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Knowledge Acquisition for the Creation of Assistance Tools to the Management of Air Traffic Control

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Abstract. This paper presents an approach which has for objective to model new tools allowing to help the controllers to assume the incessant increase of the air traffic (actual version of the platform AMANDA V2), as well as help them in the negotiation phase and cooperation with their counterparts of adjacent sector (objectives of the new version of AMANDA). Help them in furnishing some tools able to quickly share information, and to maintain good common situation awareness. An approach is proposed, it is divided in three main phases. A first phase which consists of understand and to model the decision-making process of controllers. The second phase introduces a multiple criteria decision-making methodology. This Methodology has for objective to understand in more details the activities of controllers and the cases of cooperation with adjacent sectors. Finally, the last phase is the operational level of the approach, and consists of an application of repertory grid methodology in order to guide the interviews with the different participants of the study. This will allow realizing the knowledge acquisition, keeping in mind objective to develop new tools. To conclude this paper, the last part presents an example of application of this approach and the first results.

Keywords. Multiple Criteria Decision Making (MCDM), Repertory Grid, Human-Machine Cooperation, Situation Awareness, Air Traffic Control.

Introduction

The DGAC (French acronym for General Direction of Civil Aviation) foresees that in the next 10 to 20 years the air traffic will double or even triple. This increase of traffic will be impossible to assume with the current control methods. Indeed in a mental point of view, the number of aircraft and information to manage will be considerable and operators risk to be overloaded at certain times of the day, to the detriment of safety. It therefore becomes necessary to assist controllers in their work, offering them new tools and new ways of working that will allow them to assume this increase.

The LAMIH works with the DGAC since many years in this optical. The laboratory has developed several platform with a common philosophy which is to keep the operator at the centre of the loop, and thus to develop cooperative systems. The

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objectives are to extend the principles developed in the last platform, and for this it is necessary to understand how the planning controllers (PC) work.

To understand and analyse the activities of the PC, a multiple criteria analysis is proposed. This methodology will serve as support for the modelling of new space of cooperation between controllers of different sectors. A repertory grid methodology will be applied in order to guide the knowledge acquisition. This methodology is the operational part for the multiple criteria analysis.

This paper begins with a presentation of Air Traffic Control (ATC), with its problematic of traffic increase. The second part presents the project AMANDA (Automated machine MAN Delegation of Action), in its current version as well as the objectives of the new version. A third part presents the approach which is put in place, it is divided into three parts: the decision-making process modelling, application of a methodology multiple criteria decision making (MCDM) to support the collection of information and then the repertory grid as operational aspect of the knowledge acquisition. Finally a final section presents a first decision model based on the expertise of a "decision engineer".

1. Management of en-route air traffic

1.1. Organisation of Air Traffic Control

The ATC is organized in 3 layers: « Airport control », « Approach and terminal control » and « en-route control ». This latter layer manages flights passing through in the airspace between departure airport and the approach control of the destination airport. The Objective of en-route ATC is to guarantee the safety of aircraft and their passengers. To do this the controllers must take care that aircraft remain separate by a minimum separation distance (in vertical and horizontal level), while ensuring that they also respect the economic constraints of time and fuel consumption.

To simplify the management and the supervision of traffic, airspace is divided in geographical sector and in level of 1.000 feet. A sector is permanently supervised by two controllers, composed of a Planning Controller (PC) and an Executive Controller (EC). The PC coordinates the movement of aircraft between his sector and the adjacent sectors. This coordination consists in a negotiation of entrance levels and exit levels. The PC takes care too, to regulate the workload of EC. For his/her part, EC is in charge of sector supervision, that's mean to supervise that the aircraft respect the flight plans, and to maintain the safety distances. If the EC detects a possibility of crossing under this safety distance, he/she must do all is possible to restore the separation distances and avoid the conflict. Generally it is necessary to reroute one of the aircraft, and then to take back this aircraft in its original trajectory when the separation is guaranteed. This action is called conflict resolution.

1.2. Motivation of the study

Some statistics can quickly demonstrate the problem of air traffic control. In 25 years (1977 to 2002) the traffic transiting in the French airspace has increased of 250% [1]. The Air traffic is today higher than 2.500.000 aircraft per year that gives on average 7.000 aircraft per day. In a sector like Bordeaux for instance, the controllers must manage 20 to 25 aircraft per hour, this is the reasonable limit for the controllers. The

DGAC foresee that in 10 to 20 years these statistics go double even triple. The controllers risk thus to have some difficulties to manage this increase with actual tools (radar view, strip, telephone, radio) and risk to be overloaded to certain moment of the day, and this to the detriment of the security. Reduce sectors is now impossible, because the conflicts resolutions need a minimal geographical area.

A total automation of the ATC is impossible too, outside psychological consequence that this would induce to the passengers, the techniques to realise this automation, imply an entirely instrumentation of aircraft, that is not economically conceivable. Currently to avoid these overload of controllers, who could not maintain an optimal security level, different solutions are adopted, like the planning of flights and the regulation to the departure of airports, or the coordination between sectors that allows reducing the complexity of air conflict even to avoid that these conflicts had really happen.

2. Project AMANDA

The question is approached in terms of assistance to the controllers. Tools which help to improve the regulation of the workload of controllers are proposed. It is imperative that these tools come within perfectly the control tasks and the work of controllers (as a pair, as individually), to produce a beneficial effect. It is in this perspective that the project AMANDA [2, 3, 4], as well as others project developed in the laboratory since fifteen years [5, 6, 7], takes its place. These projects have always a same philosophy, which is to keep Human, operator, in the control loop. These projects do not research to fully automate the management of ATC, which would result in loss of competences for the operators, as well as a loss of situation awareness (SA) [8, 9], which would prevent operators to be able to react event of default by a system.

2.1. AMANDA V2

AMANDA V2 assists controllers (PC and EC) of one sector, in giving some tools which be able to allow a delegation of task [3], but also some tools which permit to share rapidly a same representation of airspace, and conflicts, and thus to maintain a common SA.

2.1.1. STAR

AMANDA integrates a tool of trajectory calculation and of assistance to the resolution of air conflict, called STAR. STAR works in cooperation with the controller. The controller detects a conflict; he/she has the possibility to use STAR to help his/her to resolve the conflict. To do this the controller indicates the strategy (called directive) that he/she desires apply to resolve the conflict. A directive or strategy is like, for example, « AFR1542 PASS_BEHIND KLM1080 ». STAR takes into account this directive in order to propose a solution. To do this STAR calculates the whole of trajectories which response to the directive, without, of course, create new conflict. STAR proposes then ONE trajectory to the controller (after a choice in function of some criteria like number of deviation, consumption of kerosene...). The controller can examine the solution proposed by STAR. If the solution is satisfactory, the controller can delegate the effectuation, that's mean the sending of instructions to aircraft. In this

case STAR has in charge to communicate instructions (change of heading, FL...) directly to the aircraft. Thus the controller is discharged of the effectuation and communication with pilots.

2.1.2. Common Work Space (CWS)

The CWS [10, 11, 12] is an essential notion introduced with AMANDA. This space allows a sharing of information between all agents (human, like controllers and artificial like STAR). Each agent can introduce new information in this CWS according to its competencies (know-how), and in accordance to its role (authority) in the process. All the agents can take this information into account in order to carry out their tasks, or to control and check those of the other agents.

This CWS allows mainly to maintain a common situation awareness between the two controllers, to share their representation of the problems (here in sense of air conflict or loss of separation) to supervise and/or to resolve. The controllers have the responsibility to maintain up to date this space, in order to, on the one hand to preserve a coherent "picture" of the situation and airspace, and on the other hand to inform the platform, and mainly STAR, with the conflicts that they detect.

2.2. Experimental results

The principles presented were tested experimentally with the help of qualified controllers regularly practising their functions. For that three scenarios of traffic were designed to test three experimental situations differentiated by the level of assistance provided [3]. The scenarios simulate a realistic traffic (traffic configurations usually encountered on a real sector) but twice more loaded than into reality.

From a general point of view, the general principle of providing assistance allowing a regulation of workload has been recognized relevant by controllers. In the situation where STAR and CWS assisted controllers, 93% of clusters expected were created. For 75% of these clusters a directive or a differed order was selected and 63% of those directives or differed orders have been delegated to STAR. In terms of workload, the tools available allowed to controllers to manage without any difficulty the traffic load.

The experimentations have emphasized that the tools have favoured the anticipation of controllers. However this anticipation has been increase by the absence of simulation of adjacent sectors. Indeed, the PC was liberate of the management of coordinations with the adjacent sectors, and has an entirely liberty to change the level of entry or exit of aircraft. This excess of anticipation has allowed to the PC to act on traffic and aircraft in order to reduce the number of conflicts. The workload of EC has been artificially reduced.

The module STAR has proved unsuited to the practice of the EC. Indeed, the calculation methods used provide a trajectory avoiding the aircraft at the meadows of the standard separation and returning to the original trajectory in the shortest. The controllers were then disconcerted by the efficiency of STAR. In addition, taking into account the unstable aircraft (changing flight level) by STAR was not optimal, as is the concept of "interfering" aircraft (aircraft that the system considers necessary to take into account to solve the conflict, and in many cases an unstable aircraft). The controllers do not seem to have this notion of interference, for them an aircraft is in the conflict or it is not.

2.3. AMANDA V3

The objectives of this new study are [4]: the integration of adjacent sectors and improvement of trajectory calculation, STAR. This integration of adjacent sectors consists of an extension of CWS principles to the cooperation between Planning Controllers of adjacent sectors. This new CWS will:

- Facilitate the negotiations between sectors; in allowing to quickly visualizing the flight concerned by negotiations (the workload, the time necessary, and the risk of ambiguity will be reduce).
- Allow to share between sectors: changes in the trajectory of aircraft, this should help to reduce uncertainty about the positions and conditions of entry for flights in a sector.

Concerning the module of calculation STAR, it is too much "efficacious" compared to the methods and habits of controllers. Indeed, the calculation methods use mathematical methods to provide the new trajectory allowing resolving the conflict. That gives "perfect" trajectories, avoiding the conflict aircraft at the meadows of the minimal separation distance (5 NM) and returning to the shortest to the original trajectory. This tool does not include additional factors introduced by controllers such as a safety margin above the minimal separation distance (15NM), a deviation rate (heading) comfortable ($<30^\circ$), an anticipation of unstable aircraft. The controllers were then surprised by the trajectories provided by STAR.

By adding the notion of adjacent sector, the decision evolves; it came out of the sector. It is therefore necessary to analyze and integrate in a coherent manner the decisions inside the sector and those outsides. To do this, a decision making model is required; it is the object of the following point.

2.4. Approach

The study is divided into three phases. The first phase focuses on the analysis and the structuring of the decision-making process. Several questions come up here. First of all, an analysis of the decisions of PC in phases of coordination with the adjacent sectors is required. But these decisions must be put in coherence with the decisions of the PC in the intern management of his/her sector. They must be also put in coherence with the intern management of the sector by the EC. This phase will conduct in a description of a coherent control decision process. This point is developed in more details in section 3.1.

The second phase is methodological. It aims to structure each decision of decision-making process. A general methodological framework must be researched to promote the coherence of each decision considering their links with the decision-making process. Several participants contribute to the decision; each one according to his/her owns value system. The methodological framework must also allow structuring the exchanges between the different participants in the decision. It should also help to identify, to represent and to manipulate the different value systems of the participants. This phase is described in section 3.2

The third phase is classic in the field of decision-support, it is the modelling phase. This phase aims to identify and to structure the elements allowing designing some tools to aid the decision makers. It is therefore necessary to collect the decisions elements handled by the controllers. It is important to note that the controllers are not the only holders of these elements. Staffs of Air Navigation in charge of the training of

controllers have a favourable position in this phase. It is the same with “decision engineer”, designers of tools present in AMANDA. However air traffic controllers are the only ones who can make validation judgments of model (through the results they produce). This phase is developed in section 3.3.

3. Structuring of problem

3.1. Decision-making process

The decisions of control are in line with a continuum. At the most complete level, they consist of to change the trajectory of the aircraft by applying adjustments to flights parameters of aircraft in order to resolve, operationally, a conflicting situation. The EC has in charge this operational level, and he/she can cooperate with STAR. It is the axis 3 on the figure 1, below.

Previously, these operational decisions have been prepared by the PC who has information before EC. The PC may already identify a conflict situation and inform the EC at the good time. This latter will integrate this new situation in the management of his/her traffic. He/she will specify the preparation, and the “pre detection” of PC to be able to operationalize later. The EC occupies a central position in the tactical level (axis 2 on figure 1) in collaboration with the PC. The CWS constitutes a cooperation help between the two controllers. The EC also has the possibility of cooperating with STAR in this tactical management.

Finally, at the sector level (axis 1 on figure 1), the PC is the first to have available the information about flights which preparing to pass in the sector. The PC gets a strategic vision of potential conflicting situations. The CWS enables him/her to explain this vision and to share it in order to the EC exploit these information to manage the sector. In the context of this strategic management, PC may come into contact with adjacent sectors with in order to change flights levels of entry or exit of aircraft to avoid a conflict in his/her s0ector and thus reduce preventively the workload of EC. The CWS is therefore quite naturally an area of strategic management between PC, coherent with the tactical management by the synthetic vision which it presents.

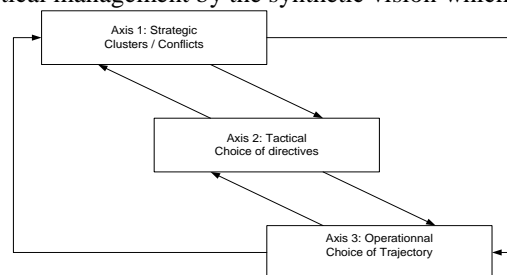


Figure 1 Synthesis diagram of three axes of the study, and the links between them.

These three axes are studied as independently as possible with the aim of obtain refined results and focused results on a specific problem, and therefore provide the opportunity to deepen each level. But the axes are interconnected; indeed choice a trajectory without having problems is somewhat surprising. It is thus quite logically, that appeared influence between axis 1 and 2 and between axis 2 and 3. The existence of operational decisions quickly appears plausible in the current state of our thinking.

These quickly decisions correspond on a direct link between the axis 1 and the axis 3. This possibility will be studied.

3.2. Multiple criteria methodology

The job of an air traffic controller is characterized by the research for a compromise between different value systems. This is typically the concept of managing flows aircraft. Thereby, the controllers act on the traffic by ensuring optimal security, while trying to reduce delays and the consumption of fuel. ATC is by nature multiple criteria. It is quite unrealistic to summarize the actions taken by the controllers in a single goal, which would be safety, the cost or time. In addition, the actions of the controllers constitute the terminal part of the management of control situations. They are therefore the result of decisions taken previously by controllers. Consequently, it seems appropriate to address the design of aid with the point of view of the methodology of Multiple Criteria Decision Making (MCDM).

The MCDM methodology [14] replaces the concept of decision as resulting from the wider concept of the decision-making process wherein several participants can play a role in their own interests. For that reason, the study of decision-making problem is itself accentuated.

The MCDM methodology proceeds in four levels (figure 2). The first level is to clearly define the potential actions. The potential actions are all possibilities (real or fictitious) on the basis of which the decision is made. The criteria (level 2) are the factors (witness of the decision) which characterize the potential actions for decide. Preferences (level 3) are a set of rules by which the potential actions are put in relation across criteria. Finally, the level 4 is the establishment of a recommendation. This is the operational level of the methodology, the implementation.

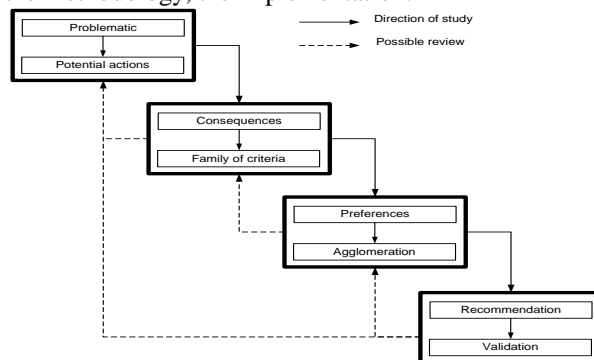


Figure 2 Synthesis diagram of the Multiple criteria Decision Making methodology (MCDM).

The study of three axes independently will therefore lead to conduct three MCDM, and thus to define three problematic; obtain three families of criteria... But the recommendation (level 4) will be most certainly more overall. For example during cooperation between PC, the strategic level, the PC can be lead to justify his/her requests, the operational level. In any case, it will result of these three studies only one cooperative system, a single platform. This platform will be composed of different decisions, tools different responding and corresponding to each of the recommendations and axes, but they will be grouped within a single environment, CWS.

Human Machine Cooperation aspect is the unifying thread of the study. This aspect takes place essentially in the level 4, the recommendation. The main objective is to understand the steps and the use that the controllers do of adjacent sectors, their manner of cooperate... Human Machine Cooperation aspect can thus be considered as a synthesis of MCDM.

3.3. Repertory grid

Repertory grid is a methodology developed by an American psychologist, Georges Kelly (1955) [15], in order to study the psychological construct in pathological case (schizophrenia...). This method will allow compare « elements » (different event, actions, states or entities). To do that, the method will « force » the patient to ask him/her and thus establish a list of « constructs », as exhaustive as possible. The constructs are divided in two groups: the similarities and contrasts. Each construct (similarities or contrasts) will be then evaluated or weighted in function of the different elements of the grid. The elements, the constructs, and the weighting will represent the « construct map » of the patient.

The standard representation of a repertory grid is a matrix, with in column, the elements, and in rows, the constructs. The constructs are divided in two poles, and generally the similarities, obtained in first, are on the left of the matrix, and the contrasts are on the right (see table 1). At the intersection of each pair element-construct there is a weighting given by the subject and which represents how the subject applies or evaluates a construct in relation to an element.

Table 1 Standard representation of repertory grid

	ELEMENTS	
Constructs: Similarities	Weight	Constructs: Contrasts

To establish the list of constructs, it is several methods; one of the most common is the “triad methods” which consist in taking 3 elements and to ask itself what two elements have in common that the third has not. The list of similarities and contrasts is thus obtained in comparing each element with this method, or until the subject has no new construct to propose. The second step is to complete the grid with weightings. It is possible to use 5 weightings (1, 2, 3, 4 and 5) or 9. The most frequently use is a weighting of 5, avoiding thus a too important dispersion. The principle is the following: the subject uses a 1 if the element is near of the notion of similarities of the construct, and 5 if it is rather the contrast side. A 2 (similarity) or 4 (contrast) will be used if the notion, evoked by the construct, is less evident that previously. And finally a weighting 3 exists, if the subject can not, or be not able to evaluate the element, the subject has no preference.

The overall problem detection / resolution of conflict is divided in three axes. These axes will be studied independently. Three MCDM will be therefore applied, and hence at least a repertory grid for each MCDM [16]. The grids will be built with the results of the AMANDA V2 experiments.

During the AMANDA V2 experiments, all data have been recorded, that means that it is possible to replay what the controllers have made (creation of clusters, choice of directives and deviation of aircraft, use of interfaces...). Data will be used in order to identify interesting cases, and to use them for interviews with the different participants (controllers, instructors, but also "decision engineer", in this case, the designers of

experimental situations). Interesting case means for example, if the reactions of controllers were different: the creation of cluster, or in the choice of a directive or a trajectory to be applied. This analysis of the results will provide a number of cases which will be then submitted in a first time to the "decision engineers", which will try to understand and to explain the actions of controllers and this with another point of view.

4. A first decision model

From the results of AMANDA V2 experiments, a collection of grid was built, and presents to the participants a variety of elements (in sense of Kelly) that they will be analyze. These elements are the potential actions relative to the studied axis. In axis 1 (conflict detection, clusters), it is the typical conflicting situation in the sector, or conflicts which have aroused among controllers varied and different responses. The first grid (for which the elements submitted to the participants are presented in the table 2) is based on both a conflict fairly typical for the sector (here Bordeaux), and for which the responses of controllers are all different.

Table 2 Repertory grid proposed to the subject

BAL632 KLM1884	BAL632 KLM1884	BAL632 KLM1884	BAL632 KLM1884	BAL632 KLM1884
BCS1080	AFR1657 BCS1080	AFR1657 AEL2789	AFR1657	

The table 2 corresponds to the elements which are in the repertory grid, presented to the controllers. This table is composed by the different clusters proposed by controllers² during AMANDA V2 experiments. The first row corresponds to the real conflict. That means that the BAL632 and the KLM1884 pass on the beacon "VELIN" with less of one minute. These two aircraft are not separated by the minimal distance of separation (5NM). The second row corresponds to the additional aircraft that the controllers of Bordeaux have choice to take into account to resolve the conflict. These aircraft are called "interfering aircraft", that means that they are not directly in conflict with the BAL632 or with the KLM1884, but it is necessary to take these aircraft into account to resolve the conflict. For example if the controller reroute the BAL632 it is necessary to take care to the AFR1657 which is just behind the KLM1884. These interfering or contextual aircraft are thus constraint in the phase of resolution.

This first grid is proposed to a « decision engineer », who is one of the designers of the platform, and who has created the experimental situation. He known relatively well the sector and its configuration, and have a good expertise of the job of controllers.

The first key point is the variety of responses from different pairs of controllers during the experiments. All controllers have detected the conflicts and included the BAL632 and the KLM1884 in the cluster, but what would have mean if these two aircraft are not in the cluster? The likely answer is that in this case the aircraft had been reroute upstream (previous sector), and thus the conflict did not exist. This manoeuvre involves coordination between the two sectors.

² A radar view is proposed in figure 3 to better understand the situation

The second construct proposed by the subject concerns the presence of the AFR1657. The AFR1657 is not engaged directly in the conflict, but to take into account for a resolution. For the subject, the AFR1657 is therefore essential in the conflict because it constrains strongly the BAL632 trajectory. For him the fact that it is not here in some clusters does not mean that controllers do not taken into account of this aircraft, but they exclude certain resolutions which can be problematic. It appears that controllers have an idea of how they will resolve the conflict, before the creation of the cluster.

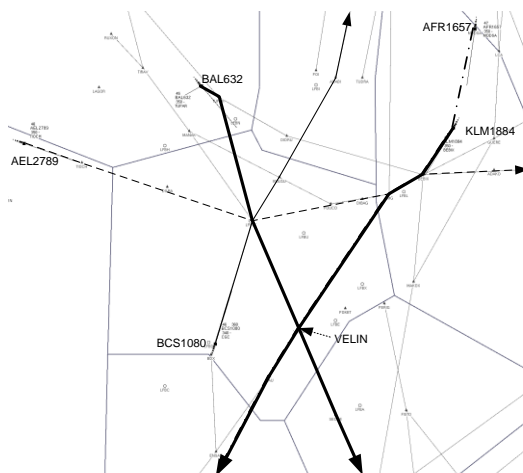


Figure 3 Radar view of the conflict

The third constructs proposed, is the case of BCS1080, which is an unstable aircraft (changing Flight Level). In other words, it will necessarily come to cross flight level 350, where the conflict is situated. The controllers do not control well the climb ratio (or down) of aircraft. In the same way that AFR1657, BCS1080 will therefore constrain the future trajectory of BAL632. Half of the pairs have added this aircraft, and have decided to climb very early so that it does not interfere with the trajectory of BAL632 (with the exception that the pilot acts rapidly). This requires anticipation for instruction on BCS1080, maybe even upstream of the sector, and therefore coordination. The other pairs felt that the aircraft was not a problem, because it has enough time to climb, and not interfere with the trajectory of BAL632.

Finally the fourth construct proposed by the subject is the case of AEL2789. The AEL2789 only included in a single cluster. It is true that its involvement in the conflict is not obvious because it is relatively far from the aircraft (BAL632 and KLM1884). However, it must be taken into account if the controller chose to reroute the AFR1657 to put behind the BAL632. In this case the AFR1657 will be closer to the AEL2789 and it is necessary to supervise the distance between this two aircraft. For other pairs, for which a deviation on the AFR1657 was not envisaged, the AEL2789 was no problem, and had no reason to be included in the cluster.

The first point which appear, and which is important is the fact that controllers already have a fairly accurate idea of how they will resolve a conflict even before creating the cluster. This "knowledge" of the solution is very decisive for the choice of aircraft to be taken into account. Depending on the strategy already established, the controllers therefore choose only the aircraft that will be a problem in the application of

their strategy for resolving the conflict. This is therefore clearly a link between the axis 2 and the axis 1 of the decision-making process (Figure 1).

From this first grid, it is already possible to extract criteria, which are subject to confirmation with other grids and validated by controllers. The first criterion is that to be in a cluster, an aircraft must really be a problem and have an involvement towards the resolution strategy that the controller has imagined. It is the case of the AFR1657.

The second issue concerns the unstable aircraft (here the BCS1080). The controllers do not control well these aircraft, and their trajectories. So an important criterion will be the anticipation. Anticipating an unstable aircraft can make possible that this aircraft will be on its new level before it crosses the initial problem (2 pairs of controllers do it and they consider that the BCS1080 is not embarrassing). But this anticipation takes time, and a reasonable workload, and involves coordination in most cases. This can become difficult with the increase of traffic.

Table 3 Result of first repertory grid

Similarities	BAL632 KLM1884	BAL632 KLM1884	BAL632 KLM1884	BAL632 KLM1884	BAL632 KLM1884	Contrast
	BCS1080	AFR1657 BCS1080	AFR1657 AEL2789	AFR1657		
BAL-KLM Basis conflict	1	1	1	1	1	Absence of BAL-KLM
AFR constraint BAL632	5	1	1	1	5	AFR take into account, not included
BCS constraint BAL Anticipation	1	1	5	5	5	BCS1080 is another conflict.
AEL in conflict if action on AFR	5	5	1	5	5	AEL no problem

5. Conclusion

This paper begins with an introduction of Air Traffic Control and presents the problematic, which is the increase in air traffic. The second part presents the platform AMANDA developed in the laboratory, which has for objectives to help controllers in their tasks, only on one controlling position for the moment.

The platform is composed of two main tools: A module for trajectories calculating, as well as delegation of tasks (STAR), and a space of cooperation between the controllers and the tools, called Common Work Space (CWS). Thanks to these tools, the controllers can cooperate more efficiently, and to discharge a portion of the activity (the calculation and application of trajectories) to manage new aircraft. These tools have been tested with professional controllers and have obtained encouraging results. These results lead to the new version, AMANDA V3 which is the centre of this article. The objectives of this new version are presented at the end of the second part, and they concerned particularly the introduction of adjacent sectors.

The third part concerns the establishment of an approach to model the new tools of AMANDA V3. This approach is divided into three main points; the first is to model the decision-making process of controllers. The second point is a presentation of the MCDM methodology. This MCDM will guide the study. And the last point concerns the repertory grid methodology, which will serve of operational support to the MCDM,

and will support the interviews and the knowledge acquisition. Finally a last section presents an initial decision model, and an application of the approach to one axis of our decision-making process.

The continuation of this study will be to achieve other grid on three axes, in order to obtain as much information as possible, and to determine a set of criteria and a model of preferences. This work will be done largely with decision engineers, who are also the designers of the platform. Then it will be necessary to validate all the criteria and preferences with operational controllers.

Acknowledgments

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