SUPER 2022: Manned Electric Flight and Analytical Aircraft Design Institute of Aircraft Design Supervisors: Jonas Lay, Johannes Schneider

> Jackson W. Barger Aerospace Engineering University of Arizona



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My Projects and the IFB

During my time at the IFB, I had the opportunity to work on several different projects with different supervisors. At the beginning of the program, I did research into regulations regarding minimum contingency fuel requirements regarding a proof-of-concept commercial hybrid-electric aircraft as a part of the GNOSIS project. I was researching ways to quantify technology improvements that contribute to delay and failure reduction in order to argue for a reduced reserve fuel requirement since batteries don't have the necessary energy density to store the required energy reserve. I did research into applicable European aviation regulations to see what rules applied and what loopholes we could exploit and then did academic research to help set up an argument for a reduced final reserve fuel for our proposed aircraft.

I had the opportunity to do some CAD work, where I designed a cover and mount for a high-voltage battery cable for the eGenius hybrid-electric aircraft. It was a simple task, but it had to be done quickly, as we needed it to be designed and printed for our testing shortly after being given the project. The first issue I ran into was having to use Catia, a CAD software I had no previous experience with. After a steep learning curve fraught with random software errors, I became proficient with Catia and came up with a few different designs. These designs were 3D printed at the Institute and evaluated in our Iab. After a few revisions, my colleague and I had several different designs ready to take to the airfield. I got to install my part into the eGenius when we were reassembling the aircraft, and my part was installed in the airplane when it completed its world record breaking 1000-kilometer speed run. While it may have been a small piece in terms of the extremely complex aircraft, it is pretty cool to know that I had a part in helping make the flight happen.

Another CAD project I had the opportunity to work on was to create an aerodynamic cover for a metal part that stuck out from the underside of the wing. This project was a great opportunity for me to learn about surface modeling in Catia and it provided lots of unique challenges to overcome, such as keeping the part streamlined, making sure it fit the metal piece snugly, and ensuring it conformed to the wing's curvature. I got to install my second part on the plane after it had been 3D printed and my part provided a (small) aerodynamic contribution to the eGenius's world-record 2000km flight!

For the second half of my time in Stuttgart, I was mostly working on MATLAB projects. My first project was to code an airplane design calculator that provided an estimation for the design gross weight of a commercial aircraft based on a number of toplevel design requirements. I was given a chapter of a well-known aircraft design handbook and turned the calculation process into a MATLAB script. I then expanded this project by creating similar MATLAB-based estimation methods for the Lift over Drag ration and Oswald Efficiency factor, both of which are very important in preliminary aircraft design.

The Institute itself was a great place to work. Everyone was very friendly, and they all spoke great English (which was a huge relief). One of my favorite things about the IFB is how communal it was; every day at noon we would all meet by the elevators on our floor so that we could all walk down to the cafeteria and eat lunch together. It was a slightly different group every day, but it was a great way to get to know everyone in the Institute in a slightly less formal setting. It was also interesting to see some of the benefits of the work-life balance in Germany, where everyone takes around an hour to eat a communal lunch.

Perks of Working with Aircraft Enthusiasts

One of the most notable work experiences were our work trips to Mengen airfield, where the eGenius is kept. It is a ~2.5-hour drive to Mengen from the Institute, so everyone wanted to put in a full day's work to make the trip worth it. We would often work long days and get back from the airfield around midnight; but it was great to be able to do some hands-on work on the eGenius. On one occasion we were able to fly to Mengen using one of our supervisors' aircraft through his flying club. It was about a 30-minute flight instead of a 2.5-hour drive and we got to fly over the beautiful German countryside, as well as a large German castle.



Another great opportunity that was arranged for me by the wonderful folks at the IFB was the chance to sit in on a flight test for students. The flight test consisted of a series of maneuvers done by a professional pilot, each demonstrating a different stability or instability of the aircraft's design. Some of the most notable maneuvers were a sudden

nosedive (everyone's head hit the roof of the aircraft) into a stabilizing oscillation and a 60-degree banked turn that was over two Gs!



These experiences were truly amazing and unique to work in the IFB. Many of the people who work there have their pilots license and always love to chat about all things aviation.

Stuttgart

I wasn't sure what to expect before I arrived; but after living here for just over two months, I love Stuttgart. The city itself is quite beautiful with lots of parks and green spaces to spend time in, and a nice mix of old and new buildings. The parks were a great place to spend a warm summer evening hanging out or running on one of the many paths. One of my favorite places in Stuttgart was the Markethalle, a permanent indoor market with lots of local produce, cheese counters, pastry shops, and restaurants; it was a great place to get some local groceries and a nice meal. There are lots of great beer gardens in Stuttgart that you should visit for a local brew. If you don't like beer, maybe try a radler, which is beer mixed with lemonade, or just go to hang out.

As far as attractions in Stuttgart, I would really recommend going to the Porsche Museum, the Mercedes Museum, and the Killesberg tower.



Travel

Stuttgart is very centrally located, so it is a great home base to see more of Europe on the weekends. The second weekend of the program, we did a group trip to Heidelberg to see the town and castle. I also went to Paris, Munich, and Amsterdam!



I did a solo trip to Lausanne and Bern in Switzerland, where I got to see some of the prettiest mountains, lakes, and rivers in the world. I also got to see the stage 8 of the Tour de France at the Olympic stadium in Lausanne.



Advice

It was a great summer overall, here are a few things I'm glad I did, wish I had done, and some general tips:

- Buy a Eurail ticket, if you want to travel on the weekends, this is the easiest way to do it.
- Learn some German before you come, at least enough to order food, introduce yourself, and a few basics like please, thank you, etc. While most Germans speak English, they usually appreciate you making an effort.
- Walk around Stuttgart instead of taking the U-bahn; I didn't realize how beautiful the city actually is until I stopped taking the trains (which often run underground) and instead started walking across town (don't worry it's not that far).
- Have lots of patience for the German Bureaucracy. There will be lots of paperwork, confusing forms, and Google Translate. There are forms for everything so make sure you keep track of everything and stay on top of sending everything back because it is easy to fall behind and forget to submit something important.
- The best piece of advice I can give for this trip is say yes to every opportunity. There are so many great things to do, people to meet, and places to see. You never know what is going to happen, but I enjoyed every adventure I went on, planned or otherwise. So, when you are here, take advantage of every opportunity you get to do something new!

SUPER Program, Summer 2022 Institute: High Performance Computing Center Stuttgart (HLRS) Field of Research: Virtual and Augmented Reality Supervisor: Dr. Uwe Wössner



Caroline Hyland Field of Study: Computer Science Home Institute: University of Arizona

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Introduction to the Research

I was fortunate enough to spend 10 weeks of the summer working in the visualization department of the High Performance Computing Center at the University of Stuttgart (HLRS). During my time there, I participated in a variety of projects, each with their own lessons and challenges.

My first project at HLRS centered around creating visual representations of the sounds produced by a drum set. This project was designed as a synchronous virtual component of a live performance at a conference in New Zealand. There was a presentation at the conference involving live music performance, and it also included a live-stream of additional real-time

drum performance at the University of Stuttgart. The purpose of the performance was to demonstrate 3D virtual reality representations of sound. In order to achieve that, I was asked to create 3D models of various moving, flowing shapes in different colors and textures in order to represent different sounds produced by the drum, with the goal of capturing the sensation or feeling evoked by the particular sound in the visual representation. These visualizations were then displayed in the CAVE¹ as the drums were played, with the representations of each sound "appearing" in 3-dimensional space near the location of the drum from which they arose and slowly fading into the distance as time moved on.



In this first project, my contribution was at the very end of the development process, but I was fortunate enough to be able to participate, after that, in the initial stages of a different



project at HLRS and see how they develop their community oriented projects from the start. This project focused on understanding the interactions between pedestrian, bike, and car traffic in Marienplatz, one of the main plazas in Stuttgart. In addition to using cameras set up in the plaza for data collection, I participated in a live data collection experiment, where students wore GoPros and stress monitors while walking and biking a designated route

¹ The CAVE is one of the most important visualization tools in the department, and it is utilized for many of the simulators and virtual reality projects completed there. The CAVE is a five-sided glass cube with projectors focused on all sides in order to create an immersive virtual reality experience or people standing inside it. These projectors project two different images superimposed on the CAVE walls: one is designed to present the "right-eye view" and the other to present the "left-eye view". To ensure these images are presented with the correct perspective, one user wears a special pair of glasses (the "master glasses"), upon which the projections are centered to provide the optimal 3D perspective. All other users also wear specialized glasses to process and focus the two projections, and the closer each user stands to the user wearing the "master glasses", the better their 3D view will appear.

through the plaza. This was done to quantifiably record their experience at various locations in the plaza to identify areas where the interactions between cars, bikes, and pedestrians present the greatest stresses or challenges to each group. After data collection, I was also able to help with the simulation portion of the project, specifically the bike modeling. Using CAD software, I animated characters riding bikes, which could then be used in the Marienplatz simulation to create a more realistic representation of the biker in the modeled interactions.

I am also a huge theater fan, so I was thrilled to have the opportunity to work on a project for the state theater in Stuttgart during my time. During the course of the project, I was able to



visit the state theater a few times and look behind the scenes at the set for their production at the time: "Fabian oder der Gang vor die Hunde". I was tasked with adding details to the 3D model of the stage setup that was already in use including textures and animations so that the 3D model was capable of all modifications that can be done on the actual stage and could be controlled from a button panel. A special setup was designed in the lightbox of the theater in order to project the 3D model of the stage

against the actual stage backdrop to create side-by-side images consisting of half real stage and half 3D model.

My final project this summer focused on implementing an additional feature for an existing plug-in HLRS developed for REVIT in order to model airflow in and around buildings. My task was specifically focused on developing additional code to process configuration files so that default values for various settings in the program can be entered through configuration files rather than hard coded every time the program is run (which was the previous system).

Technical Lessons Learned at HLRS

In my time at HLRS, I was exposed to a range of new areas in computer science. Working in

the visualization lab was especially exciting for me, since I had never had the opportunity to work on virtual or augmented reality projects prior to this experience. My first day of work at HLRS, I was able to join a class with architecture students visiting the institute to learn how to use CAD (computer-aided design) software for 3D modeling and animation. It was also the first time I was able to create something that I could see in the CAVE, which was a really amazing experience. In addition to learning about 3D software and animation, I also gained experience with two programming languages I had never previously worked with: C++ and C#.



My Experience in Stuttgart, Germany and Beyond

In addition to the research opportunities at HLRS, there was no shortage of adventures to be had in Stuttgart. Stuttgart itself is a rather large city center, so there is always something happening on the weekend to explore, from music festivals to flea markets to cultural events. I was able to experience it all right inside the city. Furthermore, there are quite a few small towns just outside of Stuttgart, which are only a 30 or 45 minute transit ride away, allowing



you to take a break from the "big-city environment" of Stuttgart and explore a "small-town setting", for example the royal gardens

at Ludwigsburg or the vineyards in Esslingen am Neckar. All of Germany is connected by an extensive railway network, allowing for travel throughout all of the country as well, which allowed me to get a better

understanding of how the specific region can affect German culture and traditions. For example, the culture, common phrases, and natural environment in the Swabian region (where Stuttgart is located) is vastly different than in the northern region where Berlin is located.



In addition to just opportunities to explore the Stuttgart area itself, the city is centrally located to allow for train travel around Europe on weekends. My research team at HLRS was extremely supportive of my desire to travel as much as possible over the weekends while I was there for the summer. They let me take a few Fridays off in order to make 3-day weekends so I could travel to slightly farther locations, allowing me to visit a total of six countries during my stay.



Tips for Future SUPER Students

It feels very strange when I think about the fact that my summer experience at HLRS is already over, but I am so excited for all the students who will have the opportunity to

research at the University of Stuttgart in the future through the SUPER program. Perhaps the biggest piece of advice I can give you is to be open to new experiences, whatever they may be. During my time at HLRS, I tried a variety of new software and programming techniques I had never worked with before, and it was an amazing opportunity both to learn more about computer science and to get a better understanding of what type of work I would like to pursue in the future. I also had the opportunity to travel alone for the first time, which taught me quite a bit about myself, and is an experience I would highly recommend to anyone who has never tried it before. Of course I had an amazing time on all of the trips I planned, and I definitely do encourage you to plan trips throughout Germany and Europe, but try not to let yourself get so caught up in your plans that you miss the little things all around you. Some of

my favorite memories from this summer were from experiences that I simply "stumbled into" while I was there and decided to explore. After seeing a sign for it at the transit station with another SUPER program student, I decided to attend my first ever music festival in Stuttgart with a few other students in the program, and, even though I did not know any of the bands or speak the language in which they were singing, it was still an amazing experience, and I now have some recommendations for German music that I never would



have known otherwise. That brings me to another recommendation: get to know the other students in the SUPER program with you. I know it can be a bit daunting to suddenly arrive in a foreign country and meet all these new students from different universities, but I made amazing friends through the program I was able to travel and explore with on weekends and after work. In short, just be open to new experiences and try to let yourself say "yes" to any opportunity that falls your way while you are there, because you never know what might turn into the most amazing experience that you never could have imagined.

Hasina Shir University of Arizona–Home Institute



Picture of Heidelberg, Germany

University of Stuttgart

Institute for Technical Optics- Host Institution

Title of Project:

Using Radiation Pressure to help separate particles to detect various kinds of bacteria and viruses

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Institute of Technical Optics

From day one, the Institute of Technical Optics made me feel at home. The entire institute was very welcoming and excited to have me.

My first week at the institute was like a game of catch-up. I had not been informed of my project prior so it really felt like I was thrown into the thick of it, but with the help of my mentor, I thrived. My project dealt with developing a system which used a combination of radiation pressure and laminar flow to sort particles (like bacteria and viruses) along a microfluidic chip. At the end of the microfluidic chip, I was to build an imaging system that would be able to see what the particle was. This was with the intent to be used as a proof of concept for a device to be used in hospitals at hand sanitizer stations. Hypothetically, the hand sanitizer stations would monitor the bacteria and viruses in the hospital when people placed their hands in it for sanitizer and recognize when a new onset of disease has increased in quantity.

While I did have previous research experience in the field of biomedical optics, this project was very different from what I had worked with previously. So, it was at first daunting to be living in a foreign country, working in a foreign lab, and working on foreign research, but with each passing day, I began to feel more confident in my work.

I began to meet and bond with the people of my institute, meeting for lunch every day and coffee after. My first full week in the lab we had a sundae party on Monday and a pizza party on Tuesday! With my friendly institute, having cake almost every week, even the most daunting tasks began to seem bearable and even fun. I continued the institute's "tradition" of bringing in a cake as a newbie, I actually brought in two by the end of my stay.

The phenomenal part of being there was feeling so accepted by my institute. I don't speak German, but whenever I was around, everyone immediately switched to English and tried to make me feel as included as possible. From planning a movie night at the institute, to planning a trip to Europapark, I was completely blown away by how happy I was at the institute. My mentor and other labmates took a day of unpaid leave to travel to Europa park and share a day full of crazy rides, sun, and good company. A photo of us on one of the rides can be seen below.



Of course, I hoped to have a good experience when planning this trip, but I could not have imagined the amount of kindness and generosity I would receive during my stay. Leaving the institute is something I am very sad to do. I'm incredibly grateful for my time at ITO.

Travel/Experiences

Aside from my work and great company from my lab mates, I also had the chance to explore Germany! On my first weekend, I went to the Porsche museum with my fellow SUPER classmates and learned about the rich history of Porsche and its relation to Stuttgart.







On the first public holiday in June, we went to Heidelberg to explore the town and the castle. It was a breathtaking view from the top of the city after going up in a historic trainWhile I might have been skeptical of the train at first, the view was well worth the wait. Enjoying a coffee at the top with a pretzel certainly felt like the German experience. After taking a beautiful walk in the

forest we settled on lunch near the forest. While my Käsespätzle was delicious, my berry ice cream may have been even better!



While being in Germany, I have had the privilege to experience life and culture in a different country; whether it be through discussions with my lab-mates, flat-mates, and everyone I met along the way. I found myself growing as a researcher, as well as an individual. The lessons I learned here I will carry with me for the rest of my life.

Advice/Tips:

- Take everything day by day. Don't let yourself become too overwhelmed when it comes to your project, do good diligent work and by the time the program is over you will have great things to present
- Explore the area you are around with the intent of living like a local- it made me feel so much more at home and helped me build more confidence in myself
- Travel, travel, travel! You know some of the public holidays ahead of the trip, plan ahead for those trips. On weekends, going to nearby cities on trains is very feasible
- Have faith and confidence in yourself, if you don't believe in yourself, no one will

SUPER Report

Chemical Process Engineering

University of Arizona

Biomedical Engineer

Flow Field Technology

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Before Arrival:

I was first made aware of the SUPER program in one of my engineering classes at the University of Arizona. As soon as I heard about it, I was eager to look into it since I was not sure to expect. The communication before was amazing, the staff was incredibly helpful from both ends and made sure that everything was set before arriving to Germany. There are lots of super interesting projects going on at the University of Stuttgart so there is plenty of options to choose from and the staff will help you. There are a lot of different documents and tasks you have to complete which can get a little difficult especially with the language barrier but as long as you stay on top of the due dates, everything will be fine.

Tip on Germany:

On arrival, the weather was amazing compared to Arizona and the people at the airport were extremely nice and helpful. English is very common in Germany so there isn't a huge language barrier with the occasional person who does not speak any English. This makes going to the store relatively easy and restaurants are really good with having English speakers. The dormitories we were set up in are decently sized but make sure to prepare for no A/C and no ice anywhere. The cultural difference was not incredibly different, there are some minor things such as smoking is a huge trend here. Another thing to watch out for is how quickly you have to pack and pay for groceries; it feels like they are rushing you so be prepared. Stuttgart has a variety of different restaurants especially Turkish food which is sold almost on every street. All the food I had has been pretty good and I highly recommend trying the different beers. Stuttgart also has a wonderful night life with lots of great events going around all the time. There is also plenty to do while here like visiting the mineral baths or adventuring around the city or best of all, travelling. Stuttgart is well located in both Germany and Europe to allow travel to any place you would like due to Europe's amazing train system. They ICE trains make travel within Germany extremely quick and is typically very reliable. I highly recommend taking every opportunity possible to travel and see as many places as possible. I would recommend Heidelberg, Grabkapelle, Cologne, and Munich for sure and if you are looking for a bit of a longer trip, Berlin is definitely worth the visit. The institutes we worked at were very friendly and highly supported us travelling throughout Europe. They are more than happy to work with you and will gladly give time to travel. Being near both France and Italy, those are two places worth visiting and there are also wonderful places to hike and see the beautiful nature side of Germany. If you do plan on travelling outside of Germany by train, make sure to pay attention and keep an eye out because things can change slightly such as train stops. I also recommend getting a SIM card for your phone, it is nice to have the peace of mind that no matter what you can figure out what to do with your phone. Although, WIFI is widely available here and stopping at a coffee shop will allow you to connect and figure anything out that you may need. It is also a great idea to always carry some cash with you because often places won't accept card due to issues with the banking. I ran into that issue a couple times when going out to dinner and it was pretty annoying to try and solve so just keep a decent amount of cash just in case.

Experiences:

I have truly enjoyed my time here in Germany and I am entirely grateful for this opportunity from both my home institute and the University of Stuttgart. There are multiple challenges with travelling and living abroad but this program made the experience a lot easier and more enjoyable than what I imagine it would be like to do it alone. The SUPER program also provided multiple student-led trips to places around Stuttgart which was great since it was like having a tour guide. The work I participated in for the research was at the institute of chemical process engineering. This does not correspond with my major, yet I have learned a lot of valuable information and got to experience what it is like working in both industry and research aspects. The main project I was working on while here in Stuttgart was developing a flow field for a fuel cell with multiple different designs. This varied from a range of using 3D modeling to construct the designs, testing various ideas to obtain the desired outcome, consulting in group discussions, and planning methods to insulate surfaces for our flow fields. The experience of working with this group has proven very valuable and will be a great reference in future opportunities of mine. Everyone in my lab was extremely nice and helpful, I even received help with settling in which was nice. My supervisor was extremely supportive and nice while helping us with our projects and he also gave us the space to do things on our own.

Pictures:















My SUPER Experience at the University of Stuttgart 2022 Sanjay Chakinala Institute of Thermodynamics and Thermal Process Engineering Purdue University Major: Chemical Engineering Project: Determination of Thermodynamic Properties Supervisor: Timm Esper

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Experience with the Program:

The SUPER program was not my first time being away from home for an extended period. That being said, studying abroad in a foreign country for two months straight was a new experience for me. While this experience certainly was worth it, there were obstacles that I encountered. There were times that I felt homesick, lost, or lonely, but the reason I got through that was because of the other students in the program with me. The memories we formed from our time together will never be forgotten.

One of my fondest memories with the rest of the SUPER Program was when we decided to take a day trip to Heidelberg, Germany. Heidelberg is a smaller sized town that is half way between Stuttgart and Frankfurt. Because Heidelberg is so close, it only took an hour train ride to get there which made it the perfect destination for a day trip. We arrived in Heidelberg around 9:00 am and got the chance to walk around the beautiful city. Afterwards we walked to the top of a mountain peak near the city, where we got an amazing view of the city.



After grabbing lunch at a restaurant at the top of the city, we slowly started to walk down the mountain. On the way down the mountain, we stopped and walked around Schloss Heidelberg, the castle that resided half way around the mountain top. In the castle, we got to see the interior and get an understanding of the castle's history. Afterwards, we walked around the city of Heidelberg where some of us went shopping and some of us simply walked around. In the end, everyone enjoying their time in Heidelberg greatly. Definitely one of our fondest memories as a program.



Throughout the two months I spent in Stuttgart, we continued to amass new adventures and memorable moments. Whether that took place in Stuttgart or in another city, there was always something to do. I can safely say that this program made my experience abroad significantly more enjoyable.

The Institute of Thermodynamics and Thermal Process Engineering:

Despite being the only undergraduate student and the only student from my program in this institute, I always felt welcomed within my institute. Unfortunately, due to COVID related reasons, I started my time at the institute a week late. That did not prevent me from diving right into my research. With the help of my supervisor, Timm Esper, I was able to familiarize myself with the lab equipment while also understanding my overall objectives. The institute bases all of their data off of an Equation of State, discovered by a professor of the institute. This equation can tell us chemical properties of pure substances and mixed solutions and is very useful in determining the nature of species as it can tell us everything. It has many applications to outside clients; therefore, the institute strives to understand the chemical and thermodynamic nature of everything. My goal was to determine certain properties that would back the research of my supervisor.



To conduct my research, I would utilize various lab equipment throughout the institute to find specific properties of provided chemical mixtures. The properties that I sought to determine were the boiling points and the viscosities of these mixtures. These properties can tell us the most about the nature of a mixture. The image on the left gives us a preview of an ebulliometer, an apparatus that can heat a mixture to its boiling point and hold equilibrium. From there, the temperature and the pressure of the solution can be recorded using a computer application. The image in the middle shows us an LS Spectrometer, a high intensity laser that is used to calculate the viscosity of a chemical mixture. After careful preparation and filtration of the solution, the laser is pointed at the solution to detect the scattering of light. The results are recorded on a computer application hooked up to the apparatus.

In addition to using these devices to determine these thermodynamic properties, there were other methods of preparing solutions, determining the composition of mixtures, and testing the accuracy of our findings. As far as determining the composition of the mixtures I was testing, I used a gas chromatograph which can be seen in the right image. When it came to determining the accuracy of my results, I utilized scripts from Jupyter Lab and MATLAB which are in python and C++ respectively. These scripts were either provided to me or I had to type my own script. The institute provided me the chance to utilize the entirety their labs to conduct my research.

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Traveling throughout Europe:





Outside of Stuttgart, I got the chance to visit various cities throughout Germany. Whether it was to visit my family or for a simple day trip, there was always fun ways to spend the time in other cities. Outside of going to Heidelberg, my favorite cities that I visited were Cologne and Munich. Within both cities I got the chance to visit their famous cathedrals which can be seen in the images above. When I was in Cologne, I also got the chance to visit the world famous chocolate factory. My trip to Munich was amazing because I got to visit my family who was vacationing in Europe for the week. While in Munich for the weekend, we walked around the city and visited the famous Hofbräuhaus. I had a wonderful time visiting these cities and traveling throughout Germany.

Traveling outside Germany:

The blessing of this program is that given that you take the time to carefully communicate your schedule with your advisor, there is plenty of time to travel. Not only did I get the chance to travel within Germany, but I also left the country on three separate occasions.

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The first destination I got the chance to visit was Amsterdam in the Netherlands. Visiting this city has been on my bucket list for years and I am glad I finally got to fulfill this wish. In my opinion, there are a lot of tourist attractions for everyone in Amsterdam, but it also is a great city for walking around. My favorite part of coming here was seeing the diverse architecture and the various canals throughout the city.



While not my first visit to London, my weekend here was definitely one of my highlights from my time in Europe. I got the chance to revisit for the first time in 8 years and see friends from school. London is one of my favorite cities due to its size and diverse culture. From visiting Big Ben to walking around Buckingham Palace and Hyde Park, I truly made the best of the weekend I was here. My favorite moment was getting to see Big Ben because last time I was in London it was under heavy construction.



The final trip I went on was to Paris and it was with with one of the other students in the program. For both of us, it was our first time in Paris and we both loved the city. It is a massive city that is hard to completely see in one weekend. The highlights of our stay included seeing the Eiffel Tower, visiting the Louvre, and viewing the Arc the Triomphe. Additionally, we got to see the beautiful architecture, canals dispersed across the city, and a great view of the city from Sacre Coeur. My favorite moment form this trip was going to the top of the Eiffel Tower at night and getting an amazing view of the city.

Tips for Future SUPER Participants:

- Try to learn some basic German before your arrival and during your time here.
 While knowing German is not a requirement, knowing a little helps a great amount.
- Schedule flights/train tickets well in advance. Scheduling earlier can help reduce costs and secure your spot in a transit. Especially regarding train tickets, some trains can fully book a month in advance.
- Assuming you plan on traveling within your time here, invest in a Eurail Pass. I bought a Eurail Pass gave me 10 days within a two-month period of unlimited train usage for \$324. While this pass may seem expensive, it is worth the costs and grants access to travel across almost all countries within Europe.

- Do not be afraid to make friends. Meeting others in the program, people in your institute, and other people around the city can make your experience more enjoyable. Additionally, meeting people can make it easier getting around Europe.
- Do not be afraid to travel alone. Traveling alone is an experience worth attempting. It can improve one's ability to navigate a foreign country. That being said, travelling with a buddy also has its merits. It can make meeting people easier, and it can make your experience more enjoyable while also safer. Additionally, it can reduce costs of hotels/hostels.
- A fair number of buildings in Germany do not have A/C, including the student dorms. Investing in a fan can go a long way considering it can get hot during the summer.
- Learn to cook! Along with being a great life skill, it can save you money. While not all kitchen appliances are provided, they can be found at nearby stores for a reasonable price.
- Bringing melatonin or other sleeping medicine can help reduce the jetlag effects.
- Before arriving, have a plan for your phone's ability to access cellular data.
 Some carriers will have unlimited data, but for other carriers, they do not provide in Germany. An alternative is buying a German SIM card.
- Beer! While not everyone likes to drink beer, it is worth at least trying once. The beer in Germany better than almost all beer in the US. Additionally, radlers are a good alternative because they do not have as potent of a beer taste.

My SUPER Experience at the University of Stuttgart - Summer of 2022

Institute of Chemical Process Engineering

Project: Developing novel polymeric membranes

Supervisor: Dr. -Ing Andrej Grabowski

Hannah Oberg

Davidson School of Chemical Engineering

Purdue University

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Getting to Stuttgart

Flying from the United States to Europe is a daunting task if you have never done it before, I found that out quick as I journeyed alone across the ocean to a whole different part of the world for the first time in my life. No one really prepared me for the protocols to follow, what to do, and what was going to happen. My journey here was a little rocky at times with last minute flight cancellations and ticket issues. During every step of the journey, though, the team at the International Office from the University of Stuttgart helped walk my family and I through what to do and made sure I was safe and taken care of. Once I finally landed in Stuttgart after the long delays and layovers, I was met by one of the International Office employees who helped me navigate the trains to my living accommodations at the Student Hotel. Safe and sound at last!

The days following were filled with unpacking and shopping for things either I had forgotten or things I intentionally left behind, along with lots of grocery shopping since we lived off campus.

Life in Stuttgart

I am originally from North Dakota, which is heavily influenced by German culture and cuisine since most of the citizens' ancestors originated from Germany. Because of this, I didn't think that being in Germany would be that different from being at home, but, boy, was I wrong! Almost everything is different from the United States, even things as rudimentary as grocery shopping! Now to preface, I am by no means saying the adjustment to life in Germany was difficult, it was just surprising to me; all in all, it probably only took me about one week to get the hang of things. In the United States, individuality and living a fast-paced life is commonplace, just look at how quickly we prepare and eat our meals! In Germany, more emphasis is placed on social gatherings and taking time to enjoy food, drink, and the company of others. Meals with friends, family, or colleagues typically last a minimum of 2 hours, or can even be a whole evening ordeal! So be warned, when accepting a dinner invitation, you probably won't get home until 9 or 10 o'clock at night. Additionally, in the US, it is typical for people to never default to the honor-code, i.e. we don't really trust people to do the right thing on their own. In Germany, and really Europe in general, it is expected that people will follow the rules and are typically responsible for doing the right thing on their own. For example, if you are on a train (especially in the city), your ticket is hardly every checked, it's just expected that you

bought a ticket (now, don't think you can go to Stuttgart and just not pay for a ticket, if you get caught without a ticket, it's an 80 euro fine, so just buy a ticket, they're cheap). Another huge difference is a heavy emphasis placed on work-life balance. In the US, you are expected to output as much work as possible, and even are sometimes expected to work overtime voluntarily. In Germany, that is not the case; there is a huge focus on health and happiness of employees rather than what they can offer the company, so workplaces are a bit more relaxed compared to the US. Overall, the culture is just very different than what I grew up in in America.

My day-to-day life in Stuttgart was pretty ordinary. I went to work between 8 and 9 am via the public train system every morning and finished work between 5 and 6 pm. My coworkers and lab-mates were all fantastic people, willing to answer any questions I had or discuss any ideas I had regarding a project. Since the institute I worked in was off campus, I packed lunches for myself, and had breakfast and dinner back at the housing accommodation. In my unit, I had seven other roommates (mine was co-ed); we all shared one kitchen, but there were two toilets, four showers, and an array of sinks for everybody to share. Honestly, I know that sounds a little daunting, but was great! I became great friends with all my roommates, and we would often eat dinner together or travel together. The weekends were when I really got to travel and explore not only Stuttgart but also a plethora of other cities!



My research team!

Traveling

During my stay in Stuttgart, almost every weekend I was traveling somewhere or doing something! Since relatively everything in Europe is accessible by train, it was super easy to travel between cities and even between countries!

I visited many cities in Germany, including (but not limited to) Rothenberg, Heidelberg, Esslingen, and Ludwigsburg.



View from the Castle in Esslingen am Neckar



Group picture overlooking Heidelberg



One entrance into Ludwigsburg's Residenzschloss



Gardens of Rothenberg

While in Germany, I visited the Netherlands, Belgium, Luxemburg, and Switzerland. Each country is a unique blend of their own culture as well as those of the surrounding countries.



Adolphe Bridge in Luxembourg



Luxembourg's Royal Cathedral



Grand Square of Brussels at Dusk



Wandering the Brussel's city center

Research

Like I said before, my research was treated more or less as an actual job. I had set hours when I would be in the laboratory. I was given my own project to work on by my professor dealing with ion exchange membranes in a carbon dioxide fixation process. I was asked to create a model to estimate the energy consumption of the process and to design a testing protocol for the characterization of commercially available ion exchange membranes. In all steps of my project, I learned something new; I was in direct contact with industry representatives and was in charge of running my own experiments and analysis. I worked on this project for a total of 2 months but unfortunately with the back-ordered materials and equipment, I didn't get to see all my hard work come to fruition; the project, along with my work, will be passed to another researcher.

One huge difference between research in Germany versus in the US is the amount of authority or say I had. At my home university, I really just did the grunt work for my graduate students, I didn't really have a huge say in the project and was not included in any discussions. In the SUPER program, I was the head of my own project, making important decisions and being an integral part of the actual research and theory going on. I felt like I was learning something rather than just mindlessly washing glassware, etc.

Advice for future SUPER students

- This may sound odd, but when you go grocery shopping in Germany, start packing your groceries as soon as the teller scans them. Germans value time, so if you wait to bag your groceries until after you pay, you will get a few annoyed glances.
- Germans love to find any reason to have a party or a festival; take advantage of these and try to attend as many as possible! It's a great way to experience German culture and meet amazing people!
- If you don't speak any German, it's a fantastic idea to learn basic German phrases; most younger people speak English but some smaller restaurants, shops, or the older people in Germany may only speak German.

- Bring medications from home, like cold medicine or allergy medicine, if you need it; there are pharmacies in Germany, but everything is in German so it might be difficult to find what you need.
- Bring reusable bags; you have to pay extra for shopping bags in Germany, so it's just easier and cheaper to bring your own!
- Try all sorts of foods! There is a plethora of amazing foods in Stuttgart. I would highly recommend going to as many farmer's markets and specialty bakeries as you can, the food is delicious and it's not something you are going to find anywhere in the US!
- Just have fun! This is your time in Europe, if you want to travel, do it, if you want to just explore Stuttgart, do it! There is so much to do in Stuttgart, let alone Europe, so you will always find something that interests you.

Christian de Weck

Host Institute: Institute of Electrical Energy Conversion

Host University: University of Stuttgart

Massachusetts Institute of Technology

Major: Mechanical Engineering

Minor: German

Project Name: Wireless Charging

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New experiences can be challenging yet exciting. One thing my Grandmother always said was one should never be shy about trying/spending money on education and travel. When it comes to my experience this summer, I can confidently say it was 10 weeks of my life well invested. Living and studying in Germany and Europe as a whole has always been very important to me and it has been on my to-do list for as long as I can remember. I was born and raised in Boston, Massachusetts but my father is from Switzerland originally. Growing up I was fortunate enough to visit Switzerland pretty frequently to visit family and see the country but I had never fully felt integrated there as I was not there for a long enough time. I believe this experience finally allowed me to get more in touch with that aspect of my identity and showed me a lot of opportunities and possibilities of life in Europe that I didn't know were possible.



I arrived in Germany on June 1, 2022 via the Frankfurt airport and then took a train to Stuttgart. I had never been to the city before but had heard a few things about it, such as the fact that it is where big automotive companies like Mercedes and Porsche are based. What struck me initially was the quality of the public transport such as the subway in the city, but also the inter-regional trains as they were much more punctual and nice than what I had seen in Boston. Being in Germany and more specifically Stuttgart also allowed me the opportunity to speak german. At MIT I have been pursuing a minor in German as an attempt to get closer to my Swiss identity (even though swiss-german is a little different) and since returning from the program I believe my German has never been better. Simple mundane activities like ordering food, talking to a train conductor, or shopping were quite thrilling as I used these opportunities to be completely immersed in German. I was even able to incorporate my German skills and practice at my Institute.



I was unsure what to find when I first arrived at the Institute for Electrical Energy Conversion at the University of Stuttgart. Initially I was expecting a stringent environment. I had never worked at a European institution but I knew a few Germans from home who tended to be dedicated to their work and were very diligent in it. The atmosphere of the lab was professional yet cordial. With the people I met I felt like I could have conversations with them about our work but also have fun with some more informal talk. Like I mentioned earlier, Stuttgart is home to some big automotive companies, and this played a role in my research. The project I worked on, wireless charging, has a lot of important applications, and the main one we were exploring in my group was related to wireless charging for electric cars. Parked outside my institute everyday was a modified BMW i3 which had been outfitted with a wireless charging circuit prototype, the same one that I would be working on in the lab. The majority of what I contributed was related to circuit simulations, specifically related to the compensation component of the charging. This involved a lot of programming in the coding language MATLAB and creating my own simulations to model current flows, voltage, and the conversion from DC power to AC and the reverse. It was very clear to see that at my Institute I was doing real work that had a real-life useful application.



Despite the working being challenging I still felt as if I had plenty of time to explore Stuttgart, Germany, and some other places in Europe. Within the city itself I think my favorite place to go was the Charlottenplatz. Each day when I went there it was lively, with people walking around, restaurants and shops open, and some really fantastic buildings and architecture to see. Very close to the Charlottenplatz there was a flea market set up every Saturday at the Karlsplatz which I attended frequently to speak to the residents and browse the wares. One other city in Germany I went to that was quite a highlight was Dresden. I was only there for a few days but the city was magnificent. The baroque architecture, river, and history was a sight to behold. During weekends and days off I traveled to some other places as well such as Leipzig, Strasbourg, and the Black Forest.



Overall I was very happy not only with the opportunity the SUPER program provided me this summer, but also the large amount of support they gave me while in Germany. I felt much less concerned about things like transport, or food because it was taken care of most of the time. I also did not hesitate to ask questions about the culture, food, or travel recommendations.



I would give the following advice to future SUPER Program participants: Even if you are not studying German I would still highly recommend picking some up during your time there. I felt I was able to integrate into Germany quite well because of it, and even small, non extensive interactions in the germany language were quite exciting and it will make for a more authentic experience. The people you meet will also appreciate the effort you put in to speak the language. I would also take advantage of the fantastic public transport system there. In the USA it can be hard in many places to travel without a car but in Germany you can go almost anywhere. Getting an app like Deutsche Bahn Navigator made my experience of buying train tickets and other things much easier. I would also recommend talking to some German students at the University. I managed to socialize with some students in my living accommodations and it was nice seeing a different life perspective as well as sharing my experiences with them. They will also probably have a lot of good activity recommendations for what to do in Stuttgart and Germany.