Commercialising Robotic and Unmanned Systems

by **Dewar Donnithorne-Tait**

Dewar Donnithorne-Tait is President and CEO of the Canadian Centre for Unmanned Vehicle Systems (CCUVS). His involvement with unmanned systems started in 1983 with research into UGV sensors. Since then he has worked with a range of UGV and UAS research, development and acquisition projects. He says that the real benefits of all robotic and unmanned systems will only be realised when they can operate safely alongside manned systems in the air and on the roads and waterways, and discusses what must be done to achieve that.

Military forces are increasingly demonstrating the utility of unmanned systems to release humans from dull, dirty and particularly dangerous tasks. Injury and death are being avoided while valuable service personnel can undertake other, higher-level tasks, with attendant increases in both capability and productivity. In addition to military developments, university and other research is enabling ever more capable technologies related to this sector. Outside the military market, both civil government and commercial users want to exploit the benefits offered by Robotic and Unmanned Systems (RUS).

The introduction of RUS into daily public life will represent significant change. A number of issues have to be addressed for this to be achieved, including: awareness, culture, education, standards, certification, regulation, radio frequency spectrum, legislation, financial arrangements and human systems integration.

Scope of Civil and Commercial RUS

The European Union's strategic research agenda project, the European Robotic Platform, identified the following main sectors of the RUS market:

- **Industrial**: Typically static (but not always) and used in factories on assembly lines, serving repetitive processes and computer controlled fabrication.
- **Service**: Including ground and maritime transportation, domestic, educational and medical applications, assistance to physically challenging, environmental tasks.
- **Space & Security**: Space, security, defence.

Arguably the small robots used for improvised explosive device (IED) work should fall more properly into the service robot category than defence. The most visible RUS – unmanned aircraft systems (UAS) – which the International Civil Aviation Organization (ICAO) now refers to as Remotely Piloted Aircraft (RPA), all fall into the Space and Security class. Domestic robots are becoming important, particularly in South Korea, where the Government is calling for every Korean home to have an educational robot to assist in the development of young people.

Awareness and Culture

Despite a long history of seeing robots of all sorts on television and movie screens, there seems to be little public awareness of how RUS could be of use in daily life. Perhaps this is because many of the robots portrayed are evil (think of the dreaded, garbage-bin shaped 'Daleks', which can easily be avoided by climbing stairs, a skill they have never developed). The introduction of the iRobot Roomba automatic vacuum cleaner at an affordable price point is just beginning to alert people that mobile robots could usefully supplement their other, static, automatic machines in the home and garden.

There is less evidence of the acceptance of mobile robots in the workplace, despite a wide range of warehouse and other related applications including automatic handling and storage, stock-taking, security patrolling and cleaning. All these applications could take place now, in restricted environments and segregated from the general public. However, there are still implications for human employees sharing the same workspace.

There is a need for an advocacy programme to raise public awareness of what might be possible. This activity would be usefully reinforced by the implementation of widely publicised pilot projects.

Education

If we are to have a modern, competitive workforce, equipped and ready to exploit RUS technologies to the maximum, changes should be made to the educational systems at primary, secondary and tertiary levels. There is a disturbing shift away from the 'hard' subjects (e.g. mathematics, sciences) towards 'softer' subjects in secondary and tertiary education, a trend exactly opposite to that in China and India where engineering and sciences are the disciplines most in demand.

The Canadian Centre for Unmanned Vehicle Systems (CCUVS) is tackling this by short presentations to 8- to 12-year-olds to stimulate interest in science and maths and, in particular, RUS. This is coupled with work with universities to include new RUS content in science and engineering courses and

The CCUVS deployed on the Pacific with the Canadian Navy launching unmanned aircraft targets for a major exercise. The unmanned systems target market is strong and growing [CCUVS]

to propose thesis and research topics for undergraduate and post-graduate students. Both these programmes are established and are showing positive results, while ways to expand and leverage this work are being pursued.

Standards, Certification and Regulation

RUS commercialisation is plagued by a classic 'Catch 22' problem. The entrepreneur who has developed a really good way to make money out of RUS finds he or she cannot construct a sound business case in the absence of standards and regulations under which operations could be conducted predictably. Regulators, on the other hand, claim that they cannot make a business case for the development of standards and regulations since there appears to be no demand from industry. Luckily in some, more enlightened countries, there are regulations for RUS operations which can be considered as safe by the authorities (e.g. UK CAA's CAP722 regulation). It is essential that technology commercialisation authorities and government agencies realise that the growth of the RUS sector absolutely requires the development of standards and regulations to unlock the market.

For RPA (UAS), current, feasible operations are mostly those which can be conducted within visual range of the Pilot in Command (PIC). While many scoff at this limited activity, money can be made while flying safely. In Canada, there have been no reported safety incidents for this sort of operation in the last five years (and probably longer). Having normal regulation of such modest RPA activities has the major benefit of establishing the perception of routine, regulated RPA civil and commercial RUS operations, which plays its part in moving cultural adaptation forward. However, the real benefits of all RUS will only be realised when they can operate safely alongside manned systems in the air and on the roads and waterways. For RPA, where the major work to enable this is currently focused, with major programmes such as ASTRAEA in the UK and MIDCAS elsewhere in Europe, there are three areas of crucial importance for standards and regulations. The first, and possibly best known, concerns the maintenance of proper separation between aircraft in all classes of airspace, the avoidance of air-to-air collisions and of hazardous weather and terrain. A second, but equally important, area of work concerns safe, robust command, control and communications to enable the PIC to exercise his ICAO responsibilities at all times. A third area concerns human system integration considerations, which includes important issues such as Flight Crew Licensing and Operator Approval.

All these areas are now being addressed by international standards-writing bodies. These include Working Group 73 UAS of the European Organization for Civil Aviation Equipment (EUROCAE), Special Committee 203 of RTCA and Committee F38 of ASTM, the latter two international groups being based in the USA. There is other work with other groups internationally, but these three activities might be regarded as the ones working most closely with the authorities, EASA and EUROCONTROL in Europe and the FAA in the USA. These groups also participate, directly or indirectly, in ICAO's UAS Study Group (UASSG).

The Draganflyer X6 has sold to many countries around the world. It is used for a variety of small survey and photographic recording tasks and is in widespread use by police forces. Made by Xenon Dragan in Saskatoon, Canada [CCUVS]

The brilliant Aeryon Scout from Aeryon Labs in Windsor Ontario. It is the approach of the future - no pilot flying skills required. Automatic and manual control are through the autopilot. The whole system can be operated from the tablet PC and transmitted using one finger to control events. The brand new Scout is already in service with law enforcement agencies [CCUVS]

The derivation of the performance requirements on which to base standards development is a very intensive task. All three groups would welcome participation by interested parties, particularly those with relevant experience. Anyone interested should contact the author.

With the emerging standards and regulations, there are exciting opportunities for military forces to adopt civil standards. This would simplify the transit of military UAS through civilian-managed, non-segregated airspace and would give financial benefits of economies of scale.

Radio Frequency Spectrum

Since the PIC must be able to exercise his ICAO reponsibilities at all times, the continuous maintenance of high-integrity communications between Pilot Station and RPA must be guaranteed. While appropriate, protected flight control bandwidth can be allocated by national authorities for purely national work, international operations will require a similar type of allocation by the International Telecommunications Union (ITU). The allocation of radio frequency bandwidth is worked through the ITU World Radio Conference (WRC) series. Several nations have been cooperating over the last few years to procure the required frequencies. There was insufficient evidence to build a case for a firm bid at WRC 2007, but an agenda item for WRC 2012 was secured. Comprehensive studies have been under way over the last few years to build the case. Even if a very robust case is made, there is still great competition for bandwidth. All concerned are urged to ensure their national governments support the bid.

Legislation

Legislation always lags behind technology. While there is much work under way to develop the required standards and regulations to permit safe operation, a host of other legal work is required to facilitate enterprise integration of RUS. It is envisaged that this legislation will include many of the features governing use of motor vehicles and other forms of transport, licensing of drivers and pilots, liability and a range of health and safety issues both in the home and the workplace. Some consideration of these issues is under way in the Royal Aeronautical Society's UAS Specialist Group (RAeS UASSG) in the UK, and in the UAV-DACH (UAS group working UAS issues in Germany, Austria, Switzerland and the Netherlands) community in Europe, but much more is needed to identify and address the issues.

Financial Arrangements

The lack of usage statistics is a hindrance to at least two financial communities which need to engage with the RUS sector. Both would benefit from the same base set of statistics: the insurance market needs to know what the odds are so that they can manage the risk of loss, while the venture capital market needs to know what the odds are so that they can assess how much profit they can make. Without affordable insurance and appropriate investment, the RUS sector will struggle. These issues have also been identified by the RAeS UASSG, but little success has been achieved with engaging either the potential investors or the insurers, despite considerable efforts directed at the latter, where the need is more pressing.

Human Systems Integration

At one level, unmanned systems typically present the same human interface issues as the employment of sophisticated information and communication technologies (ICT) systems, such as display representation, ergonomics, orientation, environmental protection and security. But unmanned systems bring additional issues concerning remote task execution, such as behavioural and ethical considerations, and a host of health, safety and workplace regulation matters. The use of common, or standard, interfaces would significantly reduce training costs and skill fade.

One of the most significant challenges in the use of highly automated systems is the need for the human users to understand fully both the capabilities and the shortcomings of the exceptionally complex systems they are employing. As system complexity increases – and even though the human-machine interface improves and becomes easier to use – so users have to be both more intellectually capable and better educated and trained. Failure to keep the right balance between human understanding and control of complex unmanned systems and automatic execution could lead to serious consequences. There is probably already a need to revisit the existing provisions in law, especially concerning liability. A lot has yet to be achieved in human systems integration with complex robotic systems. ■