

AIRPORT TECHNOLOGY LAB

Interview with Elise Bavelaar, Dr. Mihaela Mitici and Mike Zoutendijk

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INTERVIEW/ATO



It is commonplace to have a laboratory for experimental aerodynamics, heat transfer, etc. But have you ever encountered a laboratory that not only studies but even develops and suggests innovations in airport functioning based on their operational data? As part of this pioneering effort, we spoke with Elise Bavelaar, Project Manager-Airports of the Valorisation Centre, Assistant Professor Dr. Mihaela Mitici and PhD candidate Mike Zoutendijk from TU Delft.

Thank you so much for joining us Elise! It is a pleasure to be talking to you. Please give us a short introduction about yourself and your career so far.

My name is Elise Bavelaar, and I am currently working as a project manager at the Valorisation Centre at TU Delft. I have a background in Aerospace Engineering. I finished my bachelor's and master's program at the Faculty of Aerospace Engineering at TU Delft. I did a specialization in the Air Transport and Operations section of the aerospace faculty where I obtained knowledge pertaining to the domain of airports and airlines. After graduation, I had the opportunity to start as a project coordinator within the Innovation Airport Initiative (IAI). This is an initiative started by the aerospace faculty and Delft Deltas, Infrastructures and Mobility Initiative (DIMI), which is a research-based initiative at TU Delft focusing on setting up interdisciplinary research and education projects in close collaboration with the industry. I worked as the innovation airport coordinator for four years at the faculty. Since March last year, I switched positions within TU Delft and started as a project manager at the Valorisation Center with a focus on airports and airlines. In my current role, I am still involved with the Airport Technology Lab (ATL), a fieldlab that originated from the IAI.

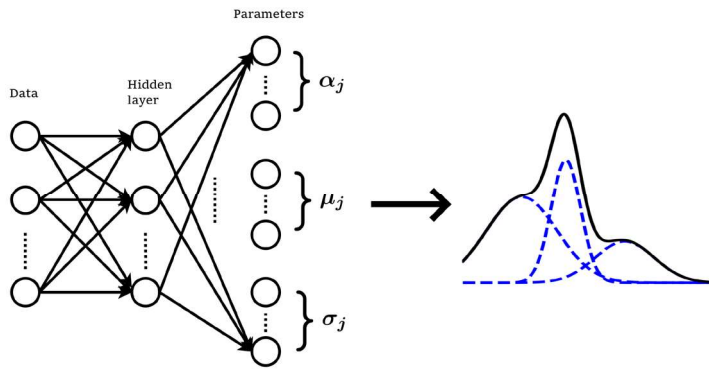
Thank you for your introduction. You mentioned that you are the project coordinator of the IAI. Can you tell us a little more about it?

The IAI is one of DIMI's and Aerospace Engineering faculty's special projects. It started in 2016 because of the shared ambition of the two parties to combine the knowledge and expertise of all TU Delft faculties in the field of airports. Among all the faculties that are currently present in TU Delft, the Aerospace Engineering faculty admittedly is the most knowledgeable in this domain. However, there are also other faculties that contribute key elements to the development of airports. Our ambition was to combine the collective knowledge of the Aerospace faculty in addition to other faculties, enabling us to achieve a lot more. Given the current challenges that the entire aerospace industry is facing, we have a strong conviction that our work can play a significant role. This was the reason behind starting IAI. Our goal was to first identify the required expertise and tie it up with collaborations from the industry. This was the first element of IAI. The second one was about setting up a fieldlab. The objective of doing so was to be able to develop, test and validate our research. This also gives us a chance to work with the industry and other stakeholders to encourage innovation. By

stakeholders, I do not specifically mean the big industries, but also the small and medium scale industries and start-ups, knowledge, and educational organizations. After a few years, we had established a good connection with the Rotterdam The Hague Airport (RTHA) and in the end, we were able to set up the ATL, which is a field-lab focusing on digital innovations. So yes, this is in short, an introduction to the IAI, which finally leads to the ATL amongst others. We also have many other projects in collaboration with RTHA and their innovation organization, Rotterdam the Hague Innovation Airport (RHIA).

That was a very well-structured run down of the events leading up to the establishment of the ATL. Can you give us a description of the specific activities of the ATL?

To start off with, I will talk about the goal of the ATL before touching on the specific activities of the ATL. As I said before, ATL is a field-lab that was set up to develop data-driven innovation, projects, and services. What this means is that such innovations do not specifically focus on achieving one goal; this field-lab enables improvements in various areas – such as sustainability, safety, security, passenger comfort, and resilience. These are all very important challenges that the aviation and airport sector should address. This is the general goal of the ATL. To achieve this goal, we work together with multiple businesses, knowledge institutions, and of course, the airport. Within the ATL, we have three main activities. We are working on establishing a field-lab infrastructure that will give us the ability to test and demonstrate research and innovations. An important element of the ATL is called the 'open airport platform'. This is a platform where partners can access and work with airport related data. The second main activity is the execution of various innovation projects. I will come back to this later when I highlight the role of the other faculties. The third main activity is the setup of a knowledge development and dissemination program where we share knowledge and link education to challenges that come up in this ATL. This also gives a chance for start-ups to collaborate and share experiences with each other. These are the three main activities of the ATL.



MIKE ZOUTENDIJK

A schematic representation of one of the methods used to predict a probability distribution for flight delay, called Mixture Density Networks. A neural network is used to predict parameters for a multimodal Gaussian distribution.

Surely these goals cannot be achieved by one team. I am sure that there are many stakeholders who play their part in fulfilling the goals of the ATL. Can you tell us a little more about the role played by the different stakeholders in such a collaborative environment and how they are instrumental towards achieving the final goal of the ATL?

I will start with the Air Transport and Operations section of the Aerospace faculty. We are working on three projects within the ATL. The first one focuses on airport data analytics and flight-to-gate planning. This is a project supervised by Assistant Professor Dr. Mihaela Mitici, along with PhD candidate Mike Zoutendijk. They are developing a tool to predict airside disruptions by using machine learning techniques. There is a lot of data available with the airports. With this data and machine learning, disruptions can be better predicted. If the cause of the disruptions is clear, the flight schedule and operation can accordingly be improved. How does it contribute to the goal of the ATL? With this tool, the efficiency and resilience of the operation can be improved. It has a lot of benefits. This is the first project from the Aerospace faculty. Dr. Mitici will touch upon the finer details of this project later on.

The second one is a project led by Assistant Professor Dr. Alexei Sharpanskykh and two researchers – a postdoctoral researcher, Dr. Sahand Mohammadi Ziabari and Ir. Adin Mekic. They focus on a tool to simulate passenger flows inside the airport terminal. Within the ATL, they specifically look at call-to-gate strategy and remote check-in of baggage. With this tool, they are simulating the efficiency, security, and resilience of airport terminal processes, primarily passenger streams. They can optimize passenger flows through the terminal while achieving the call-to-gate strategy. Within each of these projects, they also work with other partners. We do the research, while the other partners work towards the practical implementation of these tools.

The second faculty is the faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS). Here, the radar technol-

ogy research is led by Professor Yaravoy along with several researchers and a PhD candidate, Tworit Dash. They are working on a weather nowcasting model along with several other partners. They are extending the applicability of the radar system that is currently at the airport. This can give Air Traffic Control (ATC) more insight into the current weather conditions. With turbulence prediction at take-off and this weather nowcasting model, turbulence between two aircraft can be better predicted. This will ultimately lead to safer take-off and landing procedures.

The next faculty that is involved is the faculty of Industrial Design Engineering (IDE). They are connected to this knowledge development and exchange program. They try to connect bachelor, master, and student projects with the partners of the ATL. Students are allowed to work on challenges that come up in these innovation projects. This is the role of IDE. We are not the only educational institution that is involved. There is also the Haagse Hogeschool and MBO Rijnland. From the Valorisation Center, we are also involved with the start-up and accelerator program. So that is in detail about all faculties and stakeholders who are responsible for the activities of the ATL.

That is a very informative description that you have provided us with. It more than answers the question. We know that TU Delft houses some of the brightest technical minds in Europe and perhaps even in the whole world. However, an initiative such as IAI has projects that not only involve technology, but also other elements such as leadership, business acumen and so on. How do you see this lab providing the students sufficient skills in areas that do not necessarily involve technology?

It does not necessarily connect only to the ATL. Of course, I already mentioned that we give students opportunities via IDE to work on ATL related challenges. If you look at the whole operation, it includes not just technology, but also economics, psychology, passenger behavior etc. So, if you want to make improvements in this sector, you need more of a holistic approach which takes care of

more than just technology. The complexity of the assignments already lets you come across these different elements. When you get a chance to work in this lab, you will get acquainted with this for sure. In addition, if you go to these field-labs, you experience an increasingly practical environment. You get connected to not only the airports, but also other businesses that provide specific tools. If you step into this environment, you must find out how to bring this theory that we experience in studies to the practical environment. This is challenging and gives you a chance to develop management and leadership skills. This is a hallmark of a field-lab – we can conduct research in a more practical setting. It also gives small and medium enterprises and start-ups a chance to accelerate their activities.

We see that there is a lot of talk about projects such as EU Joint Clean Sky project, Urban Air Mobility and so on. How is it that you managed to make stakeholders see value in a field lab such as ATL especially at a time when others are investing heavily in the areas that I mentioned previously?

I must mention that I did not do all that by myself. I am coordinating the activities of TU Delft. However, we also have the airport and the other companies as well. While setting up this lab, we applied for a European Regional Development Fund via the Kansens voor West Program, which helped to kick-start the field-lab. In the end, it was a team effort. We managed to do it owing to aid from various people across several organizations. On one end, I had to identify research projects that had reached maturity in the university, ones which we wanted to develop further. We had to connect it to the interests of the airport and the partners that were involved. You can imagine that it was a long and intense process. But it helps to have a common goal. We wanted to develop this field-lab where we could collaborate in a good way, perform research, develop innovation, and connect education. In the end, we all have different interests but if you have the same end goal, you can find common ground. So that was how we were able to set up this subsidy proposal, which lays down the foundation of the ATL.

Indeed. Focused effort always pays in the end. Thank you very much Elise, for sharing your thoughts on the ATL. You had mentioned one of the projects that is currently being done in the ATL, headed by Dr. Mihaela Mitici. We will now continue our interview with her and the PhD candidate Mike Zoutendijk to go a little deeper into their area of research. Dr. Mitici, please give us an introduction.

I am Mihaela Mitici and I work as an assistant professor in the Air Transport and Operations (ATO) group. My background is in stochastic operations optimization, so I focus on enabling the transition from predictive models

to the optimization of operations. Practical applications mainly focus on aircraft maintenance and airport operations. I have been working on the ATL project for a year now. I focus on the airside operations and I am supervising Mike, who is doing a PhD on data-driven airport operations.

Thank you Dr. Mitici. We would like to know a little bit about you Mike, please introduce yourself.

Thank you for this opportunity. I am a first year PhD student at the air transport and operations section and my background is in mathematics and physics. I did my bachelor's and master's at the TU Delft EEMCS. The focus of my PhD is mostly to apply data-driven technologies or machine learning for airside operations such as flight-to-gate assignment and electric taxiing.

Dr. Mitici, you mentioned the research that your group is handling – can you go a little more in detail with how this whole research idea came about, and what is the background for this area of research?

We were discussing with Rotterdam The Hague Airport (RTHA) and our key partner, Adecs AirSystems, about innovation possibilities. We saw many opportunities to use airport data to support the way planners at airports manage their day-to-day operations. So, together, we set up the ATL project. At the end of the day, we want to have a hub of innovation at Rotterdam Airport: we want to test our ideas and see what type of meaningful information we can get from the smart processing of the data using machine learning, to predict, for instance, flight delays. With these types of predictions, we can plan operations efficiently. We focus on operations such as flight-to-gate assignment, which is quite a labor-intensive activity especially when flights are delayed or cancelled. We analyze in a similar manner novel operations such as, electric taxiing. Ultimately, we are interested in increasing the sustainability of airports using taxibots for electric taxiing.

As for results, we have already developed prediction algorithms to anticipate whether the flight will be delayed or not. We are now perfecting these binary predictions to be able to estimate the probability distribution of delays. With such information, for example we can plan flight-to-gate assignments in a robust manner.

You mentioned a very interesting thing about predicting the distribution of, for example, a known percentage chance a flight can be delayed – so, how do you see and how do you envision this technology or the research output from what you are conducting right now to be translated into everyday use? Can you tell us a little bit about the expected timeline for implementation and possible roadblocks that you might encounter in doing so?

We think that starting to work with Rotterdam

The Hague Airport, which is a regional airport, allows us to really test our ideas. We see what works and what does not; our ambition is to also be able to implement our models at large airports such as Schiphol. Now, we have models that can handle the operations quite well at RTHA. But we think that we can extend these models for Schiphol Airport, or maybe for other regional airports such as Eindhoven. In general, for us, ATL is a great first step to enable the transfer of data from airports to universities to support innovation.

Would you like to add anything, Mike?

So, in principle, you can apply the approach to other airports already. Larger airports of course, have more requirements. But indeed, if you have the data and an agreement to work with their data, you can apply these techniques, so that is the outlook for the future.

I think that this was a very detailed and important answer as well because we are always doing research on more idealistic situations, and we are always looking at ways in which this can translate into practical use. Going forward, we all know how the year 2020 has been challenging in different ways, and everyone had to adapt – especially the aviation sector. So, do you think it is an opportune moment that the ATL kicked off right when it was probably needed the most, and how do you see it helping the aviation sector, in this case, the airports, overcoming possible future scenarios like the pandemic?

For us, the pandemic time was difficult. When we set-up this project, we envisioned that Mike would actively be visiting the experts at RTHA. This was, of course, not possible. We do have online meetings, so we managed, but we do miss the face-to-face interaction with the experts. How could our research help in these COVID times? I think having good flight delay prediction models helps airports to prepare for what may happen tomorrow. So, especially in these times, our models can help the airport planners to allocate their resources better.

As a student starting your PhD during the pandemic, do you have something to add, Mike? What were some of the challenges in doing such a dynamic project, especially when you factor what Dr. Mitici mentioned, that you must really be involved on a physical level with the stakeholders?



Elise Bavelaar, Project Manager Airports at TU Delft (top), Dr. Mihaela Mitici, Assistant Professor, Air Transport and Operations (left), Mike Zoutendijk, PhD candidate, Air Transport and Operations section (right)

ect, especially when you factor what Dr. Mitici mentioned, that you must really be involved on a physical level with the stakeholders?

I started my PhD in April 2020, when the pandemic hit. Since then, I got used to working with a lot of emails and meetings, and that is still the case. Up until now, I have been able to work with everyone as planned and we have had good communication. I am happy that it is still possible to work together using available meeting software packages. So, I think it is going quite well. And going back to how research projects work during the pandemic, I would take the example of TaxiBots at Schiphol; they had the opportunity to test out the TaxiBots because the airport was so empty in spring. Experts also speak about how the resetting of the whole industry can somewhat help accelerate the implementation of ideas that would otherwise face a lot of resistance. In that sense, even during these difficult times, there is still an opportunity to innovate.

Conclusion

The ATL is certainly proving to be a hub for innovation and collaboration between different stakeholders. It aims to serve as a key knowledge partner for airport operations. Given the indelible impact that COVID-19 has had on the aviation sector, innovative initiatives such as the ATL are our only hope for surviving these testing times.



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Kansen voor West II



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