for approval.

What can I then do, as an organisation with an RPAS waiver?

Flights are placed into two classes.

Flights in class 1 must:

- Fly in daylight;
- Fly with a continuous good view of the aircraft;
- Not fly further than 500 metres from the pilot/observer;
- Fly up to a maximum of 120 metres AGL;
- Not fly in civil controlled airspace (CCA) on air safety grounds (in a radius of 15 km around the airfield), or in prohibited areas (EHP), temporary or permanent reserved areas (TSA and EHR) or hazardous areas (EHD) (see VFR Air Traffic Map);
- Not fly in Natura-2000 and Ecological Main Structure (EHS) areas. These areas are excluded from the TUG application because of the prohibition on disturbing nature. See http://www.synbiosys.alterra.nl/natura2000;
- Not fly above gatherings of persons, structures, occupied buildings, vessels or vehicles;
- Only fly within a military low flying area or below or within a distance of 3 nautical miles of a low flying route with the permission of the Defence Ministry;
- Not fly within 150 metres of gatherings of persons, structures, buildings, vessels or vehicles which are not under the control of the operator (where "under the control" means that the object is the property of the client and all persons have had a safety briefing and/or will remain in the buildings). Limit the risk to third parties to a minimum. It is not sufficient simply to put a notification in the post. (Note: flying within 150 metres of gatherings of persons is always prohibited. The separation distance to a road with a constant flow of traffic is also 150 metres. This distance may be reduced in the case of roads with sporadic traffic, provided the distance to the vehicles is a minimum of 150 metres.)

Flights in class 2 are:

- Above built-up areas;
- Higher than 120 m AGL and/or further than 500 metres from the pilot;
- At night, or for example without a continuous view of the aircraft.

Additional requirements apply to the aircraft, the organisation and the pilot before such flights are allowed. Full certification (ICAO requirements) is needed for the aircraft. The aircraft must have been built and maintained in line with the full requirements for air traffic. (DOA/POA – Design/Production Organisation Approval and MOA – Maintenance Organisation Approval).
In very rare cases where there is "great societal interest in combination with acceptable risk" permission may be obtained for a class 2 flight following assessment by IL&T.

An end user of RPAS services who wishes to fly an aircraft of his own must also meet the above-mentioned requirements.

Set up your own RPAS flying organisation?

Where an organisation decides to carry out the services on its own behalf, the implications are as follows:
The organisation must set up its own RPAS flight department, which will be responsible for:

- Acquisition and ownership of the RPAS;
- Appointment of one or more "pilots in command" and observers. Both of these may be hired in, but the associated procedure must be properly described in the Operational Manual;
- Ensuring that the pilots have adequate flying experience with the selected type of RPAS (Practical Training);
- Ensuring that the pilots (whether internal or external) have successfully completed a minimal theoretical training course, with an examination;
- The drafting of an individual Operational Manual, setting out all the procedures and the organisation involved with flying; this manual must be approved by the Environment and Transport Inspectorate;
- A (Light) Safety Management System must be introduced;
- Air Traffic Insurance must be arranged;
- A waiver of the airworthiness requirements for each aircraft must be obtained, by means of an inspection by a competent authority;
- A final test by a competent authority must be successfully completed (with a positive recommendation), with a practical demonstration of the matters set out in the Operational Manual using the organisation's own aircraft and the appointed pilots.

Having obtained the Commercial Waiver (permission for this organisation to fly, with the registered aircraft and the specifically appointed pilots) the organisation may start on preparations for the flights (see the section on "Waiver for the Carrying Out of a Flight…"), and carry this out, but only with the nominated pilots and observers.
Where there are changes affecting the "triangle", for example a different aircraft or pilot, then the relevant element of the waiver procedure must be repeated.

Aerial photographs and videos are allowed

As of 01-06-2013 an Aerial Photography Permit is no longer required when taking aerial photographs and videos. Some service providers do however continue to erroneously request permission from the Defence Ministry to take aerial photographs. They also erroneously imply that by doing so they also have permission to fly. A waiver certificate should therefore always be requested from IL&T if you wish to do business with an external business in the area of unmanned flight. If you get involved with a business which does not hold a waiver then as the client you run the risk of giving an order for an illegal flight to be carried out.

There are restrictions as a result of the privacy legislation. You should film or photograph only where you can normally gain access and take photographs using an ordinary camera, so not in gardens or above enclosed commercial or private premises. ALWAYS ask for the owner's permission first!

This text has been created with the assistance of the sectoral association DARPAS and should be regarded as a snapshot.
You should consult the following websites to find out about the current position:

- www.darpas.nl
- http://www.ilent.nl/onderwerpen/transport/luchtvaart

Aviation Police monitor the illegal commercial use of RPAS

The national police force's Aviation Department are responsible for monitoring the unlawful use of unmanned aircraft. A number of prosecutions have recently been initiated.

The Aviation Police are responsible for enforcement of the laws relating to the use of RPAS, with the objective of preventing illegal commercial use. Patrick Fung from the department points out that the police always bring prosecutions in these cases. "And it's highly likely that the RPAS equipment will be seized." A number of prosecutions have been brought, but the Aviation Police are dependent on reports from colleagues or third parties. "We don't actively trawl the internet for photographs or videos made with RPAS, but when we get a report we always launch an investigation."

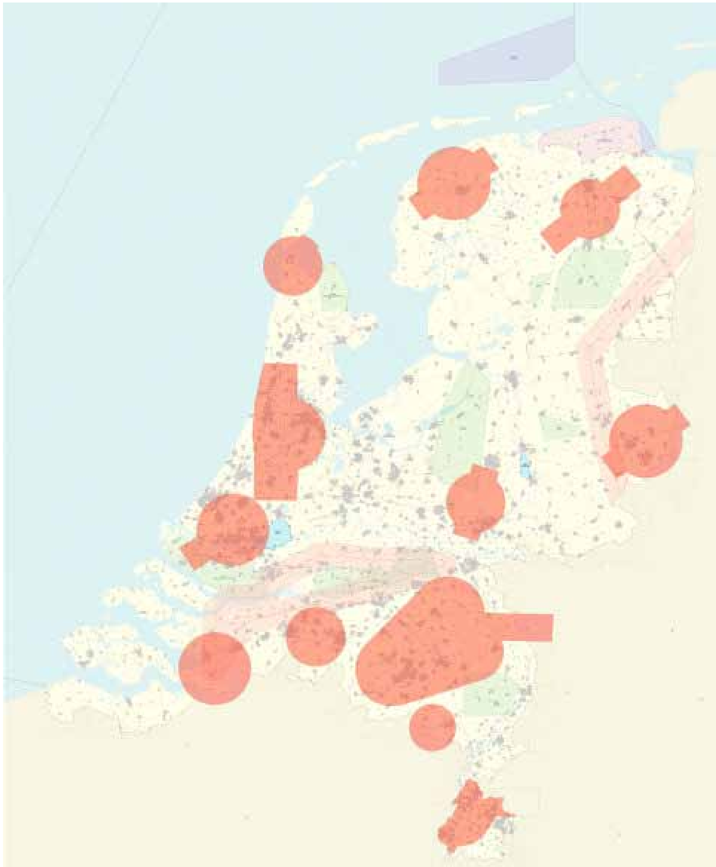
Recreation

In the case of recreational use the police look at the type of breach and the level of risk. "The number of breaches and the level of danger then determine if a prosecution is brought in an individual case," says Fung.

Prevention

"If we hear that someone intends to carry out flights and is likely to commit one or more offences as a result, then the pilot in question will be warned in advance not to fly, for example above an event or a crowd of people. If the pilot goes ahead and flies despite the warning, then he runs the risk of prosecution and the seizure of the aircraft.

The Aviation Police would like to see the vendors of RPAS alerting potential buyers about the legislation, so that they are more aware of the rules. Another point is that citizens experiencing problems from unmanned aircraft don't know how to contact the Aviation Police. The same could be said of some police officers. In both cases Fung attributes this to the relevant unfamiliarity of the phenomenon.



CTR's in The Netherlands

Benefits of international collaboration and variations in RPAS legislation between UK-NL-BE-FR

	Aircraft Mass	Airworthiness Approval?	Registration?	Operating Permission?	Pilot Qualification
UK	20 kg and less	No	No	Yes (Note 1)	Yes (Note 1)BNUC-S™ or equivalent (Note2)
	More than 20 kg, up to and including 150 kg	Yes (Note 3)	Yes (Note 3)	Yes	Yes,BNUC™ or equivalent (Note2)
	More than 150 kg	EASA Permit to Fly or UK Permit to Fly in accordance with 'B conditions' (Note 3)	Yes	Yes	Yes,BNUC™ ,CPL(A)or equivalent (Note2)
FR	25 kg and less recreational use	Yes (Note 3)	Yes (Note 3)	Yes	Yes, theoretical part of PPL, ULV of glider pilot license.
	Above 25 kg recreational use	Yes (Note 3)	Yes (Note 3)	Yes	Yes, theoretical part of PPL, ULV of glider pilot license.
	25 kg and less aerial work	Yes (Note 3)	Yes (Note 3)	Yes	Yes, theoretical part of PPL, ULV of glider pilot license.
	2kg and less aerial work	Yes (Note 3)	Yes (Note 3)	Yes	Yes, theoretical part of PPL, ULV of glider pilot license.
	<25 kg and 2><4kg not aerial work	Yes (Note 3)	Yes (Note 3)	Yes	Yes, theoretical part of PPL, ULV of glider pilot license.
	Less than 150 kg bvlos science	Yes (Note 3)	Yes (Note 3)	Yes	Yes, theoretical part of PPL, ULV of glider pilot license.
	more than 150 kg bvlos science	EASA Permit to Fly or FR Permit to Fly in accordance with 'B conditions' (Note 3)	Yes	Yes	Yes, theoretical part of PPL, ULV of glider pilot license.
NL	Less than 150 kg	Yes (Note 3)	Yes	Yes	Yes,BNUC™ NLR or equivalent (Note2)
	More than 150 kg	EASA Permit to Fly or NLD Permit to Fly in accordance with 'B conditions' (Note 3)	Yes	Yes	?
BE	Less than 150 kg (Note 4)	?	?	Yes	?
	More than 150 kg	EASA Permit to Fly	Yes	Yes	?

Notes:

1) Applicable from 1 January 2010 for aircraft used for Aerial Work purposes or if flown within a congested area and/or close to people or property.
2) Equivalent pilot experience will be considered on a case-by-case basis during application for an operating permit.
3) It may be possible to obtain certain exemptions from the airworthiness and registration requirements.
4) In Belgium only a permit for test, education, demonstration, research and governmental RPAS flights exists. The Belgian legislation for RPAS less than 150 kg is still in development.

Remarks.

1 ASA has published a roadmap for preparing and implementing RPAS rules for RPAS < 150 kg.
2 Several European countries have implemented their own rules. Some rules are common to all, others differ significantly.
3 JARUS is also working on common European rules.
4 It is possible that the information above was outdated at the presentation on 6 November. Several countries are working on new rules (Eg UK and BE) or are engaged in an internet-based consultation (NLD).

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Drafted for Interreg cluster BERISUAS (better response and improved safety through RPAS)

Simulation model helps pin down the costs of RPAS

What are the real costs of RPAS? Does it make operations more economical, or could it even be more expensive than the traditional methods? Does it provide more or better information, or information you can't obtain elsewhere? How valuable is that? And what other aspects of the use of RPAS must be taken into account?

As a Ph D student at the University of Southampton's Institute for Complex Systems Simulation Benjamin Schumann carried out research into the use of operational simulations for aviation applications. His research problem was "can simulations contribute to an improved design for an aircraft?" In his investigation Schumann focussed on three different RPAS designs, one of which was the 2SEAS20. He used the 3i scenarios (see page 5+6) as his starting point. The simulation model was supplemented with operational data of various kinds: fuel consumption, airspeed, the number of take-offs and landings, the number of times the aircraft was refuelled and its failure rate. "We calculated all this out in the simulation model," says Schumann.

Remarkable results

This initially threw up a remarkable finding, namely that aircraft were lost at a rate of nearly one a week! "But this wasn't such a bad thing," says Schumann, "after all the aim of the study was to improve the design of the aircraft." The researcher discovered that the large number of accidents was primarily attributable to landings. "The landing went wrong too often in the simulation." So the design was changed. Some components were made more robust or doubled up (redundant design) and the fuel tanks were enlarged. The idea here was that increased fuel capacity would reduce the number of take-offs and landings. A new simulation was then carried out, but the number of crashes rose from 45 to 60!

Simulation improves design

Analysis of the data revealed that the number of accidents during flight dropped from 10 a year to 0.6. "This was due to the more robust components," says Schumann. However the number of crashes on landing rose to 60. The cause turned out to be the larger fuel tanks, and the solution was to redesign the entire aircraft and conduct a second design review. There was also a significant change to the definition of the mission. "We had been flying at maximum speed at all times. But was that really necessary? Couldn't we go a little slower?"

It was decided that maximum speed was only required for rescue operations, and that speed was less of an issue for port patrols and monitoring of anchorages. "So we reduced the speed, and the number of accidents dropped off dramatically. This was because it was not necessary to refuel so often, so the number of landings was reduced. Eventually we reached a figure of seventeen losses a year. That is still unacceptable, but it does demonstrate how simulation can help to improve the design."

Costs

In order to get an impression of the costs involved a cost factor was allocated to each element of flight operations with an RPAS. "Fuel consumption, the number of starts and landings, maintenance costs, purchase costs, the cost of producing a photograph and so on. We boiled all this down to a cost price per hour, which was then applied to each scenario. This resulted in total costs of $1.5m per annum." Significant factors here were the high number of (simulated) crashes and the high airspeed, but also the (simulated) daily deployment of eight hours. So a significant proportion of the $1.5m went towards the purchase of new equipment (estimated at $30,000 per aircraft). Other cost components were the operational expenses for maintenance and the deployment of the pilot and his back-up, the cameraman and the staff who analysed the photographs.

Weighing up the added value

"It is important to weigh the added value against the costs of deployment. Take the kite surfer rescue scenario for example. How do we count the cost of saving a life? If someone is in the water too long he will drown. By deploying an RPAS more quickly you may be able to save that life. But how high should the cost of saving one more life rise?" You can't see the deck of a ship from a patrol boat. "With an RPAS you can, but it's difficult to express that benefit in monetary terms." Schumann compared the current deployment of rescue vessels with the same deployment supplemented with RPAS. "The time taken to find a person in the water decreased substantially, but the costs increased. So the benefit is in the saving of more lives. It is very difficult to quantify the benefits in commercial terms. It depends on the value placed on a life."

Benefits

Schumann says that his research shows that the use of RPAS is more expensive than is commonly believed, but it is cheaper than the traditional methods. In the 3i scenarios this involved the use of ships and helicopters. RPAS are used because of the (additional) functionalities they bring with them. “So what is the value of these? Can we get the same images using the traditional helicopter, but at a greater cost? Or does the RPAS collect data which is difficult or impossible to obtain in another way? Think for example of measuring radioactivity with a sensor mounted below the aircraft. Then there are factors like safety and public acceptance to be taken into account.”

Simulation required

In Schumann’s view a simulation of the proposed operation is necessary to get a proper understanding of the business case. The simulation needs to take account of the applicable legislation, the objective of the operation and the number and robustness of the aircraft. Schumann says the simulation model he has developed is ideal for this purpose. “The model is being used by DecisionLab and interested parties can approach them to discuss it.” Schumann himself is now working as Modelling Consultant for the London-based consultancy.

Potential use of RPAS in the port

The Harbour Authority anticipate advantages from the use of RPAS in a number of situations. Five different scenarios are initially being considered. The technical possibilities, the legislation and the business case have not (yet) been considered.

The first scenario involves the acquisition of detailed information or images of a situation as well as on-location checks on vessels in the coastal zone, on the approach area or the anchorages, on illegal activities and on ships involved in incidents. The second relates to searching for, finding and assisting with the sea rescues. A third operational situation where RPAS might deliver added value involves the detection of surface water contamination in the port (identification of those responsible and determination of the extent of the pollution in connection with the control of spillages). The fourth concept is that RPAS might be able to provide the enforcing authorities and emergency services with a better view of major incidents, their effects on the environment and the safety situation for the emergency services. And finally the Harbour Authority see a potential role for RPAS in improving the efficiency and effectiveness of their periodic inspections of port infrastructure.
A number of these scenarios are considered further below.

Anchorages
An accurate aerial survey of the anchorages will show the distances between the moored vessels, whether waste is being put overboard and whether unauthorised or undesirable vessels are approaching. So the use of RPAS can provide an insight into the situation around the approach areas and anchorages, as well as illegal discharges and smuggling.
The results of the 3i project demonstrate that there is potential here. Traces of pollution, the ID of a vessel (IMO number and name) and activities on deck or alongside can all be quickly made visible with an RPAS. Questions remain however, for example: is it possible to follow an RHIB? And how long after the information request can the client expect to see the first pictures on the screen?

Ships in difficulties
Vessels get into difficulties from time to time and need to seek a port of refuge. The Harbourmaster will then want to know if the risks associated with allowing the vessel to enter the harbour are acceptable, or might that lead to a disaster at the mouth of the Maas? An RPAS could for example carry out checks when a ship has lost part of its deck cargo and the remaining cargo is unstable.

An intruder in the harbour
An RPAS could rapidly establish a description and read the vessel's name and number. The intruder could also be kept in the frame until the arrival of a patrol vessel.

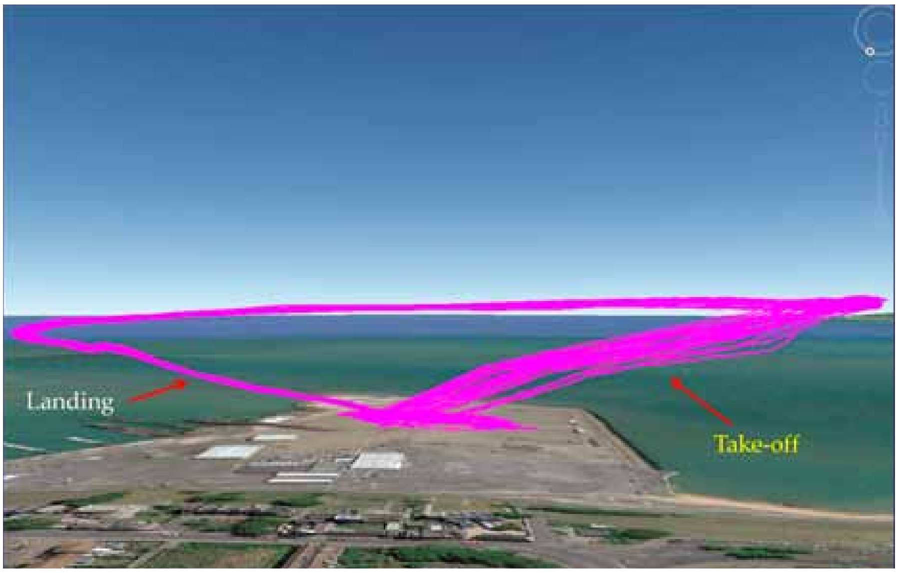
Search & rescue
Another scenario involves a man overboard, whether offshore or within the harbour. RPAS can effectively carry out searches in these circumstances, but there are a number of questions that need to be answered: how large an area can be inspected by an unmanned aircraft at a flying height which will allow the person in distress to be detected? Is it possible to hold the image of the person in the sea steady? How long can this be sustained, and how stable are the images? And here again, how long will it be before the images are available?

Oil spill
Let's suppose there has been a major oil spill: an oil skimmer can only look across the surface of the water, which provides far less information about where the oil is than if we could look from the air. The ability to rapidly deploy an RPAS also increases the chances of identifying the responsible persons and the contamination can be confined at an earlier stage.

Fire
There may be a fire in the harbour or at the quayside, or on board a ship in the port or in the approach area. An RPAS can seek out heat sources or the seat of a fire and provide an initial (visual) analysis.
In the event of a fire the first fireboat will take thirty minutes to reach the scene and the second will arrive after 45 minutes. But a fireboat can only view the scene from an upwind direction, and does not provide a view of what is happening on deck. An aircraft can get around these limitations and provide a far earlier indication of the situation, so improving the efforts at fighting the fire. If the RPAS is equipped with the correct sensors it could also establish whether hazardous substances are being released.

Places of interest; inspections of infrastructure

Apart from the inspection of anchorages the operations described above involve unplanned activities. An example of a planned operation is the inspection of infrastructure, such as quays, landing stages and slipways. One interesting question here is whether a series of photographs could be taken from the same location over a period of time, allowing successive images to be compared?



What existing applications are there for RPAS?

There's a lot going on already with remotely piloted aircraft. Football club AZ Alkmaar used an RPAS to identify the running patterns of players during training sessions. In April this year two men attempted to deliver tobacco, alcohol and marijuana to a prison in South Carolina using an unmanned aircraft! And an increasing number of photographers are making use of a "flying camera", not always with the appropriate permission.

Commercial use

Happily these systems are also being used for more serious (and legal) purposes. Engineering consultancy Grontmij have used an RPAS to inspect reed beds in a nature reserve, completing the job more quickly and without disturbing this vulnerable area. Chemicals company Dow are testing out an RPAS aircraft for the inspection of plant at height. This avoided the need to erect a scaffold, saving time and a substantial amount of money. The installation inspected was out of service. Geo-Infra, an engineering consultancy from Oud-Gastel have used their own aircraft to map out a section of the major Maasvlakte 2 civil engineering project. A spokesman for the bureau reported that this provided better information for the client, and the work was completed more quickly. So this business have identified a market for this type of service, but the stringent legislation means that they have been able to carry out only a very few similar projects.

Use by police forces

In past years the police forces have generally used equipment from the Defence Ministry for their RPAS operations. They occasionally hire in RPAS services, or collaborate with a security company, for example during events, and equipment belonging to the National Police Agency is also used.
The police have used remotely piloted aircraft to track arsonists and a gang of housebreakers targeting the elderly, and also to locate a cannabis plantation. An RPAS was also used to find a skater who had got lost on the Nieuwkoopse lakes. RPAS continue to be used occasionally, but the police have been very conservative about deploying drones, because of the privacy issues and also the legislative restrictions.

Other developments

A group of businesses and knowledge institutions have been collaborating on an RPAS project for the Dutch Institute World Class Maintenance (see rpascenter.nl). They have been working on the development of new applications and have launched various innovation projects, with pilot studies now in progress. The Zeeland Regional Safety Authority are participating in the BERISUAS project, with the primary aim of responding to disasters at sea with the aid of unmanned aircraft, while development company REWIN are busy getting a test station for RPAS close to the Woensdrecht air base off the ground.

Will RPAS be used? First define the objectives and the use, and answer all the outstanding questions

An aircraft has been developed and built which may meet the technical requirements for deployment. Scenarios for the potential uses of the aircraft have also been defined. Unfortunately however, and despite the obvious advantages of using RPAS, it was not possible to carry out live testing of the system. So the question now is: will potential end users actually use RPAS systems like the 2SEAS20 prototype?

Martin Very (Kent Police), Ingrid Römers (Rotterdam Harbour Authority) and Paul De Kruijf (Rotterdam Police) all take a positive attitude to the use of RPAS. "I have high expectations about the possibilities," says Ingrid Römers. "The speed of deployment, the potential to inspect ships from above rather than from the water. It's possible that the crews of the patrol vessels may be worried that their jobs are under threat, but that is not the case. In fact it will support them in their work, significantly expanding their field of view and allowing them to respond better and more effectively. The main change they can expect is that the route of their inspection for that day might change as a result."

It's the picture that counts

Flying is not a goal in itself. It is the image delivered that counts where the end user is concerned: within what timeframe and at what resolution can images be provided? So the speed with which the aircraft can be airborne is important. Can it take off from any given location? Is a take-off and landing strip required, or can that be done from a patrol ship for example? There are questions to be answered, depending on the objectives and the use to be made of the system: what radius of action is required, what flight duration is necessary, what control regime is needed, what kind of sensors will be suitable? Are moving images or still photographs required, and how quickly must they be sent back to the ground station?

Improved supervision and incident response

It is possible that a larger area could be monitored at the same cost using an RPAS. More information can be acquired in less time. More effective incident response teams can be put together, and at an earlier stage. Sensors can be used to establish whether an area is safe for the emergency services to enter. The seat of a fire could be localised earlier, allowing improved firefighting measures. "An RPAS isn't necessarily faster than a helicopter however," says Römers, "and they won't necessarily have a better sensor on board, something that also applies to sensors on other equipment, such as boats or manned aircraft. But because unmanned aircraft are somewhat less expensive than the traditional alternatives, it will be possible to bring down the costs."

Commercial and policy considerations

There are a considerable number of commercial and policy considerations to be taken into account before one could make a decision about using RPAS. "You need to ask what you wish to achieve," says Römers, "Are you only looking for increased efficiency, or do you want to improve monitoring, or incident control? In other words, what exactly are your needs and objectives? Once those are sufficiently clear you can weigh up the value of RPAS against the use of other resources to achieve those specific goals. Could you achieve your objectives in some other way, for example with a police helicopter? Could the Harbour Authority make collaborative agreements with the police about the shared use of police helicopters? These are the kind of questions that need to be asked."

Organising flights

Another important decision concerns the organisation of the actual flights. Will that be done in-house, or by a collaborative partner? Another option would be to contract out the work and purchase these services. "This would have all kinds of consequences," says Römers. "If your organisation is going to be responsible for the deployment of the aircraft, are you going to employ the pilots? Or are you going to allocate the role of pilot to some existing group within the organisation? Will that be a welcome addition to their package of tasks, or an unwelcome burden? What are the implications for training? Which department will you make responsible for inspecting the images? And here again, will that make a pleasant change from their present work, or will it be a tedious and disagreeable imposition? Will you separate the roles of pilot and observer, or will the pilot act in both roles?" Römers points out that the operational reliability of RPAS is something else that requires careful consideration: "Is this something you are going to include as a permanent element of your operations? That would mean that you would need to take account of potential interruptions to your operations and back-up systems. And what will be the effect of different weather conditions on deployability? If you want to operate the system 24/7, what will that mean for your organisation?"

Setting up an operational centre

"If you contract out the work, then the external partner will be taking on the role of pilot," says Paul de Kruijf. "How will you deal in those circumstances with the monitoring of the images created, and with the response of the RPAS to the conclusions drawn from inspection of the images? These issues also have consequences for your decisions about the setting up of an 'operational centre'. The police have a centre like this where the images from fixed cameras are evaluated. But you could also use a mobile ground station, or set up a department within the existing harbour coordination centre, or install a workstation in the patrol vehicles. Supposing you opt for a mobile ground station, what would the deployment time be, how quickly could you get an aircraft in the air, and pictures back to the ground? And does the aircraft need to be able to take off, fly and land automatically? In any event, if you set up your own operational centre to inspect the images coming from the RPAS, that will have significant consequences for the organisation of your operational processes, your personnel and your training arrangements."

Planned or unplanned deployment?

Cost/benefit considerations are important here, but other questions also play a role. Will deployment be on an occasional basis, and if so, will this involve planned deployment, for example at specific events? Or will it be unplanned deployment, responding to incidents for example? "How do you achieve rapid deployment," says de Kruijf, "And what does 'rapid' mean in this context? Or perhaps you are looking at more continuous deployment, surveillance operations for example? How long will the RPAS need to remain in the air in that case, and what does it mean for the number of RPAS you will need to have ready for action? In the case of a localised operation you will fly using so-called 'waypoints', for surveillance your flights will be 'random'. So how do you set up random routes? There is also the question whether flying 'beyond visual line of sight' will be permitted under the new legislation, and if so, under what conditions. Allowing this would appreciably expand the opportunities for deployment and would therefore be of benefit to your business case."

Privacy

The use of unmanned aircraft throws up many questions relating to the privacy of citizens. Is their privacy properly protected? Detection work using unmanned aircraft with a camera in the Netherlands falls under the jurisdiction of the Public Prosecutor. Surveillance using cameras is regulated by the Local Authority. "The obvious way forward is to tie in the use of RPAS with these arrangements," says De Kruijf. The Harbour Authority will in any case comply with the legislation if it is decided to deploy unmanned aircraft explains Römers. "It should go without saying that we will observe the legal requirements. It will have consequences though for the arrangement for the operational centre. Will you archive the images or not? Where will the images be examined? At a police station, in your own control room, on every patrol boat?" The views of other users of the harbour will also be taken into consideration in the decision whether to use RPAS in Römers' view. "If they don't see it working it won't be worth starting on the project." [1 2]

New insights

A good deal of new expertise has been accumulated by the project partners. As part of the national police force, Rotterdam Police are dependent on policy developments in relation to the deployment of RPAS on police operations. The policy is currently under development by corps command. "There are many potential applications for RPAS in the work of the police force. This research has greatly improved our understanding of the issues," states De Kruijf. The Harbour Authority will include the potential uses of unmanned aircraft in any future decisions on the reorganisation of their supervisory activities. "And thanks to this project we are no longer exclusively reliant on the market," says Römers. "A collaboration with the police on the joint use of RPAS is now also a possibility."

Debate

And finally we hear from Martin Very about the situation in England: "Kent Police currently have no plans to acquire RPAS capabilities. It does seem a sound idea to use unmanned aircraft to deal with maritime incidents or to investigate criminal activities at sea. And RPAS appears to be an economical solution, something that is becoming increasingly important. But the use of this type of equipment is the topic of a national level debate in England." The discussions in the UK centre on topics like safety and privacy, but there is also debate about the effectiveness of RPAS in different scenarios.

Persuasive case

"The case for the deployment of RPAS to improve safety at sea and in the investigation of criminal activities is persuasive," says Very. "In my view this project has made a substantial contribution to the national and international debate on this issue. My prediction is that, depending on the progress of that debate, the use of resources like these is very likely in the near future. The cost benefits are highly significant."

The 3i project partners are currently investigating the possibility of making the current 2SEAS20 system available to others for further research.

1 A number of business cases have been prepared as part of the project. You can find out more about these in the relevant section of this publication.

2 At the time of writing the Ministry of Infrastructure and the Environment have stated that they are almost finished with the development of new legislation. The expectation is that this will come into force in mid-2015.

Ecological evaluation

The protection of nature zones in the Netherlands is regulated under the Natura 2000 and Ecological Main Structure schemes, while native plant and animal species fall under the protection of the Flora and Fauna Act. Surveillance of the Dordrecht and Rotterdam harbour areas may potentially have negative effects on various protected species of birds and mammals. Protected species potentially vulnerable to disturbance occur not only in the protected Natura 2000 and Ecological Main Structure zones but also within the harbour areas.

Maps indicating the areas protected by national and European legislation can be consulted on the internet. Areas where species protected by the Flora and Fauna Act are found are also indicated. Protected species found around the port area are not included on these maps. (Websites: http://www.zuid-holland.nl/ and www.synbiosys.alterra.nl/natura2000.)

The Flora and Fauna Act

Species protected under the Flora and Fauna Act including rabbits, polecats, roe deer, seals and bats have been found around the Rotterdam and Dordrecht harbours, as well as various species of ground-breeding and colonial birds. Their breeding sites are protected during the breeding season, which broadly speaking extends from March to the end of August. It is not immediately clear to what extent these species and groups of species are sensitive to disturbance by aircraft.

Ecological Main Structure

Part of the Rotterdam harbour area falls under the Ecological Main Structure scheme. The effects of flying here can be evaluated by investigating the characteristics of the area covered by the scheme where flying would take place and by identifying potentially sensitive species.

Natura 2000 area

The North Sea around the port of Rotterdam is part of the Natura 2000 Voordelta area. The Voornes Duin and Solleveld & Kapittelduinen Natura 2000 areas also border on the port area. The Nature Protection Act of 1998 (NPA) provides the legislative framework for the protection of Natura 2000 areas in the Netherlands. Projects and other activities which might cause a deterioration of natural habitats and species habitats in a Natura 2000 area or which might have a significant disturbing effect on species for which the area was designated may not take place without a permit (Article 19d 1 of the NPA). For the purposes of the NPA it is irrelevant whether a project or activity takes place inside or outside a Natura 2000 area, as the legislation refers to "external effects". The possibility that flights with unmanned aircraft around the port of Rotterdam might have a negative effect on the adjacent Natura 2000 areas cannot be excluded.

Next steps

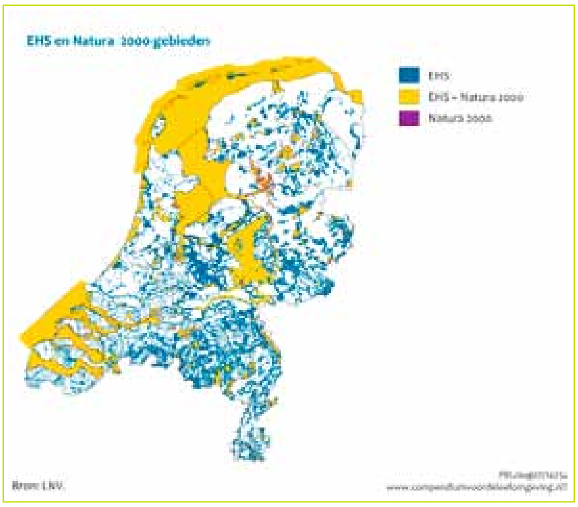
A detailed literature survey should be carried out in order to investigate the potential effects of noise and other forms of disturbance. This investigation should include the identification of the available scientific and other knowledge of the effects on fauna of flights with manned and unmanned aircraft. This research must provide an insight into the extent to which flights with unmanned aircraft will disturb the protected fauna present. A literature survey focusing on the sensitivity of protected species to aviation activities can provide a better picture of the potential of flying an unmanned aircraft within the Dordrecht and Rotterdam port areas.

It should also be investigated which target species have been designated for the Ecological Main Structure and Natura 2000 areas and whether these species are sensitive to disturbance through flying activities, in order to determine whether disturbance of protected areas is taking place. Whether disturbance will occur, and if so what level of disturbance will be created depends on a number of factors relating to the aircraft, including:

+ the height flown at;
+ the frequency of flights;
+ the level of noise generated by the aircraft;
+ the routes to be flown by the aircraft;
+ the timing of flights (day or night).

Once there is greater clarity about the above issues it can be investigated what measures will need to be taken to prevent potential disturbances to protected fauna and nature zones by the aircraft. It might for example emerge that buffer zones and/or no-fly zones are indicated to prevent disturbance. There is the possibility of introducing seasonal no-fly zones in the Rotterdam and Dordrecht harbour areas, since no restrictions apply for example to the locations of breeding colonies of gulls outside the breeding season. Specific restrictions on flying heights and times might also be applied above specific areas.

It will possibly also be necessary to request a waiver of the Flora and Fauna Act or a permit under the Nature Protection Act 1998.



EHS en Natura 2000-areas

Text: Staro Natuur en Buitengebied

Advancing technology will bring further benefits within reach

The RPAS sector is in a period of rapid development. New or improved technology is raising the quality of the equipment. Increasing numbers of businesses are seeing potential applications, while the government are working on improved legislation. So how does the future look?werkt de overheid aan betere wet- en regelgeving. Hoe ziet de toekomst eruit?

The European roadmap we have had before us since early 2014 is a somewhat formal document. Rob van Nieuwland, Chair of Darpas, says it could go either of two ways: "The rules might get stricter, for example in relation to health requirements for pilots. Or we could go the way of the recreational sector, where they fly the same aircraft but without having to deal with such stringent requirements. After all, the hobbyists can fly aircraft up to 25 kilograms up to a height of 300 metres."

Reclassification

"In the past you had manned flight and model aircraft. Then the professional use of RPAS came along, and that was made subject to the same rules as manned flight. But I am expecting to see a reclassification. There is already that upper limit of 25 kilograms for hobby use. When you look at the position in other countries you find that there is very often a classification according to weight, with less strict requirements for the lighter classes of aircraft. But in the Netherlands there is no such distinction and everything between 0 and 150 kilograms is covered by the same rules.
There are also moves afoot to allow more room for manoeuvre within the controlled airspace around civil and military airfields.

Relaxation

"As more reliable RPAS systems appear and dependable 'sense and avoid' techniques are developed the legislative requirements will be relaxed. That would be a major step forward. Technological breakthroughs can sometimes take place at great speed. Moves are afoot in the automotive sector that would see new cars able to communicate with one another. If that technique is developed further and goes into mass production, and if we can adopt that technique, then our problem is solved.

EASA Certification

"It would also help if we could reduce the impact on the ground if something does go wrong. A parachute, an airbag...? New technological developments may make it easier to comply with some of the requirements and rules, but however quickly the technology is advancing, obtaining EASA certification is often a very slow process."

Proven reliability

"Most accidents in manned flight are due to human error. Touch screen operation means that the 3i operation is somewhat safer. New automatic take-off and landing systems continue to emerge. Proven reliability will help towards a relaxation of the regulations. But there lies the problem: if you are not allowed to carry out testing, you are not able to demonstrate reliability. It would be good to see waivers for universities for example, or for a specific airspace. The airport at Woensdrecht would be ideal for this purpose."

Acceleration

"I don't see much changing in the short term, but in the medium term I do expect to see some relaxation of the rules as advancing technology opens up new possibilities, for example the "sense and avoid" techniques mentioned above. The central point is that more money will become available as this goes into mass production, so that research and development will be more efficient, accelerating the process.

New UAV projects

Another RPAS-based project is in progress, with the title BERISUAS. In fact this represents a coalition of different clusters, including 3i. The objective is to share expertise and potentially to define new projects.

One example is the Maritime Incident Response Group (MIRG), which the Zeeland Regional Safety Authority is participating in. The focus there is primarily on the response to emergencies at sea, with the development of scenarios by the project partners in which RPAS would have a role to play.

Abbreviations and Terminology used

3i	Integrated Coastal Zone Management via Increased Situational Awareness through Innovations on Unmanned Aircraft Systems.
AGL	Above ground level.
BERISUAS	The research cluster intending to make use of RPAS for maritime safety purposes.
BVLOS	Beyond Visual Line of Sight (the aircraft is no longer visible to the pilot).
CTR	Control Zone. Controlled airspace around a civil or military airfield. Different rules apply to flying inside and outside such zones.
DARPAS	Dutch Association for Remotely Piloted Aircraft Systems.
DOA	Design Organisation Approval. An EASA approval stating that an organisation can and may design an unmanned aircraft in accordance with the established requirements for such craft.
EASA	European Aviation Safety Agency.
EHD	Europe Holland Danger. An air zone in the Netherlands presenting a hazard to air traffic.
EHP	Europe Holland Prohibited. An air zone in the Netherlands which is prohibited to all air traffic.
EHR	Europe Holland Restricted. An air zone in the Netherlands with limited access for air traffic (determined by Dutch Air Traffic Control (LVNL).
ICAO	International Civil Aviation Authority.
IFR	Instrument Flight Rules. Classification of air traffic based on specified routes and heights monitored via instruments.
ILT	The Environment and Transport Inspectorate. Issues waivers.
LVNL	Dutch Air Traffic Control
MOA	Maintenance Organisation Approval. An EASA approval stating that an organisation can and may maintain an unmanned aircraft in accordance with the requirements for such craft.
NOTAM	Notice to Airmen: a coded notification to all users of airspace of an unusual event. An RPAS flight is (still) regarded as such.
OM	Operations Manual
POA	Production Organisation Approval. An EASA approval stating that an organisation can and may produce an unmanned aircraft in accordance with the requirements for such craft.
RPAS	Remotely Piloted Aircraft System(s). This term is preferred to UAV and UAS in this publication.
SMS	Safety Management System
TSA	Temporary Segregated Airspace. An airspace temporarily allocated to special purposes by Dutch Air Traffic Control.
TUG	Temporary and Exceptional Use A procedure to allow an aircraft to take off and land beyond the confines of an airfield, following approval from the provincial authorities.
UAS	Unmanned Aerial Systems.
UAV	Unmanned Aerial Vehicles.
VFR	Visual Flight Rules. The totality of rules applicable to flight whereby the pilot is responsible for the avoidance of collisions by means of good observation.
VLOS	Visual Line of Sight (the aircraft is kept in sight of the pilot).
WA	Legal Liability Insurance, where the minimal insured amount is now determined on the basis of a weight class taken from manned flight (everything up to 500 kg), and amounts to around €1m.

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Throug the website http://www.2seas-uav.com/ you can view footage of the 3i device in action.

Partners in 3i

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To drone, or not to drone?

An exploration by potential end-users of the possibilities for unmanned flight within the 3i project.

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