

The Value of the Challenge three years later

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1 Introduction

In 2008-2009, The French Operational Research and Decision Support Society (ROADEF), together with Amadeus, organized an Operations Research competition dedicated to integrated aircraft and passenger recovery [1]. Three years after the Roadef Challenge on Airline Disruption Management, what is left for the OR community, for the Airline OR community? for Amadeus? Was it worth the effort?

The answer is an absolute and clear YES! This short paper goes through the history of the competition from the Amadeus and Industrial perspective and details its achievements in section 2. Section 3 discusses how the Challenge fits in the Amadeus diversification strategy. Section 4 discusses the preparation and execution phase, and Section 5 presents the latest developments, and how Amadeus has been building upon the outcomes of the competition.

2 Achievements and Outcomes of the Competition

The competition was based on medium-size to very large instances and a stringent CPU limit for each solution. The instances involved local and global disruptions, as well as a variety of disruption types, *e.g.* delays, cancelations, reduced airport capacity, and grounded aircraft. The comparison was based on a multi-criteria evaluation function including airline operating costs and passenger inconveniences. A number of teams succeeded with a variety of methods in complying with the CPU requirements. The proposed approaches include MIP-based methods, minimum-cost network flow models, hierarchical decomposition frameworks with or without iterative coordination procedures, heuristic approaches based on the use of shortest path methods, and hybrid methods combining some of the above mentioned methods to oscillation strategies.

Altogether, and despite a set of necessary assumptions and simplifications, the problem formulation was general enough to make the benchmark a reference point for any industrial development.

Furthermore, one can emphasize three significant contributions:

- The generation of public and large integrated aircraft and passenger recovery instances, as well as the access to public engines for solution feasibility and cost evaluation. This framework allows to evaluate the generality of any academic or industrial development.
- The high importance set on passenger recovery, as reflected by the evaluation function, forced significant research effort to address this issue as part of the integrated problem, but also specifically. [2] shows that Passenger Recovery has not been thoroughly studied to say the least. Additionally, airlines are currently striving to make their operations more customer driven, with a huge and known room for improvement in the area of disruption management.
- Several successful solution methods were proposed, documented, and compared. These results are also available, whether for future research, for the airline industry, and for our fellow competitors.

3 Origins of the 2009 Challenge

3.1 New division within Amadeus

In 2006, Amadeus creates the Operations Research and Innovation division, which mission is to support the diversification strategy by conducting studies to evaluate the risks and opportunities of a variety of potential projects, with a technical focus. In the Airline IT field, Amadeus products are traditionally positioned to support the airline commercial, marketing, and passenger management functions. By working with the OR community and its industrial OR peers, the ORI division gathers scientific contributions, collects feedback on the conducted studies, shares experiences, which altogether strengthens its production.

3.2 New research area within Amadeus

In the early 2000s Amadeus penetrated the area of airline operations, supporting functions such as Schedule Mangement, or the so-called flight *Departure Control* process, which handles flight preparation from passenger check-in and boarding to aircraft load and balance control.

In the Airline OR community, the Disruption Management problem is known to be relatively complex and certainly challenging. At a first glance, it may seem inappropriate to start an airline OR activity on such a difficult problem. Now, back in the early 2000s, not only Amadeus had started working in the area of airline operations, but also had it acquired a strong knowledge

of passenger reaccommodation, also known as passenger recovery, through the development of Amadeus Altea, its Passenger Support System.

From a more industrial perspective, Disruption Management gave Amadeus the opportunity to build upon its established competence in real time and large scale operational systems. Despite these, Disruption Management was still a new functional area, for which the ORI division had to develop a thorough business understanding. The Roadef Challenge appeared as an excellent opportunity to formalize the problem understanding and gather the acquired knowledge as part of the development specification effort, which had started in parallel.

4 Starting and Running the Challenge

As for any project, one of the very first issues to be cleared was to set the scope of the problem. Disruption Management is an airline function handled by so-called Operations Control Centres, or OCC. An OCC can be seen as an airline cockpit, where the real time decisions are made about how to operate the airline. At many airlines, the OCC integrates or coordinates with a wide number of functions, such as aircraft & engineering, commercial, crew, customer service, ground staff and ground resources, catering. By restricting the scope to aircraft & engineering and passengers, one may think of an oversimplified problem, which is not the case. At best, in real-life, an OCC's decisions are based on a specific decision process for each specific resource. These processes are orchestrated in a hierarchical manner, with a coordination between Crew and aircraft & engineering at the top hierarchical level. Many airlines try to make this top level coordination between Crew and aircraft & engineering more customer and commercially driven. By developing an integrated decision process for aircraft and passengers, the Roadef Challenge is aiming at an aircraft & engineering decision process fully integrated with passengers. This would allow for the top hierarchical decision level to be effectively customer and commercially driven. The subsequent steps of the overall decision process would remain unchanged.

Beyond scoping, a number of tasks and activities had to be carried out. Going through those which involved some level of complexity, one can list

- Cost Function formalization
- Developing a Disruption Management Simulation Framework, with the holy data instances
- Deciding on simplifications
 - Should Crew Schedule Management be integrated to the problem formulation?
 - Should one severely restrict the creation of ferry flights to remain as close as possible to the real life problem?

- Which type of maintenance requirements should be formalized?
- Developing unbiased solution validation and evaluation engines
- Developing an infrastructure to automate the evaluation of competitors' engines and generate the result tables automatically
- Last but not least, defining a ranking formulation over many instances, and accounting for invalid solutions, was not a given.

And not surprisingly, a number of corrections, bug fixes, and formulation adjustments were done along the way, as competitors were reporting issues, which did not make the Challenge organization any simpler. At evaluation time, environment compatibility issues had to be addressed and substantial assistance was provided to the competitors to help them have the right environment at their end.

Altogether, this represented a significant effort for both the ROADEF team and the Amadeus team; and the collaboration between them was essential to overcome the most complex situations.

5 After the Competition

5.1 Setting up a Research Partnership

Following the announcement of the results at the ROADEF conference in Nancy, a workshop was organized at Amadeus in Sophia-Antipolis. The three winners presented their work, and the ROADEF team presented the competition, to a large Amadeus audience, mainly from Development and Marketing entities. Unsurprisingly, a long time before the end of the Challenge had Amadeus decided to engage a research partnership after the competition with one of the contenders. By the end of the competition, informal and natural discussions with the participating research labs were held in that perspective. The main discriminating factor was actually a combination of the performance per se, and the simplicity of the approach. The latter was an important criteria in the perspective of an industrial application, which would involve a number of evolutions.

From this angle, the ENAC-LAAS team with Mancel, Josefowicz, and Mora-Camino appeared as a clear leader, though they were not even on the podium. Their results on several instances were very competitive with the shortest run times, by far. The simplicity of their solution methods made us guess that minor bugs were making it fail on some instances. And, this was the reason for their overall underperformance.

An additional issue we faced, was the fact that the Senior teams were, in general, composed of confirmed researchers, with academic positions and commitments. This meant that the actual Challenge participants would not be able to fully focus on the partnership we were after, and that

may require the involvement of another lab member, who would not be familiar with the problem. Though, the team which ranked third, was actually lead by a student about to complete his Ph.D. Their approach was both original and already proven in the rail context, which demonstrated its generality. Eventually a PostDoc project with the ENAC-LAAS team was setup, and the student was selected for the PostDoc position.

5.2 Two years later

Severe disruptions have taken place since the end of the Challenge, with climate and natural disasters, and more recently industrial catastrophe, making disruption management a yet more important function of Airline Management. It is also striking to see that disruptions can be so systemic, that the airline may loose control of which customers are to be reaccommodated, and may not even know when it can resume operations. As such a further complexity dimension should be taken care of.

Amadeus has developed a combination of optimization engines, part of a comprehensive decision support system for disruption management. This optimization machinery has been evaluated on real data, which lead to further enhancements. The algorithmic foundation of these engines is found in the Roadef Challenge. Today, we are happy to see the ROADEF team investing effort in strengthening the benchmark, while we promote the benchmark in the Airline OR Community and invite our competitors to join the challenge. By that we seek to create a constructive emulation environment, and make the progress of our industry more transparent.

References

- [1] M.Palpant, M.Boudia, C.-A. Robelin, S.Gabteni, F.Laburthe, “ROADEF 2009 Challenge: Disruption Management for Commercial Aviation”, www.roadef.org (2008).
- [2] R.Acuna-Agost, M.Boudia, S.Gabteni, N.Jozefowicz, C.Mancel “A Revised Integrated Aircraft-Passenger Approach for Disruption Management in Airlines”, TRISTAN VII (2010).