Salmon delivered by hyperloop and mail by drone?

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Researcher Jackob Høgenes at SINTEF Digital is working with drones. However, this one only flies indoors. Credit: Werner Juvik / SINTEF

Developments in technology will leave their mark on Norwegian roads. More advanced IT systems make self-driving cars possible, as well as drones that can deliver parcel post – with built-in intelligence. Hyperloop technology is not just fantasy: this means of transport, based on very low air pressure and induction technology, can become a reality. Test circuits are being planned at several locations.

At first, it is unlikely that the method will be used to transport passengers, but to ship goods such as freshly killed salmon, where speed is important. At least, that's the view of a wide-ranging team of research scientists in many different technical fields at SINTEF.

The SINTEF report "Teknologitrender som påvirker transportsektoren" (Technological trends that affect the transport industry) has been written on behalf of the project group behind the Norwegian National Transport Plan. The time frame extends as far as 2060 and according to the research scientists we will experience radical changes.

These are some of the SINTEF scientists' predictions for the next thirty years:

Digitalisation will become noticeable "everywhere"

More and more vehicles will be fitted with computers which in turn will run advanced software. In addition, sensor technology will be brought into use in more vehicles. According to the researchers this will affect both traffic and our driving habits.

At present, cars contain from 60 to 100 sensors, but researchers believe that a new car in 2020 will be fitted with up to 200 sensors. Data from these sensors can be used both in monitoring the vehicle (for example safety equipment such as ABS brakes) and for maintenance purposes.

This can potentially make travel on Norwegian roads safer: The trend is that more and more data are distributed directly and in real time to the manufacturer of the vehicle and to the operator of the road network. This information can be used in IT-based safety services such as collision avoidance and monitoring the technical status of the road network.

The researchers also predict that more digital systems will mean that we will receive even more data: about everything from energy consumption to driving and movement patterns. As a result, SINTEF is highlighting the need for debate around the future ownership of this mass of data.

The future is electronic – also in new ways

In years to come we will see even more electric vehicles – cars, buses and bicycles – particularly in urban areas. This will affect the electricity supply grid and will in some cases cause local electricity supply problems. Research scientists believe that this will result in an increase in local generation of clean energy, for example using solar cells which are integrated into buildings, or small local wind turbine installations. They also foresee that road vehicles will in future be used more efficiently than at present, because people will increasingly opt for car pooling, especially in towns.

When it comes to transport over longer distances we will also notice increasing electrification, both on water and in the air. There will be more electric ferries and trains, but researchers also expect electrification of the Norwegian aviation industry to take place by 2040.

At present, most people associate the word "induction" with kitchen cookers, but electrical energy transfer by way of contactless induction technology will make its entry on our roads. Inductive charging systems will first appear in stationary charging of electric road vehicles and for charging electric buses at bus stops.

Inductive charging of buses at bus stops has already been demonstrated for more than 15 years in Italy, and similar systems are now being tested by Scania in Sweden. Systems providing stationary charging of electric cars are already on sale in the United States, and most major car manufacturers are now preparing for the integration of such technology

into their electric vehicles. A concept for battery charging in electric ferries using high power inductive energy transfer has also been developed in Norway, and is currently being demonstrated in the hybrid ferry "MS Folgefonn" at Stord.

Technology for inductive energy transfer can also be integrated into roadways to charge batteries in moving vehicles. Here, the receiver unit in the vehicle does not have to be stationary for the battery to charge. Various forms of dynamic inductive charging for moving vehicles have already been demonstrated in buses and trains in South Korea, as well as in trams and goods vehicles in Germany.

One of the greatest advantages of inductive energy transmission technology is that there are no parts subject to mechanical wear. It also becomes simpler to automate battery charging when no physical contact is needed. For this reason, researchers believe that inductive battery charging will be used not only in self-driving and autonomous road vehicles, but in time also for charging drones, ships and various types of machinery, among other things.

Hydrogen fuel will be common

While batteries both store energy and provide power directly, the hydrogen system generates electrical power by oxidising hydrogen to produce electricity and water. The energy is stored as hydrogen in a tank, and fuel cells supply power.

High-speed boats and ferries powered by hydrogen are expected to be in use by the end of 2020. The same is expected for trains and goods vehicles for long-distance transport. Hydrogen will also eventually be powering some aircraft.

With the introduction of mass-produced hydrogen-powered cars by

Toyota, Honda and Hyundai, among others, in coming years, the regulatory framework and the basic infrastructure for the use of hydrogen in land-based transport will be in place by 2020 in many countries.

Hydrogen is a particularly appropriate fuel for larger vehicles and means of transport, or when needed for long-range transport. This means large passenger and goods vehicles, long-distance buses, lorries, trains and ships.

For maritime use, hydrogen in gaseous form will be less suitable as an energy carrier for the longest journeys and for larger vessels. For such applications, hydrogen will be stored in liquid form. However, for small ships and moderate distances, volume is not a problem, and compressed hydrogen gas can be used. The first tank vessel for transporting liquid hydrogen is already being built in Japan. When completed in 2020 it will transport large amounts of hydrogen from Australia and Brunei to that year's Olympic Games in Tokyo.

Internet for goods

Goods transport, for example of consumer products, is at present booked complete, from start to finish. Things will be different in the future. There will be a more flexible form of distribution: Researchers envisage that "all" goods will be sent to a large goods terminal where they will be packed and then distributed. This allows us to have an overview of the entire stock and thus plan the best and most efficient way to ship goods from there.

The concept involves fitting the goods with intelligence – which in practice means that a product will carry electronic information about what it is, what transport requirements apply to it and where its destination is. Using this sort of concept, goods can monitor their own

shipping and send alarms or notifications in the event of delays. According to the research scientists we can also expect the transport of goods to be more efficient, safer and more environmentally friendly.

Hyperloops and drone taxis

The rise of drones – unmanned airborne vehicles – at sea and on land, has already made its mark in fields like film and TV production and inspection assignments. The technology is becoming increasingly safer and cheaper as a result of increased computing power and a sharp fall in the price of sensors. Scientists predict that autonomous drones and robots will in future carry out complex operations such as maintenance work, both alone and in combination with people.

Drones in the air and on land will contribute to what is known as "first and last-mile delivery" – the first and last legs of a transport chain which often cannot be achieved using shared transport, such as from the post office to your home.

The researchers also foresee that transport in pipelines will in future ease the pressure on roads that are at present overloaded with heavy goods vehicles. Pipeline systems have been used for a long time to transport liquids and gases, but are little used for transporting solid materials. However, St. Olav's Hospital in Trondheim uses internal pipe-borne mail and in Bergen and Stockholm pipes are used in automated refuse collection.

Because traffic volumes are growing, the need is also growing to divert goods transport away from roads. This in turn increases interest in developing a pipeline infrastructure for transporting goods over moderate to long distances. Such systems are being demonstrated and planned for the transport of, among other things, shipping containers (California and Singapore) and for pallet transport (the UK, Germany,

Switzerland and others), and are likely to be part of the Norwegian transport network within a few years.

Hyperloop technology based on induction motors and magnetic levitation will probably be commercially available by 2025, most likely for transporting goods that require rapid transport, such as fresh seafood. SINTEF estimates that we can have a Norwegian test circuit ready in 2020, but points out that the Norwegian landscape, with its many mountains and fjords, will present a challenge to large-scale hyperloop development.

Hyperloop technology is now being studied in at least 20 locations around the world, for example in India, Sweden, Finland, France, Canada, Saudi Arabia, the US and Singapore. The first full-scale test installation (DevLoop) is already operating in Las Vegas in the US.

Autonomisation of vehicles and ships

We already have self-driving cars, but user acceptance and new legislation will be necessary before this technology can become widespread. Self-driving vehicles will however become more common and will also pave the way for new usage patterns involving car-pooling and car rental. In the short term, researchers believe that we will see self-driving cars in closed areas, and used, for example, for snow-ploughing at airports.

Technology originating in self-driving cars will in time lead to the automation of excavators and fork lift trucks, among other things. The same will apply to autonomous trains, which are already operating in some urban areas. At sea, self-driving ships will see the light of day quite soon. Ships lend themselves especially well to the technology, being relatively slow-moving and operating in areas providing a certain flexibility as regards the planning of journeys. Because ships are large,

investment in autonomous systems will be a relatively small part of the total cost.

Remotely-controlled and autonomous aircraft

As people become more used to and accept unmanned transport, the trend will be towards removing the pilot from the cockpit. Technological development and increased air traffic density will also approach a point at which pilots no longer make a positive contribution to air safety.

In future, traffic at an airport will often be controlled by personnel who are not located at the airport. This will reduce the need for manned control towers. Researchers envisage that several airports will be controlled simultaneously from one location, and that this will result in more efficient instruction and training, as well as a more robust professional community. In principle the technology has been based on the transmission of two-dimensional video images from cameras located around the airport to a control centre in another location. So far, one airport in Switzerland has been certified for operational remote control of traffic from a different location, and Norway will implement the technology at 15 airports in the next couple of years.

New services linked to travel and goods transport

Increasing online shopping means that small deliveries are being made to more and more addresses. In towns this leads to major traffic-related problems and local pollution. Goods transport must therefore be organised in new ways. Distribution centres for goods must be established in towns and must coordinate and optimise all distribution of goods and ensure full delivery vehicles and optimal routing.

This will probably create a need for entirely new services providing

support for the travelling public or for goods to be transported. The researchers call this "Mobility as a Service".

The aim is to provide tailor-made systems providing transport in the most efficient and environmentally friendly way possible.

Electrification of transport presents challenges in that the electrical grid may become overloaded when many vehicles are being charged simultaneously. Smart management of charging is needed so that a large number of vehicles can be charged with the existing grid capacity. Charging must be adapted to the periods when the vehicles are to be used, and charging must if possible make use of locally generated, renewable energy.

Digital services involving co-operation and the sharing economy can lead to better resource use and reduce the negative impacts of transport. Cars and private charging stations can be shared and unused space in vehicles can be shared and used for transporting people and goods. Distribution centres for goods will demand collaboration between operators which currently work independently. New business models are a condition for the success of collaboration and the sharing economy.

The transport systems of the future will depend on the collection and exchange of information and data. It is important that personal protection is maintained according to new, strict requirements such as those of the General Data Protection Regulation (GDPR).

Goods transport and passenger travel will change as a result of new technology such as self-driving cars and drones. New services will arise and transport will be organised in new ways:

New services (which support, for example, Mobility as a Service) will contribute to transport systems which are adapted to the users' needs, as

well as to the traffic situation. Users will also be assisted in choosing environmentally friendly transport and in the event of disruptions en route (e.g. delays) they will be given information about alternative means of transport.

Key technologies and the circular economy

While it is not a direct transport trend, because technology is developing so rapidly researchers are highlighting a number of technologies which in one way or another will become prominent in many different parts of the transport sector, such as the development of light but extremely strong materials, nanotechnology and sensor technology, digitalisation and the use of robotics, automation and 3-D printing. 3-D printing is a computerised process in which a three-dimensional product is built up in layers from a raw material consisting of wire, powder or liquid.

3-D printing is primarily a tool used by product designers for rapid design and prototyping, but it is now making an entrance in what are known as distributed manufacturing platforms. This means that manufacture can be moved from large, centralised factories to local workshops and from there to people's homes. This will change both the flow of goods and the demand for transport. 3-D printing can become very important in what is known as the circular economy, which is based on making the best possible use of all resources, for example by producing spare parts, or by repairing things that otherwise would be thrown away.

In a few years' time we may perhaps be able to order spare parts from an IT specialist instead of an auto repair shop, thereby reducing the impact on both our wallets and the environment.

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