CHALLENGES AIRLINES FACE
Each day of operation, an airline is often faced with challenges that may translate into large deviations of its fleet from original plans. These challenges arise from disruptive events, also known as irregularities, which can range from severe weather conditions, airport congestion, up to an aircraft mechanical failure. Such events impact all aspects of the airline’s operation, but are most detrimental to the schedules for basic resources such as aircraft and flight crews (Clarke 1998). The fact that a single flight does not depart on time, may result into passengers missing their next flight connection, or pilots not being able to continue flying due to work-rule regulations. Since a single flight leg is a component of different types of schedules, a perturbation in one leg may have significant downstream effects. According to (Ball et al. 2007), such fragility is exacerbated by the growing complexity of the air transportation system and the tight coupling of its various elements.

THE AOCC – THE AIRLINE’S NERVE CENTRE
In order to deal with disruptive events and reduce their impacts, major airlines have established Airline Operations Control Centres (AOCCs), as seen in Figure 1. These centres gather an extensive array of operational information and data, with the purpose of maintaining the safety of operations, and efficiently manage aircraft, crew, and passenger operations. A typical AOCC is comprised of different teams coordinating together during the aftermath of irregularities. These teams include operations controllers, crew planners, customer service coordinators, dispatchers, ATC coordinators, complemented by station operations control units at airports (Ball et al. 2007). When disruptions occur, these teams adjust in real-time the flight operations by delaying departures, cancelling flights, rerouting aircraft, re-assigning crews, and accommodating disrupted passengers. The AOCC is therefore a highly complex, dynamic, and fast paced environment in which decisions made by its operators facilitate disruption recovery. Clearly then, decision-making in this environment is critical, so even small improvements to the decision-making process could translate into significant revenues.

DECISION-MAKING AT THE AOCC
The importance of decision-making has been recognised in aviation with the focus predominantly on pilots and air traffic controllers in relation to safety aspects. However, only limited research appears to have been conducted in the AOCC. Yet, this decision-making environment is extremely intense and the outcomes of decisions made are critical to achieve desired operational outcomes. Operators at the AOCC are faced with different trade-offs every day. These trade-offs are created by the complexities inherent to the processes managed and the finite resources of operational systems. Potentially, there are conflicting goals leading to dilemmas and bottlenecks that must be dealt with. Examples include minimizing the fuel costs, maximizing on-time performance and customer satisfaction, complying with local regulations, minimizing the cost of reserve aircraft and crew, and rapid recovery from disruptions. The widely established system engineering approach has not been developed to capture the ‘socio’ part of a socio-technical system. Then it should not come as a surprise when this creates un-
foreseen behaviour that goes unnoticed during the implementation of a complex socio-technical system. Instead, such system behaviour should be identified early on in the development phase. This requires an approach to identify the emerging behaviour of a socio-technical system early in the development of changes in air transportation operations.

SOCIO-TECHNICAL PERSPECTIVE
The focus of this research is on human operators working at the AOCC environment and the impact this environment has on their work. The main objective is to develop a model that can capture both the physical and social reality of the AOCC, their interactions with one another, and the external dynamic environment. This is because a successful model of a socio-technical system is one that is able to deal with different configurations of both the social and physical network, enabling it to identify a suitable technology mix (van Dam 2009). In the Airline Operations Control (AOC) context, a suitable technology mix would be one that minimizes the impact and cost of disruptions, and improves safety. The model parameters are thus the humans, elements of the work environment and how they are connected and influence each other. Hence, the question this research aims to answer is: how can we model a socio-technical system like the AOC, in a way that will enable changing both social and physical system components, in order to evaluate AOC decision-making performance?

Our approach is to embrace Agent-Based Modelling and Simulation (ABMS) because it has been extensively used to: a) analyse complex socio-technical systems; and b) address cases where agents need to collaborate and solve problems in a distributed fashion. ABMS provides a platform to integrate multiple heterogeneous components at different levels. Models of actors, technological systems, and the operating environment as well as the interactions between them can be naturally covered. In the context of air transportation, in particular where different actors, hardware, and software are interacting elements of a complex socio-technical system, we consider agents as autonomous entities that are able to perceive their environment and act upon this environment. The agent-based model can be used to assess the impact of choices made during irregularities on multiple performance criteria, such as safety and economy. Scenarios involving new procedures and technologies can also be assessed. One example that the aviation community has been interested in recently is the Single Pilot Operations (SPO) concept. In this concept, the copilot may be on the ground, and may be looking after more than one aircraft at the same time. This is because advanced technologies, particularly communication and navigation capabilities, have already relieved the cockpit of a number of jobs. Direct communication means pilots could offload high workload tasks such as re-routing to an AOC system. The assessment of such advanced concept would serve as feedback for the operation design, through highlighting which activities automation should support, which model of decision-making automation should support, and how the role and responsibilities of the human agents can be best allocated towards safe and efficient air traffic operations. This process is visualised in Figure 2.