Manned Electric Flight – The e-Genius

Universität Stuttgart: Institut für Flugzeugbau

Jamie Abel – MIT

Supervisors: Dipl. Ing. Jonas Lay & Dipl. Ing. Ingmar Geiß

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Introduction – the IFB at Universität Stuttgart

Having been to Germany previously as a tourist, I had a few ideas of what to expect of the country. I knew, for example, about its grand castles and picturesque medieval towns standing in stark contrast to modern industrialized cities. I was aware about German public transport, and how much more extensive it is compared to anywhere in the United States. I knew its traditional cuisine is hearty and meaty, and that its beer tradition is long and revered. Nevertheless, I knew that there is possible to learn much more from living and working in a country than merely visiting its sights. Hence, I spent the past summer living in Stuttgart and conducting research at the Institut für Flugzeugbau at Universität Stuttgart. This work was done under the SUPER program, which brought 15 other students from universities across North America to Stuttgart to conduct real-world research whilst being exposed to German culture.

The Institut für Flugzeugbau is situated in Universität Stuttgart’s Vaihingen campus in the city’s southwestern suburbs. The dense forests surrounding the campus make it feel as if it is deep in the countryside, yet it can be reached by rail from central Stuttgart in less than twenty minutes. My institute occupied a cluster of buildings on the north end of this campus, which consisted of a workshop, a hanger, and a collection of offices. This space was necessary to hold the institute’s main projects; two prototype experimental aircraft (the Icaré and e-Genius), both using completely novel forms of environmentally-friendly propulsion systems (solar power and hybrid-electric power, respectively). In addition to building planes, the institute also conducts research on fields related to aircraft design, including fiber composite manufacturing and wind energy systems.

My Project

During my time in Stuttgart, I worked almost exclusively on the e-Genius aircraft. At the time of my arrival, most of the major systems of the aircraft had been completed; however many of them still required extensive testing and refinement until they could be integrated into the airframe. The hybrid electric power train in particular needed extensive ground testing before it could be integrated.
Consequently, a lot of my work was focused around this system; however throughout the summer I was able to work on a diverse range of systems ranging from avionics to structures to fire suppression. The large scale and diverse requirements of this project meant that I was given numerous smaller supportive projects to complete over the three months rather than a single larger research topic to work on.

A major part of my work was to model parts and systems in CATIA (a 3D CAD package), and then integrate them into a virtual model of the aircraft. Finding suitable places in the crowded aircraft for new parts proved to be quite a challenge – as such I spent (perhaps too much) time repositioning existing parts and rerouting pipes to create space for parts. Nevertheless, meticulously modeling everything in CAD had other advantages: for example, using 3D printing it is really easy to create complex parts directly from CAD models (as I was able to do with some of the parts I designed). Modeling parts in CAD also allowed them to be analyzed in a FEA model, which is a useful supplement to hand-calculations when trying to dimension load-bearing parts.

Not all of my work was mechanical; I also did a lot of work with the avionics system, which is primarily electrical. One of the more unusual tasks I was given was to generate simulated aerodynamic data for the variometer and analyze how the instrument transfer the data to the flight computer. While I did feel somewhat silly spending all day using an air compressor to blow air into various ports on the aircraft, this task did expose me to a subfield in aerospace engineering that before I knew nothing about. Electronics also played a role in my design of the fire suppression system, which was the one system that I designed completely from scratch.
The highlight of my work was conducting ground tests of the hybrid electric propulsion chain. For these tests, the engine, generator, and batteries would be wheeled out to the lab car-park, along with an approximately 3 meter wide propeller to dissipate the electrical load. We would then proceed over the next few hours to run the system under a regime of simulated flight conditions, whilst collecting as much data as possible over almost all aspects of the current state of the system. These tests not only allowed me to practice my experimental skills, including data collection and analysis, but also showed how my hours of hard work had helped to improve the performance of the system.

Living in Stuttgart

I spent much of my free time, especially after work, exploring Stuttgart. As a global center of the automotive industry, I expected Stuttgart to be a modern, industrial city. While there are certainly elements of this, one thing that particularly struck me was the prevalence of natural areas throughout the city. Stuttgart’s position in a bowl surrounded by wooded hillsides makes it easy to enjoy nature without needing to travel far out of the city, while also provided
numerous accessible scenic overlooks. Walking through the forests and vineyards around the city became my new favorite pastimes during the summer. This exploration was made possible by Stuttgart’s public transport system, which is far more efficient and comprehensive than any transit system in North America (as well as being free for students after 6pm).

While in Stuttgart I lived in a dormitory near the city center, about a 30 minute train ride from the university. Initially, I had concerns about needing to commute across town every day; however they turned out to be unwarranted thanks again to German public transport (see above). My suitemates were mostly local students from elsewhere in Germany, which gave me an opportunity to practice my German in a less formal setting, as well as learn about local student life. In addition, all of the North American students on the SUPER program were housed in the same building, which allowed us to socialize and bond as a cohort. The dorms were self-catered, which meant another significant portion of my free time was spent in various supermarkets (especially ALDI and LIDL – I don’t know how food there is so cheap). I found this to be a fascinating insight into German culture, allowing me sample a range of lesser-known local specialties from traditional Swabian ingredients like maultaschen and spätzle to many international ingredients (especially from the Middle East) reflecting Stuttgart’s ethnic diversity. Nevertheless, it was a shock to me to see all of these supermarkets closed on Sunday – something I wish I had known before my first weekend.

Beyond supermarket opening hours, there were some cultural differences that stood out to me. For instance, many German businesses seemed to have a preference for cash, which required somewhat of an adjustment coming from a country where everything is paid for with credit cards. However, on the whole I found it surprisingly easy to feel comfortable in German culture. The work environment in particular felt similar to other universities I’ve worked in in other countries (casual and collaborative, with an emphasis placed on good ideas). Interactions between co-workers, including with supervisors, was informal – once my supervisor even
offered to buy beers for the office (something which would never happen in the United States). One thing I did notice was that there seemed to be a clearer distinction between work and personal lives in Germany, alongside a stronger emphasis on maintaining a balance between the two. This was especially clear at lunch time, during which the entire office would cease work for an hour and eat together.

**Travels**

One key advantage of living in Stuttgart is that it is located right in the center of Europe, and as such it acts as a convenient base for further travels in Germany and surrounding countries. Compared to the United States, Europe is laced with an extensive network of long-distance buses, intercity trains, and budget flights, making it incredibly affordable to explore the continent. Travelling around Germany reveals the stark cultural diversity that exists in such a relatively small country. It is remarkable to think that the trendy neighborhoods of Berlin, the industrial sites of the Ruhr, the old medieval center of Nürnberg, and the lush woodlands of the Black Forest are all part of a country that’s no bigger than Montana. Moreover, when one also considers the countries surrounding Germany, the range of cultures and landscapes reachable in just a few hours from Stuttgart is enough to fill many weekends.

![A selection of photos from my travels in Germany and surrounding countries, highlighting the diversity that exists in Europe](image-url)
Reflection

When I started my undergraduate education, I knew that I wanted to spend some of my time at university living overseas and experiencing another culture. I feel that this opportunity to live and work in Germany has proven to be one of the most valuable of my undergraduate career. For starters, the experience working on a real-world experimental flight vehicle has given me greater insight into the nature of engineering work and the fields of research that I enjoy, alongside new skills which I can apply to my future projects. However, the fact that this research was done abroad gave me benefits that I could not have in a domestic internship. I feel that living in Germany has made me more independent, and given me greater insight into a culture which before I had only studied (at the very least, it helped me improve my language skills). Moreover, being able to see Germany allowed me to fulfill a life-long desire to see as much of the world as possible, something which I hope to continue for years to come.

I would like to thank all of those who made it possible for me to have this experience. In particular, I would like to thank the Christian Bürkert Foundation for their generous support, without which I would not have been able to live in Germany. I would also like to thank all of those at the IFB, especially my supervisors Dipl. Ing Jonas Lay and Dipl. Ing Ingmar Geiß for their guidance and mentorship over the summer, as well as Prof. Andreas Strohmayer for allowing me the opportunity to work his lab group. Finally, I would like to thank Babette Endurlat-Göhler and the International Student’s Office for their efforts in organizing all aspects of this program, from finding housing to organizing institute tours.
Appendix - Advice

I leave with some brief points of advice for future participants of the SUPER program

- Don’t spend all of your time working – make sure you have enough time to enjoy your summer and make the most of this unique opportunity to experience life in Germany
- German bureaucracy can be slow and may feel overwhelming – start early, be patient, and find a way to keep track of any paperwork you receive (you may well need it later)
- Try as much local food as possible – baked goods and cold cuts in particular are far better than anything that can be bought in a North American supermarket
- Take some time to explore Baden Württemberg – some of my favorite trips were to small towns in the area around Stuttgart. In particular, I’d recommend Esslingen and Bad Urach as good daytrip destinations
- Travel in Europe can be really cheap, but remember that it is the peak summer season, and things do sell out – plan ahead and book early
- Make an effort to connect with others (even if you are more introverted) – having other people to socialize with makes weekends and free time far more enjoyable.
- All shops (including supermarkets) are closed on Sundays – do not forget to buy groceries on Saturday evening (especially if the following Monday is a public holiday)