Adjustable Autonomy in Swarms of UAVs. ***Legras, F. & Coppin, G.; ENST Bretagne-LUSSI.***

Current UAV systems employ several human operators to control a single vehicle endowed with almost no decisional autonomy. As the next generation of systems will comprise several vehicles operating together, it appears that a change in the control ratio is needed alongside an increased decisional autonomy for the UAVs. Several well-documented problems can arise when a human operator is in control of a complex automated system like the classical example of the modern aircraft or power plant. These adverse effects of automation can be summed-up into four categories:

• excessive mental workload, for example due to badly-designed information display;
• loss situation awareness, as too much automation is going on behind the scenes;
• complacency, as the automation is so effective that the operator fails to recognize its failures;
• skill degradation, as the operator relies too much on automation.

There is no doubt that these classical problems will arise in the context of multiple UAVs control. We argue that there is a need to design new instruments that allow an operator to interact efficiently with a large number of semi-autonomous UAVs. Introducing adjustable autonomy in the various components of the system (perception, information analysis & display, decision, action) is the first step in this direction, but we propose
that this should be done with the following design principles in mind:

• exploit pre-existing mental models of the operators or construct new
ones that are easily integrated;
• using these, inform the operator of what the system is doing, why,
what it is about to do, and how it is going ;
• take advantage of this to involve the operator (allow him/her to
step-in in relation to this information).

In the framework of the SMAART project (funded by the DGA, French Ministry of Defense), we are currently conducting research on the control of a swarm of rotary-wings UAVs for the surveillance of critical sites like strategic air-bases, possibly in conjunction with other means of surveillance. One of the key features of this project is that a swarm-intelligence, emergent approach was chosen to control the UAVs rather than a more traditional (e.g. teamwork-based) approach. Rather than reasoning on mission objectives, strategies or goals, the UAVs decide their actions according to the local values of digital pheromones. Therefore, there is a real challenge in bridging the gap between the operator's and the system's representations. For example, the operator manipulates objects like the frequency of patrols in the vicinity of a hangar, or the presence of an intruder in the perimeter, whereas the UAVs base their behavior on several surimposed digital grids of numerical values which diffuse and evaporate. Adjustable autonomy in SMAART is used not only at the UAV level to affect how they determine their behavior, but also at the interface level. We propose to the operator several levels of information display and management, decision aid for the selection and dispatching of UAVs, etc. The system is currently in the software development phase and wizard of Oz simulation with operators in the loop will be conducted in late 2007.