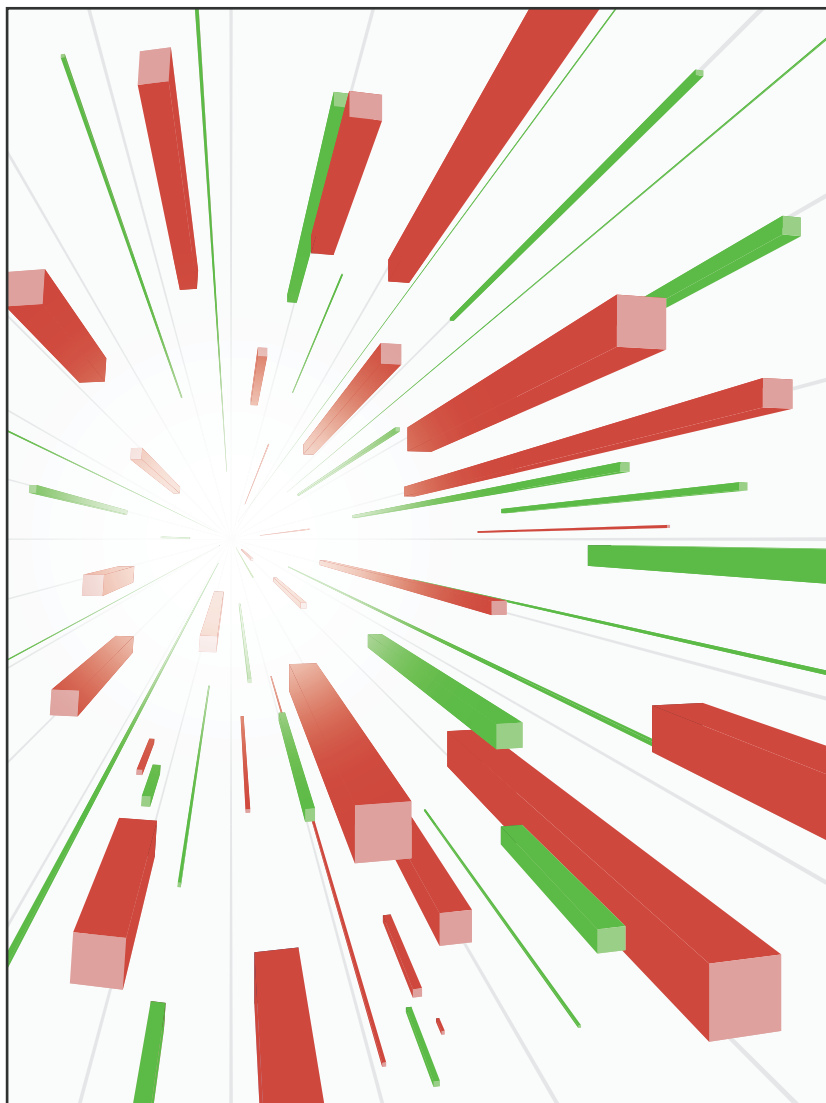


# Francken Vrij



Volume 24, edition I



Past



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## Special thanks to:

Hilbert Dijkstra, Melav Salih, Gertjan Pomstra,  
Jelle Bor.

## Editorial

**B**ack in the day, life was a lot simpler: global warming didn't seem like that much of an issue, social media hadn't yet taken over our lives, and the Francken Vrij would be delivered on time. This being my first time as editor in chief, I expected some hiccups along the way, but we went way past the due date. The only good thing about this is that my punctuality can only go uphill from now. But alas, all that is in the past now. You might have noticed that this year marks a lustrum for Francken, and we figured it would be a good time to look back on where we came from. Hence the theme of this edition: "Past". I hope you enjoy reading it!

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# Edition 23.3

## 6 Chair's Preface

Chantal Rikse

The first preface by Chantal as the chair of the association.

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## 7 News of the Association

Sibren Wobben

Since the previous Francken Vrij, there have been several social and study related activities. Here you can read about a few highlights from previous months.

---

## 15 History of symposia

Leon Trustring

Francken's symposia have been a staple for years. Leon takes us all the way back to the very first one, and takes us through the changes over the years.

---

## 10 The lustrum week

Sibren Wobben and Carla Olsthoorn

To refresh your memory on this memorable week, Carla and Sibren have summarized the ocean-themed lustrumweek.

---

## 19 Life after Francken

Hilbert Dijkstra

Former board member Hilbert tells us how he ended up working for Nedap and living in Boston.

---

## 22 Francken

### Abroad

Melav Salih

She has just returned from Japan, and you can read all about her experiences with the cultural and educational differences, as well as her research at Tohoku University.

---



## 27 Puzzle

Gertjan Pomstra

A vague description of the village and the location of three trees are all you have to base your map of *Franckendam* on. Can you reconstruct the rest?

---

## 29 Past

Jelle Bor

Jelle has somehow managed to draw a parallel between losing your beer at a *borrel* and the beginning of the universe. Going through the rapid expansion, cooling and formation of matter in the first few minutes of the universe, he explains how we all came to be.

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# Chair's preface

By Chantal Rikse

**T**he last time the Francken Vrij was published, we were still kandis and had to write a little piece to introduce ourselves. I had thought that would be all I would have had to write for the Francken Vrij, but little did I know...

A few months ago, we officially became board of this beautiful association. I must say that we already learned quite a lot from it, but we still have our *leermomentjes* to help us learn some more. Our experiences as a board were all in the recent past.

Since we're already speaking about the past, I would like to take you even further back in time: all the way back to the big bang, when the universe came into existence. Here, the first particles were formed that eventually led to the founding of T.F.V. 'Professor Francken'. Sadly, not a lot is known about the events related to our association that happened in the  $13.787 \pm 0.020$  billion ( $10^9$ ) - 35 years prior to the founding. The history that is known, can be found in the almanac, so I won't go into detail about that either. What I do want to say is since I was born years after Francken was founded, I

consider this association as pretty ancient. It might as well be a second big bang in history, because to its members this must have been as impactful as the big bang itself and to most it is as ancient as it is to me. 





# News of the Association

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By Sibren Wobben

**I still have** to get over the fact that I'm no longer the editor in chief of the Francken Vrij. However, now that I'm the secretary of Francken, I have the honour of recalling for you guys all the (crazy) things that happen in the months that I have been board. I have the feeling that I won't run out of inspiration since I'm writing this 172 days after our Transfer-GMA. I hope you'll enjoy my summary of our *past* activities.

## Summer BBQ

Our board started with the annual summer BBQ. As this was our first activity (only two days after our transfer), it was kind of a stressful activity. Apparently there are a lot of things one has to think about while organizing an activity. It also doesn't help when your members start flipping the entire room at your first activity. But we survived!



### Pienterkamp

After the BBQ, we didn't have a lot of activities since the exams had just started and the holidays were around the corner. But after 2 months of freedom we always start the year with Pienterkamp. As a board member you fortunately don't have a lot of responsibility during the camp. I think the camp was great success! For once the food was actually good, there wasn't any rain on the activity day (so I was able to play many rounds of *vlaby*), and I was able to meet a lot of freshmen. If they had half the fun I did, then they'll have had a great weekend! *To prove that the cooking-committee competent and cooked very well, I included a picture of Puck wearing a very great cooking-apron:*



### S.L.E.F. destination announcement borrel

As this is a lustrumyear, we wanted to announce the destination of our annual excursion sooner in the year to create more hype! In a 5 minute and 36 second video, the committee built a lot of hype for the destination. You could cut the tension with a knife! They first announced that we would go to Canada, after which there was a short silence, and then they announced that we'll also go to the USA.

### Applied Physics-Quiz

This year the Applied Physics-Quiz was made by Ids, and presented by him and Bradley. Ids had some very *interesting* questions. As always, we had a general round (which was obviously a round filled with questions related to the word *general*), a speed round, a freshman round (in which only freshman could answer questions, which is guaranteed to yield hilarious answers). Knowing Ids a bit, I could have guessed that there would be some questions related to Star Wars. What I didn't expect was a *Where's the Wookiee* round (based on *Where is Waldo*).



Figure 4: Proof that Ids put in a "Where's the Wookiee" round.


### Information meeting for freshmen

Professor Rudolf approached FMF and Francken to organize an event for freshmen. Professor Rudolf gave a lecture on why studying (Applied) Physics is hard, what is expected from the students, and what difficulties one might encounter in their study. After that, a bachelor student, master student, and PhD student gave a talk about the problems they faced and had to overcome.

### Lustrumweek

You might have noticed, but Francken has a very special year: it's our lustrum year. However, this part is going to be short, not because nothing interesting happened during the lustrumweek, no no no, just because we are going to dedicate an entire column to the lustrumweek!

### Klaverjas tournament

I can't get through my board year without at least one Klaverjas tournament. Luckily our Fraccie already organized this event for us. If I remember correctly, my partner and I ended up in the *left row* (speaking in Dutch football terms). The eventual winners of the tournament were Pieter and Jelle. However, everyone is a winner if you have fun, right? In that case, you can see the true winners were the committee. 





# Lustrum-week 2020

By Carla Olsthoorn & Sibren Wobben

**E**arlier in this edition, in *News of the Association*, you will have read that we were going to dedicate an entire column to the lustrumweek. We had activities for six days straight so there is lots to talk about!

The theme of the entire week was *Oceans*. At this moment in time (many months after the lustrumweek), we still have fish-themed stickers, rubber ducks, and tropical decoration all around the room (now all decorated with a Christmas hat). With this theme in mind, the lustrum committee organized a competition between two color based teams. Every day the blue and red teams were able to score points in a week long competition. The result of this competition was very arbitrary because, unsurprisingly, no one could agree on the result... However, the website suggests Team Red won.

## Monday - Sharks vs Crocodiles

I'm still not sure if this was the best or worst activity of the entire week. The competition of this day was completely based on the '*rubberbootborrel*', which was invented about five years prior. For those of you not familiar with this event: In this game, both teams pick two people from their team to sit on a shark (in the case of Team Blue) or on a crocodile (in the case of Team Red) who have to stay there until specific requirements have been fulfilled. The goal is to move a certain amount of steps forward on the 'board' with your animal, the 'board' being the floor of the franckenkamer. This was achieved by a set of challenges that were presented in a couple of rounds. Team Red obviously obliterated Team Blue, who in return jumped into a pond in order to somewhat equal the score of the week.



Figure 1: A depiction of a Pieter, Puck, Wouter, and a particularly good looking Delân being the first to ride the crocodile and shark

### Tuesday - Build a trebuchet day

Although Team Red was way better at completing challenges, Team Blue was better at actually doing things. This was most apparent in the preparation Team Blue did for their *whipper trebuchet* (look it up). The board of Cover even came to help Team Red, but this wasn't enough; Team Red's trebuchet fell apart, whereas Team Blue was actually able to fire theirs.



### Wednesday - Sushi Workshop

And then the lustrum week was already halfway through... Nothing suits the theme of this year's lustrum better than making sushi ourselves. Having arrived at the location, we found a long table with not a lot of space to sit, but covered with a lot of food. So, we started making all kinds of sushi; vegetarian/vegan and (luckily) meat based sushi. Although everyone loved making sushi, I think that most loved our desert even better. We were exposed to a new amazing creation, namely small eclairs, topped with chocolate and filled with whipped cream and salted caramel. After this joyful night everyone went in their own direction having gained a couple of pounds.

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### Thursday - Mysteryhunt Wednesday

In the mysteryhunt when ran from pub to pub to solve a series of puzzles. Some of the puzzles were actually very difficult. Until this day there is still one puzzle I haven't been able to grasp (even after the committee provided me with the answer). Luckily for me the committee provided everyone with free beers at every pub. So, even for me (someone who isn't the greatest with puzzles) there was something to do during this activity.



*Figure 2: Joris partying with a palmtree which could be found in the room throughout the week.*

### Friday - Vrijmibo extreme with silent disco

Luckily this activity wasn't a competition. The committee provided everyone with headsets and the dancing could begin! In a silent disco everyone has a headset and people can choose a channel they want to listen to. This results in people headbanging while others are slowdancing at the same time.



*Figure 3: A typical depiction of a silent disco - a lot of people screaming at each other while only a small percentage is actually partying.*


### Saturday - Dies Natalis

It's our birthday! Together with our alumni we started this day with a cruise through canals of Groningen, during which most alumni were especially annoyed by the fact that the crew underestimated the amount of beer that would have been needed. After the cruise we headed over to Francken where our alumni started their routine of destroying the room; I still remember a certain former President of the association proudly pulling a nail out of the door. Luckily they were not only there to destroy everything; some former board members were also able to tell me stories about the history of our room. After coming together and chatting, for the first time in a very long while, we walked to the cantine where a delicious meal was waiting for us. We ended this day with our closing party at Dizkartes; one of the most enjoyable Francken parties ever! After this party we obviously went into the city and stayed there until dawn.



### Sunday - Four Mile

This wasn't an activity planned by Francken. However, some people thought it was a good idea to run four miles after a night of partying. I secretly respect these people; I wanted to cheer them on but wasn't able to make it out of bed (let alone run the four miles myself).

Overall it was one of the very best weeks Francken has ever hosted! I want (again) to thank the committee for organizing this amazing week, and I'm actually a bit jealous that they got to organize this. I hope to see everyone back in five years when I'm no longer board (but that one annoying alumni that pulled the nail out of the door). 







# Francken Symposia

By Leon Trustram

As one of Francken's most important events of the year is around the corner, and in light of this edition's theme, we thought it would be fitting to reminisce a little bit about the past of Francken's annual symposium.

Since this year is a lustrum year at Francken and since most of you reading this will have still been in high school at (and before) the time of the previous lustrum it seems logical to point out the most recent changes and developments, and show some nice pictures from back in the day. So below you will find a short history, a list of all our symposia themes of the past, and some pictures from the past.



*Figure 1: The last Francken symposium that Professor Francken attended in 2001.*

As some of you might know: Our association was born on the 12th of October 1984 after the study program of applied physics was reformed and the name of the association was changed from 'Vereniging voor kandidaten Technische Natuurkunde' (association for candidates Applied Physics) to T.F.V. 'Professor Francken', in honour of Groningen's first professor of Applied Physics: Jan Carel Francken, who had just retired.

The first symposium of our newly named association was a celebration of the first lustrum in the spring of 1989 and was titled 'Ingenieur en management' (Engineer and management). Between 1989 and 2011 almost all symposia themes still had a Dutch title, which makes sense since the FSE of the University of Groningen didn't officially become international until 2013 or 2014 in light of the major increase in international students since the start of the 21st century. This internationalisation means changing the names of a lot of buildings and such. Fun fact: In Leiden they made the unfortunate choice of renaming the university library from 'Universiteitsbibliotheek Leiden' to 'Leiden University Library' which is LuL as an abbreviation. I'll leave it up to our international readers to google translate this to English themselves to discover why this is an unfortunate new name.



Figure 2: Typical symposium promotional banner, taken from 2016's symposium.

Anyway, back to symposium history. Below you will find a list of all previous symposia themes and a selection of photos from the most recent symposia.



Figure 3: Professor Jeff de Hosson giving a talk at the 2005 symposium in December at Nijenborgh. (Nice christmas tree on the left)

Since the symposia dates have changed over the years from the spring to the fall season and back again, I've listed the academic years and it's corresponding theme. Interesting to note is that since the inception in '88-'89 until '10-'11, the annual symposium was held at Zernike campus in Nijenborgh and (later) in Bernoulliborgh.

Since '11-'12 the symposia have been held at external locations, the first being in the 'Kruithuis', an expansion of the 'Stadsschouwburg'.

On the next 2 pages you will find out all the symposia themes since the beginning and find a selection of photos throughout the years.

'88-'89: Ingenieur en management.  
 '89-'90: Exotische materialen in de westerse wereld.  
 '90-'91: Optische elektronica.  
 '91-'92: Soft condensed matter.  
 '92-'93: De ingenieur op zijn plaats.  
 '93-'94: Innovatie, succes verzekerd?  
 '94-'95: Microgravitatie: een gewichtige situatie.  
 '95-'96: Fysici in de automobieliindustrie.  
 '96-'97: Energie voor innovatieve technologie.



Figure 4: First external symposium location at the Kruithuis in 2012.

'97-'98: Licht in een flits, optica in de techniek.  
 '98-'99: Fysica on de loep: Micromechanica en nanotechnologie.  
 '99-'00: Beyond 2000.  
 '00-'01: Communicatie.  
 '01-'02: Milieu.  
 '02-'03: Beeldvorming.  
 '03-'04: Tijd: techniek in het verleden en de toekomst.  
 '04-'05: Fysica in de lift.  
 '05-'06: Waar ligt de grens?



Figure 5: Symposium 'Sense, compute & control on may 2014 at the Grand Theatre.

'06-'07: Fysica en transport.  
 '07-'08: Techniek in media en communicatie.  
 '08-'09: Medische fysica.  
 '09-'10: Sport en Techniek.  
 '10-'11: Saved by physics.  
 '11-'12: The nature of physics.



Figure 6: Professor J.C. Francken's talk at his last symposium in 2001.



- '12-'13: Forecasting phenomena.
- '13-'14: Sense, compute & control.
- '14-'15: Light matters.
- '15-'16: Growing smaller: small steps into a great future.
- '16-'17: Rocket science.



Figure 7: View from the crowd at 2017's symposium 'Rocket Science' at the Heerenhuis.

- '17-'18: Power from within.
- '18-'19: In a materialistic world.
- '19-'20: Cognitive Matters: Physics of cognitive advancements.



Figure 8: Break time at EM2 during 2019's symposium 'In a materialistic world'.



Figure 9: 'Karakterborrel' symposium theme announcement borrel 2020.

## Final words

From reading the previous 3 pages I hope you will agree that a lot has changed in the past 30 years since T.F.V. 'Professor Francken' organised its first symposium. Since the beginning we have changed from the lecture halls within the Zernike campus to different external locations, we've become more international and have started promoting the symposia themes at a 'karakterborrel'.

Of course this doesn't mean that symposia are better now than in the past, it just means that things have changed accordingly with time due to things like internationalisation and digitalisation.

The new trend of hosting the symposium at an external location has as an advantage that we have a more professional setting for the speakers and a better atmosphere than our Zernike lecture halls. The disadvantage is that the symposia location is no longer around the corner of the offices of PhD and professors to drop by for 1 or 2 talks during their busy day.

In Dutch we say: 'Elk nadeel heeft zijn voordeel'. In English: 'Every cloud has a silver lining'.

We hope to see you on the 13th of May 2020 at our next symposium 'Cognitive Matters' at the Puddingfabriek!





# Life after Francken

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By Hilbert Dijkstra

**W**ithin this little write up I will tell you a bit more about why I decided not to follow all the cool people to Amsterdam to start their career in 'The Randstad' but first moved to the 'boring' Enschede to start my career at Nedap and I will explain why this has been my second best life choice (number 1 obviously has been the year as a board member of Francken).

At the end of my studies I knew one thing for sure: I wanted to be a strategy consultant. I founded and organized the first edition of Expedition Strategy which got me interested in that type of career. After Expedition Strategy I participated in a few business courses and this got me really hooked. While awaiting my US VISA for my internship with Samsung I had some time to kill and I decided to join the Nedap



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Masterclass since I really enjoyed the business courses I had done until then; not because I was genuinely interested in Nedap but more so for the fun experience and the nice restaurants that they take you to during these events. Little did I know... During the masterclass I learned more about Nedap and quickly was sold on the company, the people and the culture.

If there was one thing I learned about myself during my studies is that I really like to create, do things my way and have an impact. This is what I found at Nedap. One of the company mottos is "better ask for forgiveness afterwards then for permission in the beginning" and this really demonstrated within my first year at Nedap. I started as a product developer in one of the software teams at Nedap Retail as a Product Owner and found myself presenting at our largest

international customer in Sweden with my first 6 months. This was kind of nerve wrecking but of course also very exciting and challenging to do.

I quickly learned that I liked to work close with customers and that I liked to work internationally. After 2 years I transitioned from a Product Owner role to a Product Manager, which allowed me to work closer with our customers and travel the world to meet our customers. I lived for a month in London to work with Tesco, I travelled to Asia to meet our Asian Business Partners and travelled more and more to the USA to meet with our American customers like Under Armour and Foot Locker.

At one moment I was travelling to the USA on a monthly base and together with Nedap I decided that it would make more





Figure 3: Hilbert running the Chicago marathon

sense for me to live and work full time in the USA. Therefore I moved to Boston in the spring of 2017 together with my wife, to join the Nedap US team. This is where I still work and live. It has been a fantastic adventure so far and gave me the opportunity to explore a new part of the world.

While in Boston I became a runner, since Boston has a very active lifestyle, and I recently finished my first marathon in Chicago. At this moment I am the team captain of our software team in the USA leading the sales and implementation efforts for Nedap Retail in the USA. Looking back at the past 6 years at Nedap it has been a true

rollercoaster of experiences and different roles. This doesn't have to be like that at Nedap but I need change and Nedap is able to accommodate that for me. I was able to make a step every once in a while when I felt restless and needed a new challenge.

It is really exciting to see that since I joined Nedap more Francken members found their way to Nedap. During my studies there already was a crazy amount of "Jaspers" at Francken and it seems to chase me now that first Jasper Compaijen and more recently Jasper Pluijmers joined me at Nedap Retail.

Congratulations to all of you on the 35th anniversary. A great milestone. Cheers!





# Francken Abroad

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By Melav Salih

**K**onichiwa, is one of of eight Japanese words I know. Someone who watches anime probably knows more Japanese than I do. Yet, here I am! Sendai, Japan's city of trees, was massively hit by the Tohoku earthquake and tsunami in 2011. After receiving aid from several countries, Tohoku University started to internationalize and accept students from all around the world. Every year, more courses are introduced in English as the internationals intake increases.. The first thing I realised was the lack of trash bins. While in the Netherlands you always find a trash bin in a 100m radius, in Japan it is quite the contrary. Although it is known for its cleanliness, you will rarely find a trash bin on the streets. That's because they don't need them. It is considered bad etiquette to walk while eating or drinking your cup of coffee.

## Kyoto

The first 24 hours of arriving in Japan, I went on a journey to Kyoto, which is 4 hours by shinkansen (bullet train) or 11 hours away by kosoku bus (highway bus). I took the highway bus as it was half the price of a train and I did not regret it. They give you slippers, a blanket, a pillow, a green tea juice box (classic Japan), free wifi, and your own little space as curtains surround you on all four sides. Although I have not been to any other big cities besides Sendai and Kyoto yet, I have a sense that Kyoto will still be my favorite. The diversity of shrines and temples, the geikos (geishas) on the streets, the spectacular views, and the historical essence was captivating. Drinking by the river with other exchange students from Groningen that I had just met (or Airbnb-host) with the soft summer breeze and the

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rustling of the city behind me were nights to remember. Falling on your bottom in a crowded shrine, and consequently walking with a limp, within the first 48 hours of moving needs to be noted as that was a classic Melav moment. As I type, I realise that I have not injured myself in two weeks and have only had four physical accidents since my arrival.



### Karaoke

(Of course) we went to karaoke after the party. Karaoke is always fun, but it is a whole other level of fun in Japan. You rent out a booth and get unlimited non-alcoholic drinks and soft ice cream for as long as you want for around €10 in the weekend and as low as €5 during the week. If you want, you

can take in your own food and drinks, too. Since the 7/11 is right below the karaoke bar, we stock up there and spend 6-7 hours relentlessly trying to sing all night long. With the amount of French people on exchange here, I have relearned French while singing along to their songs instead of learning Japanese. Accident #4 (my last one): I chipped off the same tooth that I had to get operated in Copenhagen during Buixie by drinking out of a bottle of wine. My greatest feat seems to be going to the dentist in 5 different countries. My bicycle isn't the only thing I'm good at breaking.

### Matsushima

Matsushima Bay, close to Sendai, is said to be the third most scenic view in Japan. We went during the oyster food festival that coincided with the autumn illumination festival. We took a sea tour on a ship to show us all the little islands. They have named every standing island, even the ones with so much as one tree on it. We also walked across the bridge to an island called Fukuurajima. Here, I had the brilliant idea of dipping my feet with my tights on in cold water and then wearing my shows. Miraculously, I did not fall ill the next day. More of my brilliant ideas followed as I encouraged everyone to carry a heavy bamboo stick filled with water and sand that got us all dirty, which we all had a laugh about. I am not a fan of seafood, but I kept an open mind and tried an oyster. Now I can confirm that I am not a fan of seafood.



### University

I coincidentally discovered Fridays for Future in Sendai as I was going for a meeting on the Arts & Literature campus. Strikes are not a part of the Japanese culture, so it is more of a stand in front of one of the main cafeterias. They have just started and seldom have more than 10 people at a time. But climate change is a growing issue in Japan, especially as the new government has announced plans to open new coal plants all around Japan. Most students advocating for climate action enjoy skiing in their hometowns. Twenty years ago, it was common to ski in November. Now, there are only a few places where you can ski at all. Tea ceremonies are a big part of Japanese culture. You will be served matcha tea with local sweets while you sit and listen to someone playing folk music on traditional Japanese instruments.

### Educational differences

Courses are only taught by the professor without any tutorials and most of the subject is expected to be self studied.

The classes are 90 minutes long with no breaks, but the lunch hour is universal with all the faculties and courses: 12:00 - 13:00 no classes are held. All my professors will always start, and often end, with an anecdote. I have heard about how my measurements professor got his only two driving tickets within 3 months and got his golden license revoked; I now know the difference between a Brazilian, German, Chinese and Japanese presenting thanks to my solid state physics professor; my quantum mechanics professor always gives us a story about why he is late (#relate) as I take notes on acceptable excuses to give to my professors for when I am late; my individual research professor has complained about how he does not like his daughter's German husband; my nuclear physics professor often goes on talking about his research which is far from our scope of knowledge as he investigates what happens in neutron stars. I feel like I learn more about the professors during my classes than about the subject itself.



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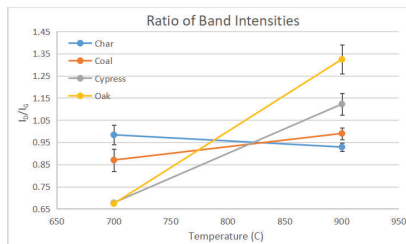
## Research

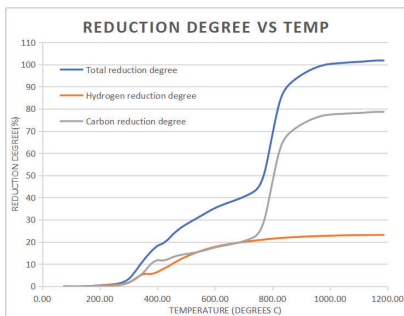
As university officially started October 14th, it has only been a month into my research. The first month was mostly getting adjusted to the lab and knowing understanding the background of my research. Every lab is different and every exchange experience has been different in Tohoku University. Coming here, I had no idea how important this course, individual research training, would be and had zero expectations. This would not be my thesis, but I had to work a minimum of 15 hours a week on it. I decided to go to a lab that did research in materials science to reduce carbon emissions.

My research title is "The Development of the Iron Making Process Using a Composite of Un-Carbonized Biomass and Iron Ore" in the Eiki Kasai laboratory and my supervisor/partner is a materials science Japanese masters student. Iron ore goes through a series of steps before it is used as pure iron in the steelmaking industry. We focus on the reduction process, which proceeds until 1200°C. In our experiments, we use different types of woody biomass (Japanese cypress, oak, cedar) and biomass char, and compare them to different types of coal under different conditions. As a result, we have found that, mostly due to the catalytic properties of Na, Ca, Si and K in the gasification process that occurs between 700-900°C, biomass has a significantly lower reduction temperature, meaning less energy

is needed to complete reduction. To the right is my graph for my reduction experiment for cedar with a C/O = 1.0. For coal, the reduction process starts at ~600°C, whereas for cedar it starts at ~300°C. Clearly, the activation energy for the reaction is significantly less.

We also put the partly reduced composites through a crush test as large manufacturing companies require a strength of 1kN, while we only achieved 100N at most. This is because we are testing small samples in mm and mg. Oak proved to be the strongest, cracking at a force ten times the force needed to crack coal. Through Raman spectroscopy we could analyse the crystallisation degree to better understand the structural changes the carbonaceous material goes through under gasification and reduction processes. As the ratio of the intensities of the d-band (disordered graphene bandwidth) and g-band (graphite bandwidth) increases, the crystallite size  $L_a$  decreases and the material becomes more graphite. Below you can find a part of our analysis and the derivation.





Now, we want to find the best woody biomass and the optimal conditions for the lowest reduction temperature and the most Fe using the least energy. This is a very time consuming process as a combination of experiments for each briquette takes well over a day. I have spent 4 hours only preparing 8 samples. It is a joy in itself when your results do not come out as expected. For the next month, we have set out the following goals:

- XRD analysis of the interrupted experimental samples
- SEM-EDX area analysis of the different biomasses
- Reduction experiment for oak and cedar at C/O = 0.5 and 1.5 with iron ore and alumina
- Freeze pulverization of samples after reduction to improve separation of carbonaceous materials from composite
- Raman spectroscopy of reduced composites.





# Puzzle

By Gertjan Pomstra

“**A**nd that all happened in the village of *Franckendam*!” said the weathered old man. A long time ago he survived these bizarre circumstances and told his story around the fireplace about incoherent debates, public lynching and lycanthropy. When the old geezer finished his story of horror, he told the listeners that he couldn’t remember what the town looked like, except for three big oaks and two rivers that meandered through the village.

From his tales, you could uncover that each of the 15 villagers lived in a small square house that was joined to exactly one straight piece of road. Each house could be reached from the connected road and this road had no crossings, dead-ends and was never adjacent to water except for the two bridges. Between bends or splits, there was always at least one straight piece of road.

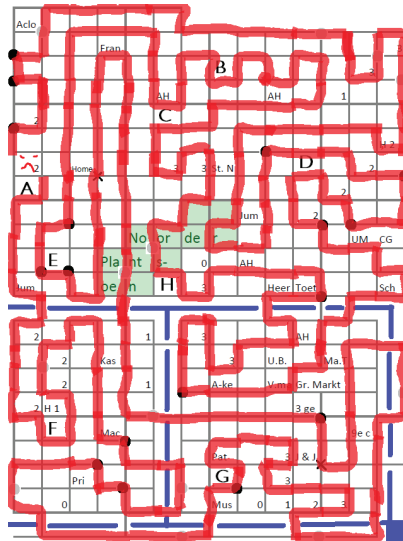
Houses never had the same longitude or latitude and they did not touch diagonally. Moreover, there was a town square with the size of 16 houses and a park with a rec-

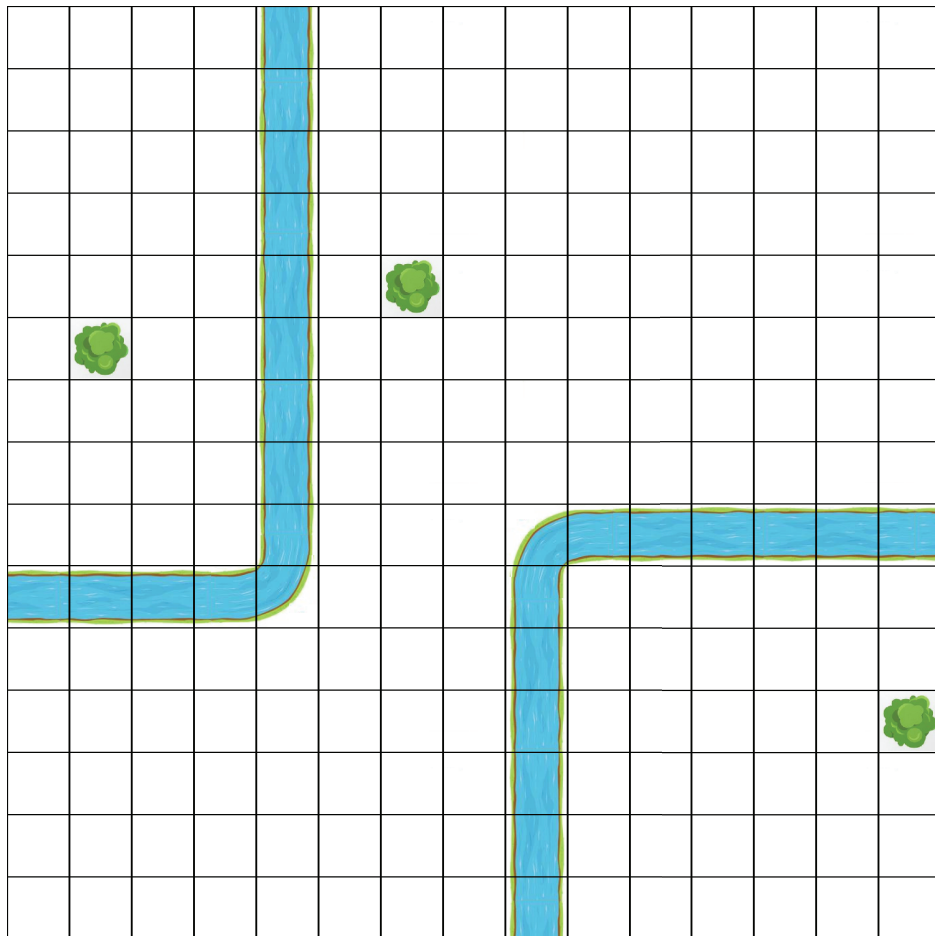
tangular shape of the size of 12 houses.

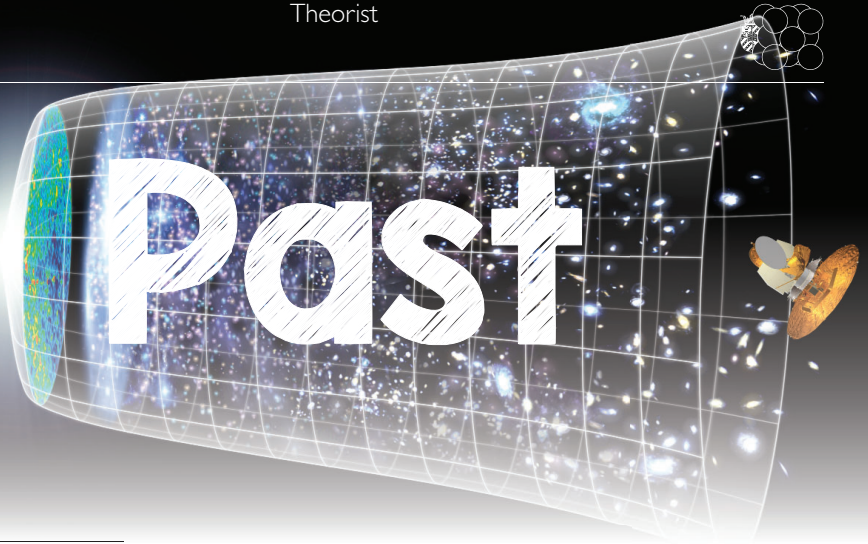
If you are able to recover the topography of the village, you can mail the old grandpa your solution to [franckenvrij@professorfrancken.nl](mailto:franckenvrij@professorfrancken.nl). He would be very grateful and reward you with a goldfish if you mailed him the correct answer.



*Solution to last edition's puzzle:*







By Jelle Bor

**W**e have all been in this situation: you are at a borrel and suddenly you've lost your beer. You know it's somewhere close by, but there are a lot of beer bottles around you. You take a sip of a bottle that might be yours, but you're still doubting whether you have found it. Ahhrr, wrong one. Experiencing this peculiar feeling, you give up and get a new one. The Big Bang theory went about the same. But although we can continue our partying, the physicists are still searching for that one bottle that generated this whole singularity of our cosmological model of the 13.8 billion-year-old observable universe.

The Big Bang theory is, among others, based on observations of a continually expanding universe, specifically on the redshift of spectral lines from faraway ga-

laxies (Doppler effect). Using General Relativity we extrapolated the expansion of the universe back in time and found a point with infinite density and temperature in the past. There is a lot of speculation about how far we can extrapolate back in time to this singularity, but physics sets the maximal scale to be no more than  $10^{-43}$  seconds (the Planck time). The term Big Bang can refer to this singularity as well to the early phases of the universe, which in most models have a very large energy density, temperature, and pressure, filled with (isotropic) homogeneous reactions. There are still a lot of speculations about what exactly happened at these times. It is said that spacetime originated together with the Big Bang, the concept of which is nearly impossible to grasp for most human beings. Moreover, even the majority of physicists do not think about

the Big Bang on a daily basis, having better things to figure out (luckily, I think it might even be healthier for them). After the birth of the universe, it started expanding quickly and cooling. About  $10^{-37}$  seconds in, the universe underwent a phase change resulting in inflation (exponential grow of the universe; like a balloon) for a relatively short time. The inflation can be seen as a separate theory that explained three important problems in the (original) Big Bang: the horizon, flatness, and monopole problems. Thereafter, the universe consisted of a quark-gluon plasma and other elementary particles. Still being at such high temperatures, the random movements (like a drunken man's walk) of the particles had relativistic speeds and particle-antiparticle pairs of all kinds of particles were continuously created and destroyed. Around this time, an unknown reaction named baryogenesis happened, giving an asymmetry of the baryon number. This resulted in 1

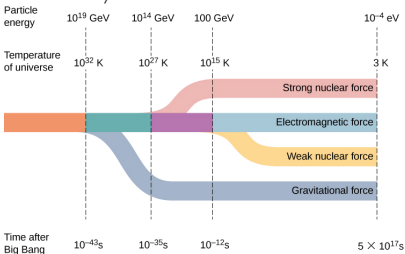


Figure 1: Evolution of the fundamental Forces of our Standard Model of elementary particle physics as a function of time.

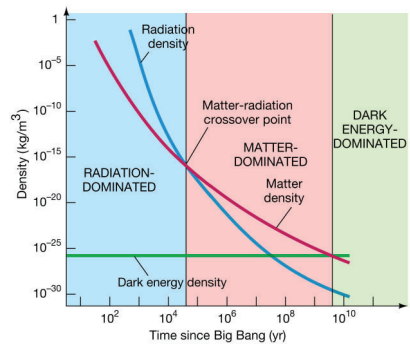


Figure 2: Different density stages of the Universe as a function of time.

extra quark (and lepton) for every billion antiquark particles. This is the cause of the domination of matter over antimatter in the current universe. Subsequently, due to the decreasing temperature and density, the universe underwent a couple of more phase changes resulting in the fundamental forces (and associated parameters) to become as described in the Standard Model of elementary particles we currently know.


After  $10^{-11}$  seconds, what we know of the events becomes less speculative, as we can make experiments mimicking the universe in particle accelerators at such energies. After  $10^{-6}$  seconds the quarks and gluons combine to form baryons. There are many combinations of these particles that can combine to many different baryons, but only a very few are stable for a long(er) time: protons and neutrons. When the



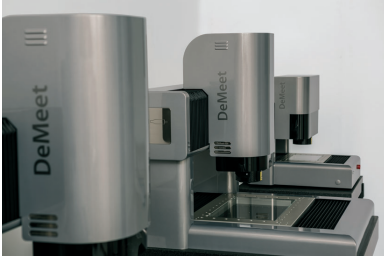
temperature sank below that needed to create baryons and antibaryons, the annihilation of these particles happened, which resulted in 1 in  $10^{10}$  baryons surviving. A similar process happened for the electrons and positrons (leptons) around 1 second after the birth of our universe. After these processes, the leftover protons, neutrons, and electrons did not have relativistic speeds anymore and the universe was dominated by photons (therefore called the radiation dominated universe).

After a few minutes, the temperature of the universe was around 10.000 Kelvin, and the process of nucleosynthesis started. This is when the neutron and protons fused together to form deuterium and helium nuclei. However, most of the protons remained unpaired as hydrogen nuclei. After more cooling the rest mass of the matter started to dominate radiation (therefore called the matter dominated universe). After 379.000 years the electrons bound to the nuclei to form the first atoms (mostly hydrogen). This resulted in a transparent universe and a decoupling of the radiation from matter. This radiation moved freely through the universe and is known as the Cosmic Microwave Background. This period is called the Dark Ages, since there were no stars, and the hydrogen gas did not allow for the visual light to move around. When the hydrogen gas clumped together, after millions of years, and gravity put in under great pressure, stars (and galaxies) started

to form (producing visible light!).

Since we are made up from atoms from dead stars, we are not separate from our universe, we are part of it. You could even say that we are the universe experiencing itself. So, we should keep on experiencing it, and try to find what happened in the very early stages of our universe. For this purpose, we think we need a unification of General Relativity and Quantum Mechanics, and a lot of theoretical physicists are working on this. There is another problem in our understanding of the universe, and it is not a small one. Besides radiation and matter, there is dark matter and dark energy in our universe. Dark matter produces an attractive force (gravity), while dark energy produces a repulsive force (antigravity). Together, dark matter and dark energy make up 96 percent of our universe and we cannot see either of them. Astronomers know dark matter exists because, for example, visible matter does not have enough gravitation to hold galaxies together. Dark energy, on the other hand, is helping our universe to expand. In fact, in 1998, astronomers studying distant supernovae were shocked to learn that around 7.5 billion years after the Big Bang the universe began expanding faster and therefore we live now in a dark energy dominated universe. That indicates that some unknown force is fighting gravity's pull, causing galaxies to speed apart from one another. For now, you may just better pop open another beer. 





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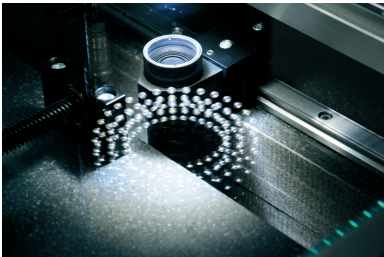
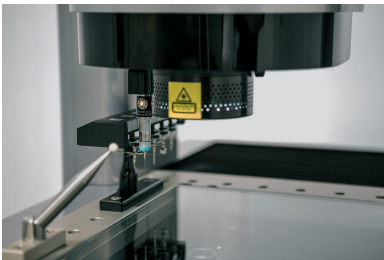
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