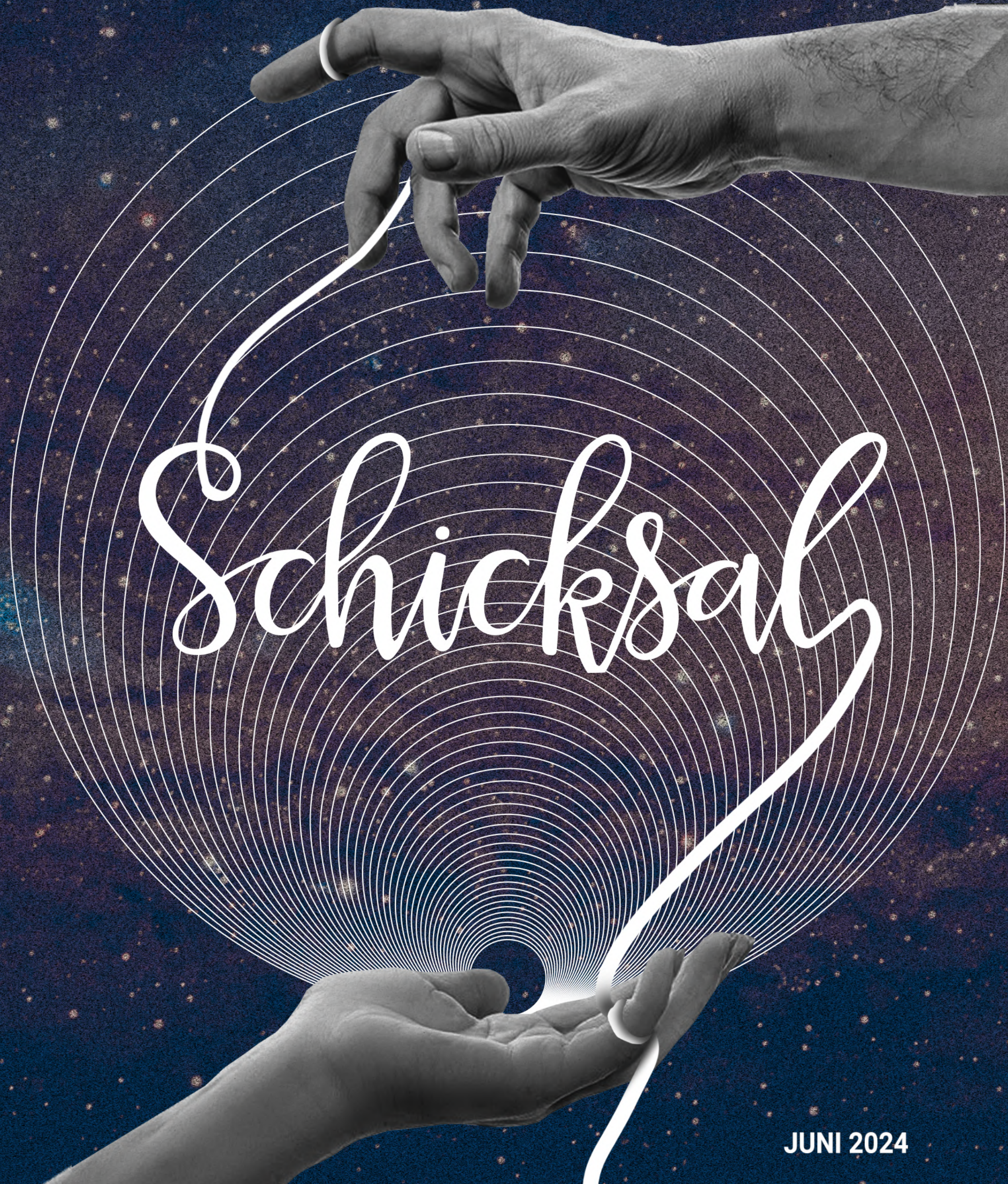
Exsikkator

VCS



Schicksal

JUNI 2024

Exsitorial

Liebe Exsi-Leserinnen und -Leser

Diese Ausgabe ist über Schicksal. Gibt es wirklich eine Prädestination der Zukunft? Kann man die voraussagen? Was ist das Fatum unserer Welt und unserer Universität? Wir können nur hoffen, dass die Parzen kein Missgeschick für uns planen. Euer Schicksal, LeserInnen und Leser? Sich mit den folgenden Artikeln zu erstaunen, viel Neues zu lernen und eine geniessbare Pause in eurer Lernphase zu haben.

Wie immer setzen wir uns mit diesem Thema im Kontext der Wissenschaft auseinander, und zwar mit Fionas Artikel über die physikalischen und entropischen Bedeutungen des Schicksals im Alltag. Parawissenschaftliches gibt es aber auch in unserer langerwarteten Rückkehr des Exsi-Horoskops.

Wenn du mit deiner Schicksalvorhersage danach noch unzufrieden bist, kannst du auch noch Aysans Protokoll zur Synthese von Glückskeksen folgen, die Geschicke aus der folgenden Exsi-Seite herausschneiden und die Zukunft von all deinen Freunden prophezeien.

Aber Schicksal ist nicht wirklich etwas Greifbares. Manchmal ist Kunst ein besseres Mittel, um abstrakte Konzepte zu erarbeiten. Manchmal muss man sich über ein Gedicht den Kopf zerbrechen – siehe Bennets «Zoo» – oder eine ganze Symphonie durchhören – siehe Fionas Artikel über Beethovens Schicksalssymphonie – um die Macht des Schicksals zu ergreifen.
Oder vielleicht ist Humor das beste Mittel: mit Lisas Modern Murder Mystery (endlich wieder die klassische Quarantäne Rubrik!) kannst du ein bisschen lachen und über Kausalität nachdenken. Du wirst dich nicht enttäuschen!

Wenn du denken magst, was du machen würdest, falls du dein Schicksal ändern könntest, wirst du vielleicht Simons Lese- und Zuschau-Empfehlungen mögen. Und falls du dein Schicksal in die Hand nehmen willst, darfst du auch Leifs Artikel über Chemiker-Politiker lesen und einen Karrierewechsel erwägen.

Verpasse auch nicht Nonôs ausführliche Reportage über einen der wichtigsten Bestandteile des D-CHABS, die Zentralwerkstatt, und die Zugänglichkeit von mechanischen Werkstattservices an der ETH. Samuel hat dagegen über die Zugänglichkeit der aufgezeichneten Vorlesungen und Online-Materialien der ETH zur Öffentlichkeit geschrieben.

Letztendlich könnt ihr Davids Aufsatz über Informationstheorie und Biosemiotik lesen, und euch zum Lösen von Dr. Eberts Spektrenrätsel und Sevims «Who said it?» herausfordern.

Ich wünsche euch eine unterhaltsame Lektüre während dem, was wahrscheinlich eine kurze Pause zwischen den Stunden des

Lernens ist. Das ist, wenn ihr wollt, dass euer Schicksal gute Noten enthält ;)

Viel Glück!

Liebe Grüsse

Nonô

P.S.: Mögt ihr den Exsikkator? Ihr könnt gerne helfen, die nächsten Ausgaben zu verwirklichen! Wir brauchen vor allem Hilfe beim Lektorat und beim Layout und Cover Designs sind immer erwünscht. Schreibt uns an exsi@vcs.ethz.ch oder tretet unserer WhatsApp-Gruppe in der VCS-Community ein!

Abbildung 1.1: Schicksal-Redaktionssitzung. Von hinten links nach vorne rechts: Daniel, Antonio, Farkas und Bennet; Raphael, Samuel, David, Alex und Lisa; Samira, Nonô und Léona.

Präsi labert

Liebe Mitglieder der VCS

mit Freude begrüsse Ich euch zu dieser letzten Exsi-Ausgabe des Semesters, was aber natürlich auch heisst, dass ab jetzt **der richtige Spass beginnt**.

Generell blickt die VCS in meinen Augen auf ein erfolgreiches Semester zurück. Während das vielleicht im Vordergrund nicht so aufgefallen ist, ist hinter den Kulissen viel passiert – etwa bei den **Finanzen** der VCS, an der **VCS-Website**, aber am meisten im hochschulpolitischen Bereich. Hier wurde nun erfolgreich die **Vernehmlassung zu PAKETH** beantwortet. An dieser Stelle noch ein grosses Dankeschön an alle, die bei den verschiedenen HoPoKo-Treffen mitgewirkt haben.

Ein weiterer Dank gilt an jeden und jede von euch, die die **wiegETHs-Umfrage** ausgefüllt haben. Die Rücklaufquote ist mit über 40 % auf demselben Level wie 2019 und reicht für uns, um **statistisch relevante Daten** zu erheben. Wir versuchen, euch über die Ergebnissen auf dem Laufenden zu halten, vielleicht schaffe Ich es in der nächsten Ausgabe einen Exsi-Artikel dazu zu verfassen.

Nun rollen die **PVKs** an, die Events werden (sehr viel) weniger, und generell kommt unser Tagesgeschäft etwas zum Erliegen, was aber nicht heisst dass Ihr nicht jederzeit **Anregungen für Veränderung** in der VCS bringen könnt. So sehr wir lernen müssten, so sehr lieben wir das prokrastinieren. Ich schliesse da einfach mal von mir auf andere. Daher schreibt gerne eine Mail, falls Ihr Vorschläge habt.

Ich wünsche euch jedenfalls eine sehr **erfolgreiche Lernphase** und eine noch erfolgreichere **Prüfungsphase**, macht euch nicht zu verrückt und gönnt euch auch mal eine Auszeit!

Ihr könntet diese Auszeit ja zum Beispiel mit der VCS auf der Hüttenwanderung verbringen! Vielleicht ist es ja Schicksal, dass es noch 6 freie Plätze gibt... (Anmeldung auf der Homepage)

Ganz liebe Grüsse und eine erfolgreiches Lernen

Euer Paul

Schicksal

Exsi

Der Glaube an das Schicksal

Über Zufall, Wahrscheinlichkeit und deren Relevanz in unserem Leben

Fiona Buchholz «Das ist halt so, das ist Schicksal», höre ich manchmal. Aber ist das wirklich *einfach so*? Oder kann man die Dinge beeinflussen? Und was genau ist Schicksal überhaupt?

«Was ist die Formel für die Entropie?», fragt Prof. Barnes mal wieder, «1,2,3…?». «$k \ln(\Omega)$», antworten alle im Hörsaal. Die Entropie. **Die entscheidende Grösse, die allen Vorgängen eine Richtung gibt**. Alles geschieht so, dass die Entropie des Universums ansteigt. Es ist unumkehrbar. Vorausbestimmt. Gar schicksalhaft.

Kann man also sagen, wenn einem der Versuch im Labor zum wiederholten Male nicht glückt, dass daran nichts zu ändern sei? Das vielleicht die Entropie einfach nicht zunehmen will? Oder das es an einem selbst liegt, dass es Schicksal ist?

Laut Definition der Philosophie ist Schicksal die «Einwirkung auf das Leben des Menschen, die **ausserhalb seiner Verfügungsgewalt** liegt».[1] Es ist älter als die Philosophie, allerdings hat sich die Bedeutung des Schicksals im Laufe der Zeit gewandelt. Früher wurde es als «blinde Macht» oder «Los» beschrieben, oft in Form von Naturgewalten. Viele Mythologien enthalten den Glauben an **Schicksalsgöttinnen, die selbst auf Götter Einfluss haben**.

Heute hat das Schicksal vor allem in den Religionen eine Bedeutung, als göttliche Prädestination. In den Naturwissenschaften spricht man heutzutage eher von Determination als von Schicksal. Egal wie man es nun nennt, es gibt **zwei konträre Anschauungsweisen**, die das Schicksal mit unserem alltäglichen Leben verbinden. In der einen ist alles, was geschieht, fremdbestimmt und die Menschen haben keinen Einfluss auf die Geschehnisse und **tragen somit keine Verantwortung**. Die andere Perspektive stellt das Schicksal als die natürliche **Folge der individuellen Absichten** eines jeden dar, womit die Entscheidungsgewalt und die Verantwortung beim Individuum liegen.[1]

Also sollte man jetzt an das Schicksal glauben? Ist eine der Perspektiven zu bevorzugen? Gibt es das Schicksal wirklich?

Was sagen denn Naturwissenschaftler dazu? Wenn man nach Artikeln zu Schicksal sucht, dann stösst man schnell auf zwei weitere Begriffe: Zufall und Wahrscheinlichkeit. Da reicht ein Blick in die Quantenmechanik, um zu bestätigen, dass **Zufall und Wahrscheinlichkeit die Welt beherrschen**. Wenn wir nur ein einzelnes Teilchen nehmen – sagen wir mal ein Elektron – können wir nicht genau voraussagen, wie es sich verhalten wird. Wenn wir allerdings eine grössere Menge von Elektronen betrachten, ist es berechenbar, wie sie sich höchstwahrscheinlich verhalten werden.[2] In einem System mit mehreren Teilchen ist immer **der Zustand mit der höchsten Entropie am wahrscheinlichsten**. Durch die Entropie lassen sich also unter anderem Zustände, Vorgänge und Reaktionen voraussagen. Aber sie werden **nur mit einer bestimmten Wahrscheinlichkeit** eintreten, womit wir wieder beim Zufall wären.

Auch die Erde und wir Menschen sind ja quasi aus Zufall entstanden. Im Universum gab es viele Möglichkeiten, wie sich alles entwickelt haben könnte, aber die Wahrscheinlichkeit, dass alles so passiert ist, sodass wir jetzt hier sind, war wohl ausreichend hoch und es ist eingetroffen. Zwischenfazit: Es gibt den Zufall und er kann uns glückliche Zufälle im Leben bescheren, doch die Wahrscheinlichkeit ist das, was zählt. **Vom Herumsitzen allein werden wir dem Zufall kaum eine hohe Wahrscheinlichkeit bieten können, uns positiv zu überraschen**.[3]

Nun könnte man einwenden, dass die Quantenmechanik nicht unbedingt all das erklärt, was wir tagtäglich beobachten. Wenn ich meinen Stift fallen lasse, dann ist es nicht zufällig, dass er nach unten fällt. **Wir beobachten oft Ursache und Wirkung**. Die Himmelskörper laufen auf ihren Bahnen, Körper verändern ihre Zustände nur, wenn eine Kraft auf sie einwirkt, und wenn ich nachts nur fünf Stunden schlafe, dann bin ich spätestens in der zweiten Vorlesung eingeschlafen. Das ist kein Zufall, sondern die **Konsequenzen von universell geltenden Gesetzen und meinem hohen Melatoninspiegel**, der mich zum Ausruhen zwingt.[3]

Wo wir in unserem Alltag von Schicksal sprechen, trifft meist ein gewisser Handlungsspielraum auf Zufall. **Echter Zufall** sind manche Gendefekte, andere sind beeinflusst von der Vererbungswahrscheinlichkeit. **Handlungsspielraum** ist beispielsweise, dass viele Krankheiten zu einem gewissen Grad vermeidbar sind, durch gesunde Ernährung, Sport oder Impfungen. Wer sich kaum bewegt und von Fett, Zucker und Alkohol lebt, braucht sich nicht wundern, wenn die Herzkranzgefässe dicht machen oder die Leber den Geist aufgibt. Das hat wenig mit Zufall zu tun.[4]

Dennoch kann man alles richtig machen, und es trifft einen trotzdem. **Manchmal ist eine Krankheit dann doch Schicksal**. Jedenfalls wenn man an Schicksal glaubt. Diese Überzeugung kann im Leben einerseits Vorteile bringen, denn unkontrollierbare Ereignisse, wie der vorzeitige Tod eines geliebten Menschen, **wirft die Menschen, die**

an Schicksal glauben, nicht so sehr aus der Bahn, wie die, die glauben, die Dinge selbst beeinflussen zu können. Auf der anderen Seite sind schicksalsgläubige Menschen oft weniger erfolgreich, da sie den für sich **vorbestimmten Weg für unveränderbar halten**.[5]

Also was jetzt: Schicksal oder nicht? Egal ob man es Determination, Zufall oder irgendwie anders nennen möchte, dieser Faktor existiert in der Mathematik genauso wie in der religiösen Lehre, egal woran man nun glaubt. **Manches ist nicht vorhersehbar**. Trotzdem können wir viele Dinge sehr wohl beeinflussen, indem wir ihnen eine Chance geben und **durch unsere Taten die Wahrscheinlichkeit für ein gewünschtes Ereignis erhöhen**. Man kann durch Zufall in der nächsten Physikalischen-Chemie-Klausur eine Sechs schreiben, um seinem Schicksal aber eine Chance zu geben, wäre es besser, zu lernen. Damit erhöht sich die Wahrscheinlichkeit für das Ereignis einer Sechs in der Klausur. Damit es tatsächlich eintrifft, ist dann vielleicht noch ein Quäntchen Glück nötig. Oder es ist Schicksal.

Ob man nun an das Schicksal glauben mag oder nicht, ist zweitrangig, **solange man sein Leben in die Hand nimmt** und sich den Konsequenzen seines Handelns bewusst ist. Denn an den Naturgesetzen, sowie an Ursache und Wirkung, ist nicht zu rütteln. Das kann selbst das Schicksal nicht.

Quellen

[1] E. Elm, R. Ewertowski, «Schicksal», zu finden unter https://www.spektrum.de/lexikon/philosophie/schicksal/1824, **2008**.

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[3] S. Sonntag, «Das Leben ist Zufall», zu finden unter https://www.deutschlandfunknova.de/beitrag/wahrscheinlichkeit-und-schicksal-was-ist-zufall, **2017**.

[4] B. Verlinden, «Das Leben bestellen, prüfen, wegwerfen», zu finden unter https://www.sueddeutsche.de/wissen/medizin-und-schicksal-das-leben-bestellen-pruefen-wegwerfen-1.964225, **2010**.

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Machining Excellence

Behind the Scenes of the Central Workshop at the Chemistry Department

Nonô Saramago, Daniel Schiller[1] If one is venturing the long and mysterious corridors of the HCI and finds oneself before an unpretentious door between the first and second fingers on the D-floor, one will likely be faced with a spectacular scene: Hidden from the view of most, one can find a **collection of gigantic machines** capable of inspiring awe in anyone with the slightest interest in science and engineering. Inside, a team of fifteen capable machinists operates a range of different machines and tools to provide a **crucial service** for the research activities at ETH's chemistry department.

Not only most undergraduate students, but even many PhD students and researchers at D-CHAB have never heard about the central workshop, or have no idea about how large the possibilities are when it comes to their services. "Not all of our clients know that we exist", Christoph Bärtschi, a machinist and head of the workshop sector responsible for LOC, explains. "Typically they initially want something small, and then always larger and larger as they get to know the workshop and everything we can do here."[1]

Unfortunately, due to the current **budget cuts suffered by ETH**, which rippled down all areas of the university, the workshop is struggling. "It's the ETH in Zurich.", laments Prof. Alexander Barnes, "The highest precision machining tools should be right over there in that workshop, and they're not – because **we're not putting enough money** into it"[2]. Are there any solutions to these problems at the department and university level?

The Central Workshop D-CHAB

The central workshop provides numerous services that are vital to the way research is conducted at D-CHAB. The services of the central workshop include the mechanical maintenance of research equipment and infrastructure, such as the vacuum pumps, gas ducts, and liquid nitrogen systems of the HCI building. Its main function, however, is the **fabrication of machined metal and polymer parts** that are not commercially available for use in research.

In order to provide these services, the workshop is equipped with a significant number of machines. This includes **six 3- to 5-axis**

1 Daniel contributed to the first two sections describing the workshop.

2 CNC stands for computer numerical control. These machines allow you to cut, drill and mill parts with much more accuracy, in less time and without as much manual labour.

CNC milling machines[2], as well as a significant number of CNC lathes, manual lathes and manual milling machines of different shapes and sizes for all kinds of milling and drilling requirements, from micrometre to metre range.

Figure 4.1: View of one part of the workshop.

Welding is also a frequent service. Finally, 3D printing has become a major part of the workshop portfolio, very appreciated thanks to its material flexibility, speed, and versatility. Customers are able to simply send in their design, it is left running overnight and they come back to clean the parts in the morning!

Other advanced manufacturing techniques, such as glass blowing, spark erosion, and laser cutting are not available at the central workshop, but can be ordered at other workshops at ETH (or, in the case of glass blowing, at UZH). Whenever it is determined that a specific part cannot be produced inside the workshop, the machinists still have the know-how of where such service can be ordered externally.

Redefining Research Possibilities

The groups at ETH that develop new methods and technologies profit greatly from these services. The largest piece of technology ever developed by the workshop, both in physical size and time spent, was probably the Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometer with a cryoprobe and an excitation laser that was built for the Chen group. FT ion cyclotron resonance mass spectrometers on their own are available commercially, but the specific arrangement required by the Chen group is not.[3]

This novel machine is intended for the investigation of gas-molecule tagged ions by laser spectroscopy: a rather specialised field of physical chemistry that no commercial machine is suitable for. Its purpose is to increase the duty cycle to be able to have a spectrum much faster. “If you bring the timescale of the spectroscopy down to the same timescale as synthesis or computation, then it **actually matters for solving problems**", says Prof. Peter Chen[3].

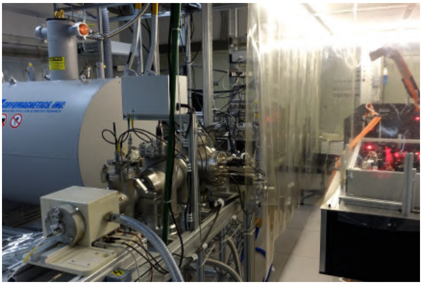

Figure 4.2: FT-ICR MS built by the Chen group with help of the workshop.

The spectrometer was built from scratch, as it was **equally complex and expensive** as the modification of a commercial device would have been. This project spanned eight years and depended strongly on the existence of a fully staffed machine shop with many sophisticated machines. The Chen group also used the workshop's help to modify many commercial spectrometers, for example, to add a stage with a 16-pole or 24-pole ion guide to a commercial mass spectrometer[3].

Prof. Barnes and his group, as another example, are developing new strategies for NMR. Their main project is building their own **handheld high field magnets** by putting a high electrical current through tightly wound **HTS tapes**[3]. "Within about nine months, we went from 7 Tesla to 47 Tesla, which is the **strongest magnetic field** in the world."

This poses great engineering challenges, especially regarding the cooling and the charging, and requires multiple iterations, and the help of the **two machinists working for the group** is absolutely crucial[2].

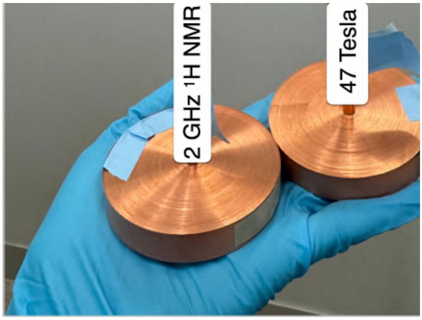

Figure 4.3: Handheld magnets developed by the Barnes group in cooperation with Michael and Ronny from the workshop.

Other large-scale projects include the prototyping of a seasonal energy storage unit that is based on the **generation of hydrogen from pyrophoric iron powder and steam** from Prof. Wendelin J. Stark. In this project, the chemistry part is easy. The challenge is to engineer something that can be used **safely and cheaply by society** to store solar energy harnessed during summer, which means it has to be performed at atmospheric pressure. Their goal is to provide such reactors to Switzerland and

[3] High temperature superconducting tapes.

even the rest of Europe, and developing this without machinists and electricians is practically impossible[4].

In addition, the workshop contributed to numerous other projects that have already grown into spin-off companies. For example, the cartridge-based synthesis system, a so-called "coffee machine" for chemical reactions, was developed by the Bode group and commercialised by the company Synple[1,5].

Short Paths, Close Communication

The way in which researchers can order parts and collaborate with machinists for their manufacturing is an important aspect regarding the value that the workshop can bring to research at our department. As we are not an engineering department, most students, PhD students, and even postdocs don't have that much knowledge about machining and mechanical engineering.

This means that a scientist can't just send a perfectly designed CAD, they need the advice of an expert. "You'll just draw it with square corners because it's easier to draw. The machinist can make square corners, but it's really hard. He'll tell you to make the corners round because you have a round drill. It functionally makes no difference, but it's so much easier to make," explains Prof. Chen[3].

The researchers know the science behind the part they need, while the technicians know how to best design it and which materials and machines to use to produce it. Integrating that knowledge to produce the best possible part without the need for multiple iterations, wasting time and money, requires communication between machinists and researchers, as well as machinists between themselves, as some technicians have different skill sets.

Figure 4.4: The view of the lake between the first and second fingers, shared by the workshop and other research groups, including the currently very short icicle from the liquid nitrogen supply and sometimes the social life of the HCI ducks.

Due to the geographical proximity of the workshop to the laboratories, scientists can simply go downstairs anytime to talk with the machinists about the parts they require or the machines they are building. The workshop employees can also visit the labs to fix things or understand better what they are machining parts for. There is **little to no bureaucracy**, a scientist can just speak to a machinist and get their desired part the next day, or even in a couple of hours. In terms of space and time, the paths between the researchers and machinists right now are **as short as possible**.

Time is an especially important factor, as it gives you the **flexibility to make mistakes**. Professors agree that in many cases, multiple iterations are needed and welcome, including Prof. Barnes: “If you think that you can go in the morning, make three mistakes and finish something at the end of the day that **gets your science going**, you are excited and motivated. If you go into the lab, and you think you need to be perfect with this design and think everything through, and then you’ll get it in four weeks, you will, I don’t know, check your Twitter.”[2]

According to Prof. Stark, the communication between mechanics and scientists is crucial to accelerate research: “Research is unpredictable. We are entering uncertain territory, whether in the theoretical science or terms of application. And that’s why we have to be able to **react quickly and flexibly**. The further research goes into things where we don’t understand what’s going on, the faster we have to conduct research in this open space, otherwise it will take forever to get anywhere. And the more relevant is the exchange between people, including those with **different educational backgrounds and different approaches**.”[4]

No Charlie Chaplins

For the machinists, this working model also makes their job more fulfilling. Machining can be a very manual and repetitive job, especially when working in the industry, where each technician is typically specialised in a particular task. Working in a research workshop is much more appealing, the work is **diversified and unexpected**, as it depends completely on what is being researched at the moment, and can change within just a single day.

Advising the scientists is a large part of the job, in which the machinists can also contribute with their expertise. That way, a job at the workshop includes both **brain work**, – thinking about solutions to problems in research, – and **manual labour**, – where they can materialise things with their own hands. This is where D-CHAB’s workshop differs from others’, such as that of the physics department. “They really have this division into people who only manufacture and people who mainly design and make drawings”, informs Prof. Hans-Jakob Wörner, which means that not all technicians working are responsible for both. But this **manifold nature** is, according to the machinists in the D-CHAB, what makes their job more interesting and motivating.[1,5] More importantly, it attracts the most talented technicians to work there.[2]

"This isn't just a machinist working at a company making a hundred screws per hour. Their work here is more creative: 'Oh, how do we solve this problem? How do I put this all together to make something new and brilliant that can address this scientific question?' And there's this huge group of workshop poly-mechanics over there that are all into that and have been trained for that", explains Prof. Barnes.

In some institutes, such as the IMPS and the LPC, the employees work specifically for a certain group. This allows them to get a better understanding of what the group is working on. While there is a high turnover for PhD students and postdocs inside groups, these machinists can work there for several years, going to group meetings, and also social events, learning from the scientists and actively helping on long-term projects. That way, they can also help with the transfer of knowledge, accelerate progress and avoid that the same dead-end roads are treaded again.

Michael Urban, for example, works directly for the Barnes and Wörner groups: "The biggest advantage is also that we helped develop the things and that we know exactly what is available in the setup and what is not, and what can be optimised, where are the difficulties and problems and how to tackle the whole thing."

In other institutes, such as the ICB, there is a rotation system where, each year, a different worker is the point of contact, the leader, with whom the professors can communicate. This system leads to a sense of responsibility, improved interpersonal relationships and cooperation, as it allows researchers to get to know all machinists better.

Machine Dreams, Budget Nightmares

"We keep having to do more with less money and fewer people". This is the reality at the central workshop at D-CHAB, but also at most of ETH. Despite ongoing growth in student numbers, the Bundesrat has shortened its funds for ETH two per cent for the next ERI period[4][6]. Stephan Spiegel, the Vice-President of Finances and Controlling at ETH, says in an interview that "we are currently living on our freely available reserves, but they will be completely exhausted by the end of 2025."[7]

Although ETH doesn't plan more financial cuts for 2025, the workshop is still left underfunded. Large machines are too big investments for the departments to pay on their own, which is why most rely on finan-

[4] Education, Research and Innovation policy in Switzerland for the period of 2024–2028.

cial help from the Scientific Equipment Programme (SEP), which (guess what) also has had major cuts. According to Prof. Wörner, who is responsible for submitting the quotation of requests for new machines to the SEP, "three years ago it started to become more difficult to get our proposals accepted because the SEP had less money. We've really had greater difficulties now with the last machine, to get it financed."[8]

"The Scientific Equipment Programme is an internal funding program where researchers, workshops, and technology platforms can apply for financial support for scientific equipment"[9]. This is the description by Dr. Sarah Lechmann, who works for the Office of Research at ETH and is, amongst other things, responsible for reviewing small proposals (under CHF 50'000) to the SEP.

For every new machine they need, the machinists at the workshop draft a proposal with an offer on where to buy it and also counter-offers and how much financial support they need. If an application is rated as qualifying for support, typically between 30 % and 50 % of the total costs are covered by the SEP. Prof. Wörner takes care of the administrative work of finishing the proposals. In case of replacement proposals, this also includes a list of publications which wouldn't have been possible without using that device.

Dr. Lechmann explains that there are multiple criteria for their decisions: "Can the people in the lab operate this device? Do they already have experience with it? What has already been achieved with it? What kind of publications, what kind of research? Is the choice of device right for what they want to do?" Large proposals (over CHF 50 000) are sent to external reviewers, who are people from the relevant research areas or who have the same type of equipment.

She also stresses that, due to the budget cuts, they are driven to prioritise machine replacements or repairs over new acquisitions for novel and potentially risky projects, and devices that will be used by a higher number of people. The budget is under ten million Swiss francs, so we can assume that they cannot finance more than a low double-digit number of funding requests above 50'000 francs per year. "They have massively less money than last year, and that reduction is significantly more extreme in proportion to the reduction in ETH funding", mentions Prof. Wörner[8].

This is worrying, as scientific equipment is one of the pillars for excellent research, as it allows the development of new methods. As Prof. Barnes emphasised: "If you're not building something new that's enabled by the workshop, then inherently, you're competing with other scientists, which is silly, because we're all trying to do the same

Figure 4.5: Main building of the *Eidgenössische Technische Hochschule* one of the "driving forces of Swiss industrialisation".[10,11]

thing: make society better and make science better. So anytime you are competing with another person in science, you're kind of failing. You're missing the whole point. You should be **competing with yourself and with nature**, and the way you can do that most effectively is to build a new piece of technology or instrumentation."

Most universities in the US and Canada, based on multiple accounts from the professors we interviewed, have much **inferior infrastructure and workshops** than we have in Europe. While some students lament not being able to use the machines themselves, as is the case in many American universities, it is undeniable how much more possibilities having a workshop like ours creates. Prof. Chen and Prof. Barnes, both from prominent universities in the US, Harvard and MIT, respectively, underlined how the machine workshop's infrastructure was one of the things that **made the position at ETH attractive**.

The Cost of Unpredictability

The current working model of our central workshop requires **physical proximity**, **little bureaucracy** and a **large machine pool** with diverse machinery to allow the flexibility needed to machine a variety of parts. This is naturally expensive. So many different machines are not always being used, but might still be needed some of the time.

Figure 4.6: HCI building (on the left), the most expensive non-military building in Switzerland at the time of its completion in 2004.[12]

It is very different from a mechanical workshop in an industrial setting, where machines are running the whole day to produce a commercial amount of each part. It is clear that machine capacity utilisation as a measure of efficiency **does not translate to the most value to research** in the case of a university workshop. As Prof. Wörner puts it: "We don't need to produce a giant number of parts like in the industry, we need flexibility."

"When you have this individual group setup, like we do, where people have a direct contact person, then it's more optimised for research because you have a relatively **quick path between the idea and its implementation**. On paper, of course, it looks as if we weren't working at all. But we don't just produce parts, we also work internally in the group, we help out with the experiments ourselves, when things don't work or when something needs to be repaired. And that's why our machines are **not always fully utilised**", explains Michael.

However, in terms of research, this time that the machinists spend talking with scientists is **not wasted**. "In an academic workshop, the machinist works with the students much more, which inherently costs more. But the student learned something from this. It made me a **better scientist**. Centralising the machine shop would mean that this contact gets lost", underlines Prof. Chen.

Trying to balance the machinery utilisation at different workshops to maximise their use is not always that easy. While it might seem a good idea to merge workshops to share the machines, this doesn't guarantee an improvement in the use of synergies, as it is **impossible to predict** what will be needed in research. Maybe one day fifty people need a specific machine and the other day none. Creating a system to maximize that would be hard.

It would also impair the model that we

have today. Having fewer workshops for more people would reduce the geographical proximity and prevent the workshop staff from getting familiarised with the work of specific groups. "From a certain size or from a certain distance, it will no longer be possible to work the way we do here now", Bärtschi explains. "Purely in terms of workflow, that will be difficult. And the fact that certain people would have to know what the groups throughout all of ETH actually need, would be relatively difficult to realise."

As Prof. Stark explains: "We shouldn't just calculate how much it costs to make a hole in a metal sheet. Of course, it's cheaper if you centralise it. But then you forget that it's not just about someone making a hole in a sheet of metal with a drill, it's about knowing where to put it and why it's the right solution for the researchers. This support goes much further than actually carrying out the mechanical job, and if we hinder that communication by bringing in distance and making them fill out a form or request time with a mechanic, then we're putting hurdles in between."

It's All about the Money, Money, Money

No matter how it is done, sharing machines between departments also complicates how parts and services are priced. The reason there is so little bureaucracy is that we are all in the same department. The way it works at ETH is that the department is a budgeting unit. As explained by Prof. Chen: "Everything within the department is coming out of the same pot. Within a department, you don't have internal billing, because that's just moving money around inside the same pot with friction losses. So having a workshop in the department means that there's no reason why even any group that needs a service can go talk to them, and there's no billing. It's covered by our budget."

In the end, whoever pays gets the services of the workshop provided to them. As the workers are hired by the institutes and the machines are owned by the department, providing services to multiple departments would create the need for billing. Charging for materials is easy. The biggest questions are: who pays for the manpower? Who is responsible if something gets damaged?

For example, the workshop of the physics department has a larger warehouse than the D-CHAB's, with a larger selection of materials. People from the other department can buy parts and materials from the D-PHYS shop and pay for the item. But this also means that the chemistry department needs to pay a yearly contribution to the physics department to compensate for the person that operates this store.[8]

So, billing for workshop services should be avoided. We want to get the maximum utilisation out of each machine, not **hinder access to it with cost barriers**, which are necessary when working with multiple departments. According to Prof. Chen: "The problem with most American universities is that the management decides that the machine shop should operate with the same rates as a commercial shop, but they still have to charge more than commercial shops because they have to somehow bill for the time they're talking to the students."

He continues: "There are certain big groups which did a lot of construction, so they can afford to hire their own **internal designer** and **purchase parts outside**. Then, it is cheaper and more efficient for them to go outside. This means that the workshop's revenue decreases, and the management says they have to cut the size of the workshop or raise the prices, until nobody else goes there, and the management says that **there's no demand**, so they close it. Then, the small research groups **get into trouble** because they can't just go to commercial shops, as they can't afford their own mechanical engineer to make drawings that actually make sense on the first try."

ETH-Wide Synergies

There is yet another difficulty. Not all groups require enough machined parts to make it worth it to pay for workshop access. But they might need a part now and then and would rather pay for it individually. As an institution dedicated to excellence in research, ETH has the responsibility to **provide such services to all research groups and institutes**, not just those that require it frequently enough to afford to have their own workshop.

One way that ETH tries to meet the needs of all researchers for machined parts is through the **TechPool**. Through this platform, any ETH member can order parts customised for their needs, either **in person**, via Telephone or E-mail, or using their **24/7 online tool**. The manufacture of these orders is then assigned to machinists at different departments of ETH and sometimes UZH, depending on their availability and on which specialised machines might be needed, or ordered at an external shop. The manager of TechPool since 2018 is Peter Stäuble, who started working at ETH as workshop coordinator in 2016.

This platform is mainly thought of as an **access point for those who don't have direct access to a workshop**. Yet, it also allows anyone to have a part produced using any specialised technology or machined at any workshop of ETH and by the TechPool external partners, independently of which department they come from. The **departmental barriers** to the access of technologies are better overcome.

Before the establishment of this platform, it was very complicated and risky to develop projects between multiple departments due to communication issues. Now, the TechPool executes jobs ordered by all departments at ETH[5] as well as central organs and distributes them over all twenty workshops of the university. "We either buy this technology for every workshop, but you may not have the space or the money, or we make it accessible via an organisation, which then takes care of the administration and cost allocation", explains Peter Stäuble.

The orders made on the online portal are first analysed by the employees of the TechPool. They advise the clients if necessary and make a cost and deadline estimation, which can then be confirmed by the customer. Any unpredicted increases in price are covered by the TechPool, which provides better cost certainty.

In addition, despite paying full price for the raw materials and any externally bought items, the clients only have to pay for forty per cent of the production costs of a given order. This consists of the hourly fees for the machines used, which includes the salary of the machinists operating them, and sometimes replacement costs for these machines. This makes sense, as all these billings are ETH internal, so no money is being lost by just charging less to the individual client.

Another member of the TechPool is responsible for constructing or correcting the CAD drawings out of the customer preferences to give to the machinists. Some clients, typically from engineering related departments, just upload their completed CAD designs, which require little further optimisation, their choice of materials and other details in the online portal, 24/7, and just want to get their parts exactly as they are, without delay.

Others, who don't have any know-how in machining, might come with a rough drawing and want to speak with a technician and be advised about the best way to produce a part that fulfils their needs. The TechPool is adapted to work with both models, so that the machining and building requirements of all of ETH can be met. Yet, while for some an online-request-based model for individual orders make more sense, having the machinist and researchers interact and work together is fundamental in our department, and it depends on things working the way they do right now.

Each to their own

This all goes to show that there are many possibilities on how to operate a workshop

5 Apart from D-MATH, and especially often by D-MAVT, according to Peter Stäuble.[13]

depending on the wants and needs of the clients. However, it is important to notice that the D-CHAB workshop's clientele, as strongly emphasised by all professors we talked to, is naive when it comes to machining. This means that the communication to the technicians at the workshop is indispensable.

Every department, institute and group has its wants and needs, and having so many workshops as well as the TechPool allows all those different models to coexist at ETH and everyone to be able to access to them. Further centralisation might, at first glance, seem to improve how much the workshops can do for their clients with less budget. However, it is important to reflect on how this would affect the independence and flexibility of each workshop to have their own models.

As put by Dr. Lechmann, right now ETH lays an emphasis on the "Mindset to share". But that can't be extended to the point of losing the flexibility we have. The notion that maximizing machine utilisation equals "sharing", or that it is even possible outside the square walls of industry, is distorted.

If anything is actually increasing the value that the machines can create for research, it is the sharing of information. According to the machinists, improving communication between workshops of different departments would allow them to be informed when a machine that is busy in their workshop is free in another and to know which technologies each workshop possesses. The TechPool was a large development in terms of connecting all workshops, but departmental and institutional workshops are still very necessary.

The integration of the global access and efficiency provided by the TechPool with the flexibility and agility provided by the smaller scale departmental workshops is what allows the workshop model at ETH to support cutting edge research so well.

Conclusion

The members of D-CHAB greatly value how fast and personal the workflow at our central workshop currently is. This unbureaucratic and agile work model unfortunately only works on a small scale. Elongating the distance from the machines to the labs or increasing the size of the workshop by further centralising what is already the central workshop D-CHAB would destroy all these advantages.

Independently of the recent budget cuts suffered by our university, investment in technology and equipment should be prioritised, as it is the basis for innovation and new experiments. It is this outstanding infrastructure that makes us stand out compared to universities in the USA, and we cannot give that up.

Excellent research and first-rate education is expensive, there is no way around it. If Switzerland – this little country with no sea access and few natural resources whose only valuable assets apart from banking are **innovation** and its **highly educated workforce** – decided that one of the most important factors in having become one of the **richest countries** of the world is not that important any more, what can two humble international students do about it? Apparently, only pay **triple tuition**.[14,15]

"The workshop is so important for us in so many ways, and we should do anything we can to support it, to keep it the way it is, to grow it and to fund it better", urges Prof. Barnes. Having access to the workshop that we have today creates a **positive cycle** inside our department of attracting the **best machinists, the best researchers and the best professors** to work here. It allows for feats of research unfathomable almost anywhere in the world. It is the **secret weapon of the chemistry department**, and we hope that now more students know and value what exists behind this unpretentious door within the long and mysterious corridors of the HCI.

Acknowledgements

I thank all the stakeholders that agreed to talking with us and sharing their views and experiences on the topic. Thank you to Daniel for accompanying me to most interviews and helping me write the first two sections.

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To Be Shared or Be Forgotten: The Fate of Lectures at ETH

The Challenges of Providing Open Access to ETH's Educational Resources

Samuel Wechsler Humanity, facing increasingly turbulent times, is in dire need of technological innovation, which in turn depends on the expertise of well-educated scientists and engineers. Fortunately, access to technical knowledge has generally become easier with new platforms such as EdX, or MIT OpenCourseWare. However, our own institution has yet to contribute to this ongoing trend. In stark contrast to the open access practices of institutions like MIT with its OpenCourseWare, ETH has not fully embraced the **potential of digital openness**, as a quantitative analysis reveals. Insights from a discussion with Professor Barnes will elucidate the barriers to open access of ETH's educational resources.

> "When you share money, it disappears; but when you share knowledge, it increases."
>
> *Charles M. Vest, Former President of MIT*[1]

In the daily grind that defines the life of nearly every ETH student, it's easy to overlook the **privilege of studying at one of the world's leading technological institutions**. At least in the first year, it often feels like we are being spoon-fed the complexities of biology, chemistry and physics by researchers who are among the world's leading experts in their respective fields. Unfortunately, these extraordinary educational experiences are largely limited to enrolled students. Despite ETH's growth as an educational institution, the reach of its courses largely remains confined to campus. In an era of ongoing digital revolution, however, this clearly does not have to be the case. While a decisive leap towards free digital education would certainly be challenging to our faculty, it would **enormously expand its impact** and empower a global community of independent learners.

Current State of open access for Lectures at ETH

As enrolled students at our institution, it can be difficult to grasp how inaccessible our online lecture series really are. Therefore, we conducted a quantitative study to better understand the objective extent of lecture inaccessibility here at ETH. Specifically, a Python script (version 3.9) was implemented to first collect extensive metadata on all lecture series uploaded to the ETH video portal during the last two decades (see Figure 5.1). A similar approach was then used to gather data from ETH's course catalogue since the 2006 spring semester, serving as an approximate reference for the total lecture output created at ETH.[1]

So what general picture emerges from that analysis? First, a look at Panel A of Figure 5.1 confirms the impression that lecture recordings are **relatively inaccessible to the general public**. Not a single department provides open access to the majority of its recorded lectures. The Department of Architecture (D-ARCH), which is the most liberal in terms of access to lectures, still only provides free access to 27.08 % of its uploaded lecture recordings. At the bottom of the list is our own Department of Chemistry and Applied Biosciences (D-CHAB), which makes a vanishingly small proportion of its recorded lectures freely available (1.30 %). In absolute terms, this corresponds to three publicly available lectures out of 231 recorded lecture series. These include two general chemistry lectures from 2018, namely Prof. Togni's Introduction to Inorganic Chemistry (ACAC I), Prof. Chen's spring semester course on Organic Chemistry (ACOC II) as well as a lecture series in Physical Chemistry by Prof. Reiher.[3–5]

But has ETH been effective in improving open access to recorded lectures in recent years? Panel C clearly proves it hasn't: in fact, since the inception of the video portal, **the proportion of freely available lecture series has steadily decreased** while concurrently more and more lecture recordings have been uploaded. In the year 2020, an all-time low of 3.30 % of publicly available lecture recordings was reached and we have been hovering in that ballpark ever since. A positive trend can be noted in relation to Panel D: at the height of the Covid-19 pandemic (2020–2021), there was a significant increase in the total number of lecture recordings (restrictively) uploaded to the video portal. While this drastic leap in digitisation was **not accompanied by an initiative towards open access**, students have evidently benefitted from more lecture recordings being made digitally available.

It is important to note that the data presented so far are subject to a strong selection bias, as only a subset of all lectures – i.e. those recorded and uploaded to the video portal – were assessed for accessibility. In reality, the proportion of accessible lecture series is even lower. A more accurate estimate of accessibility is therefore provided in Figure 5.2, which compares data **ob-**

1 For readers interested in further details, the collected dataset as well as the documentation of the exact procedure involved in the data collection are provided in the referenced GitHub repository.[2]

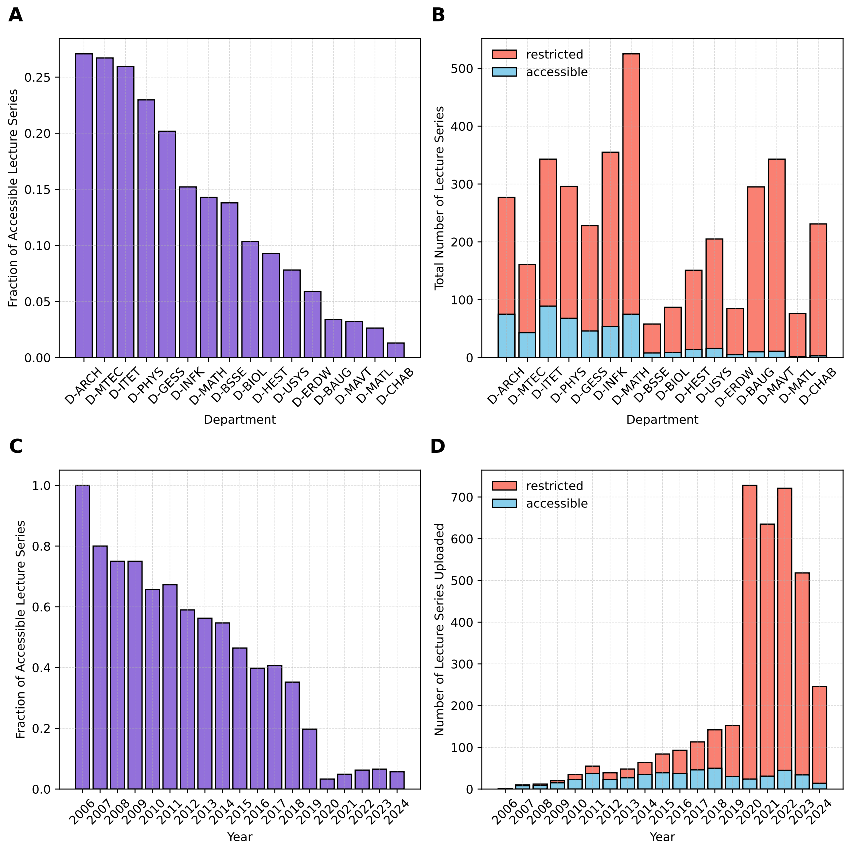

Figure 5.1: Analysis of lecture series availability on the ETH video portal. Panel A displays the proportion of uploaded accessible lecture series, emphasizing variation across departments. Panel B expands on this by showing the number of restricted and unrestricted lecture series in absolute terms for each department. Panel C focuses on the temporal evolution of lecture series availability, revealing a close-to-monotonic decrease in the fraction of publicly available lecture recordings. Finally, Panel D tracks the absolute number of accessible and restricted lecture recordings over time, displaying a significant spike in uploads during the COVID-19 pandemic. The reader is referred to the list of department abbreviations.[6]

tained from course catalogues with those gathered from the video portal. Two main conclusions can be drawn:

1. Consistent with the prevailing opinion among students, a not large enough fraction of lectures is recorded.
2. As expected, an even smaller fraction of lectures, to the point of being barely perceptible on the plot, is then made public.

Before drawing conclusions from this data, some comments regarding its potentially limited validity are in order. Firstly, the integration of data from two independent sources – the ETH video portal and the course catalogue – can result in various potential inconsistencies due to different formats, definitions and update frequencies, which may lead to a misrepresentation of the ground truth for the accessibility of ETH lecture content.[2] In addition, there are of course numerous other platforms that are used to make educational material digitally available, which were not covered by the scope of this analysis. However, the metric presented must be questioned on an even more fundamental level: while the share of unrestricted content on the video portal is technically accessible, it is still not retrievable through web search queries. In other words, most **search engines are unlikely to respond** to a query for educational resources with links to https://video.ethz.ch/.

Despite the aforementioned limitations of the collected data, a general impression of the current state of open access to ETH lectures can be gained. The consequences of the current state of affairs are perhaps most vividly illustrated by a change of perspective: suppose a high school student, who was fascinated by the intricately beautiful field of chemical sciences, was on the lookout for online chemistry lectures. Short of stumbling upon one of D-CHAB's three open-access lectures, or paying for a listener subscription and actually attending the lectures in person (during inconvenient time slots), said student would more likely end up using other resources to satisfy their curiosity. Even considering the alternate unlikely case, the resources provided would still **not be a particularly efficient tool for self-study** since accompanying lecture materials (e.g. problem sets, lecture notes, slides, etc.) are not provided.

By pursuing this hypothetical chain of events further, a clear picture of the opportunity costs emerges. Reflect on what your expectations of studying at ETH were before you actually started. For many, their expectations diverge drastically from reality. While the general notion of ETH's Ba-

2 Given the large volume of data collected, a comprehensive manual check of the entire database was impractical. However, a robust level of reliability was achieved through systematic sampling. A more detailed description and proof of concept can be found in the GitHub repository.[2]

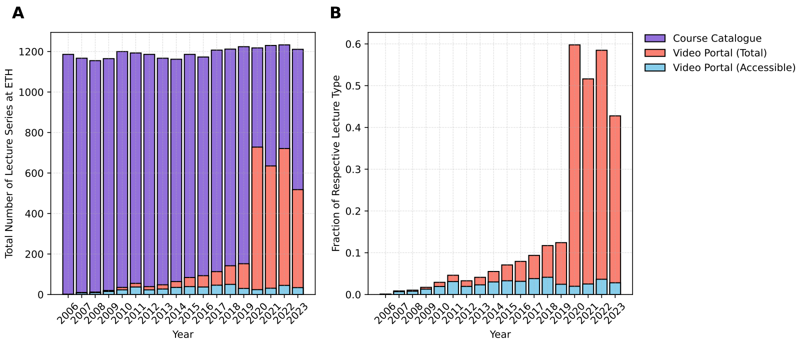

Figure 5.2: Comparison of lectures registered in the ETH's course catalogue vs. uploaded recordings on the ETH video portal. Panel A illustrates the total number of lectures registered in the ETH's course catalogue. Panel B displays the fraction of recorded and publicly uploaded lectures.

sisjahr being a high-level and rigorous educational program may persist, prospective students often do not gain a true sense of what studying at ETH is actually like until the semester begins. If ETH simply put its Basisjahr curriculum online, it would not only help students **get a better impression of what ETH truly offers**, enabling them to make well-informed decisions about their futures, but they would also inspire greater interest and **attract the brightest minds**. Thinking back to the previously mentioned high school student with a special interest in chemistry: if the student stumbled upon some of the great lectures taught here, such as Prof. Chen's organic chemistry class or Prof. Barnes' lecture on thermodynamics, how could they not fall in love with the subject? And what better inspiration to study at ETH could there possibly be?

Barriers to Broader Adoption of Open Access

Considering the vast potential of digitised but restricted educational content, a pertinent question arises: **why are professors not very willing to make their educational resources public?** After all, our lecturers are scientists who have dedicated their professional lives to the creation and dissemination of knowledge. To understand this apparent paradox, we spoke to Prof. Alexander Barnes, renowned among D-CHAB students for his engaging thermodynamics lectures in Physical Chemistry I and for his remarkable achievement in constructing the world's strongest magnet. Professor Barnes suggests that the reluctance to publish educational content online is partly due to the **pervasive culture of criticism in academia**.

> "*We as academics are held under such a microscope for failure and for making mistakes and for criticism our whole lives. [...] I'm constantly being critiqued for grants, I hear about what people in my field think about me going to 100 Tesla [...], and all this criticism can be overwhelming. [...] We develop these mechanisms of when to shield yourself, when to expose your ignorance because if you can't expose your ignorance, you can't fix it, and you can't learn. And that's probably why you don't see it happening so much*". (Prof. A. Barnes)

Students are acutely aware of the hypercritical environment that is inherent to most academic frameworks, as Professor Barnes went on to explain. Even at an undergraduate level, small errors can have a significant impact on one's academic trajectory. For example, a student's grades determine, in part, whether one qualifies for a position as a teaching assistant, or, later, whether one can pursue a PhD at a prestigious institution.

Of course, academics are not suddenly exempt from this intense scrutiny after graduation. **Tenure-track faculty in particular are under immense pressure** not only to secure grants and publish in high-impact journals, but also to teach effectively. While the extent of the latter factor varies from institution to institution, it is clear that a professor must be able to teach a class, and part of that is **avoiding mistakes when standing at the blackboard** in front of students.

"*When I was an assistant professor [...], I had these nightmares of somebody making a highlight reel of all my mistakes. Because if you did that over five years, it would kill my tenure case*", Prof. Barnes recalled. He also shared the story of a colleague at Washington University who failed to secure tenure due to his inability to effectively teach large classes. Of course, the level of scrutiny would be even higher if the lectures were made public, as the quality expected of public lectures is often higher than that of internal lectures. In Professor Barnes's experience, it takes a long academic career to **build up the confidence to publish the content of lectures**, fully aware of how harshly critics will react to inevitable mistakes.

> "*There's teaching a course and then there's teaching a course with confidence to make a mis-*

take in front of the world”.
(Prof. A. Barnes)

Conclusion

The path to open accessibility of ETH’s educational resources remains challenging. Even if more senior faculty members were willing to expose themselves to harsh criticism, significant obstacles would remain. The process of publishing lecture recordings in an accessible format is both **time-consuming and resource-intensive**, particularly if accompanying lecture materials are distributed alongside. In addition, there are numerous considerations to be taken into account, including the choice of an appropriate licence to protect the published lecture content, whether the lecture recordings themselves infringe the **intellectual property rights of third parties**, and how to provide accurate captioning for hearing impaired people. It can be concluded that any major initiative towards open access would require more than the admirable agreement of lecturers to speak to a drastically larger audience on a (bi)weekly basis. Therefore, any major push towards open access is **unlikely to succeed without significant institutional support from ETH**.

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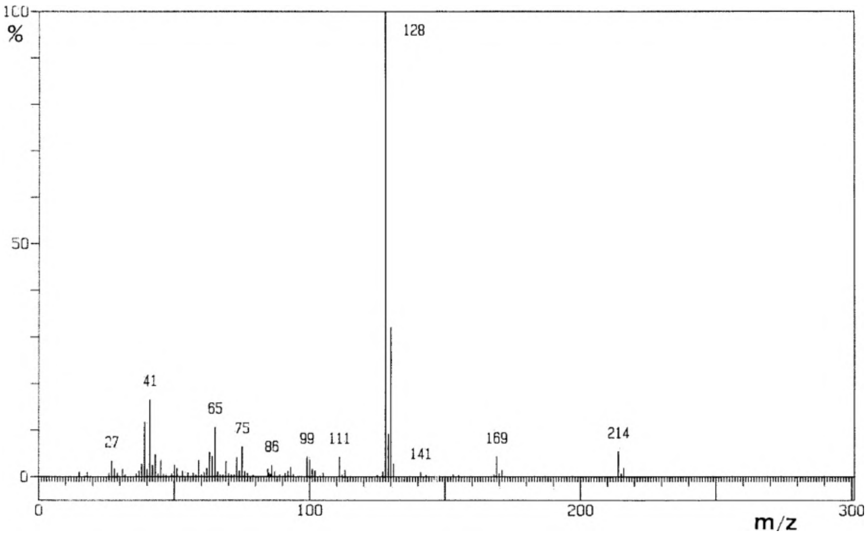
Spektrenrätsel

Zur Verfügung gestellt von Dr. Marc-Olivier Ebert Ein SEFT-Spektrum enthält die selben Informationen wie die beiden DEPT-Spektren und zusätzlich die quaternären C-Atome. CHs und CH_3s zeigen dabei nach oben, Cs und CH_2s nach unten. In einem off-resonance entkoppelten ^{13}C-Spektrum sieht man quaternäre C-Atome als Singulett, CHs als Dublett, CH_2s als Triplett und CH_3s als Quartett.

Lösungsvorschläge bitte an exsi@vcs.ethz.ch, der erste richtige Vorschlag wird mit einem Preis belohnt. Die Lösung findet ihr im nächsten Exsi. Die Lösung des letzten Spektrenrätsels findet ihr auf Seite 63.

MS

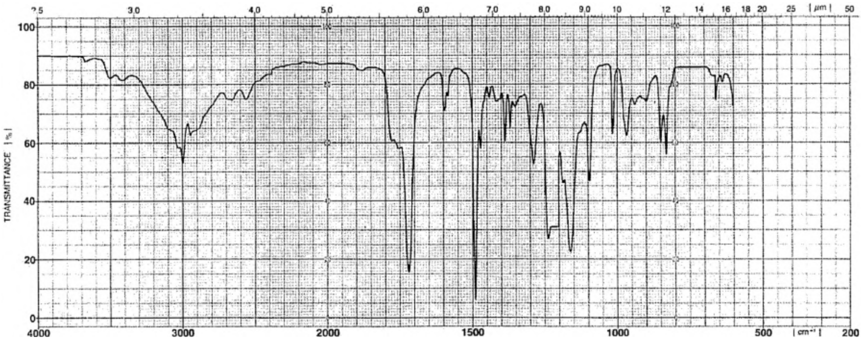
Hitachi Perkin-Elmer, RMU-6M



m^*	$m_1^+ \longrightarrow$	m_2^+	Δm
117.6	169	141	28
78.1	128	100	28
50.7	111	75	36
42.3	100	65	35

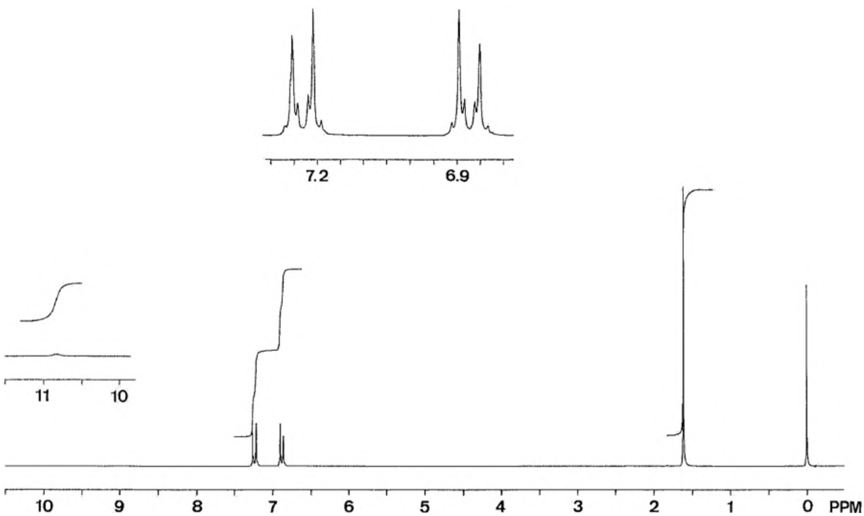
IR

Perkin-Elmer 283, aufgenommen in $CHCl_3$



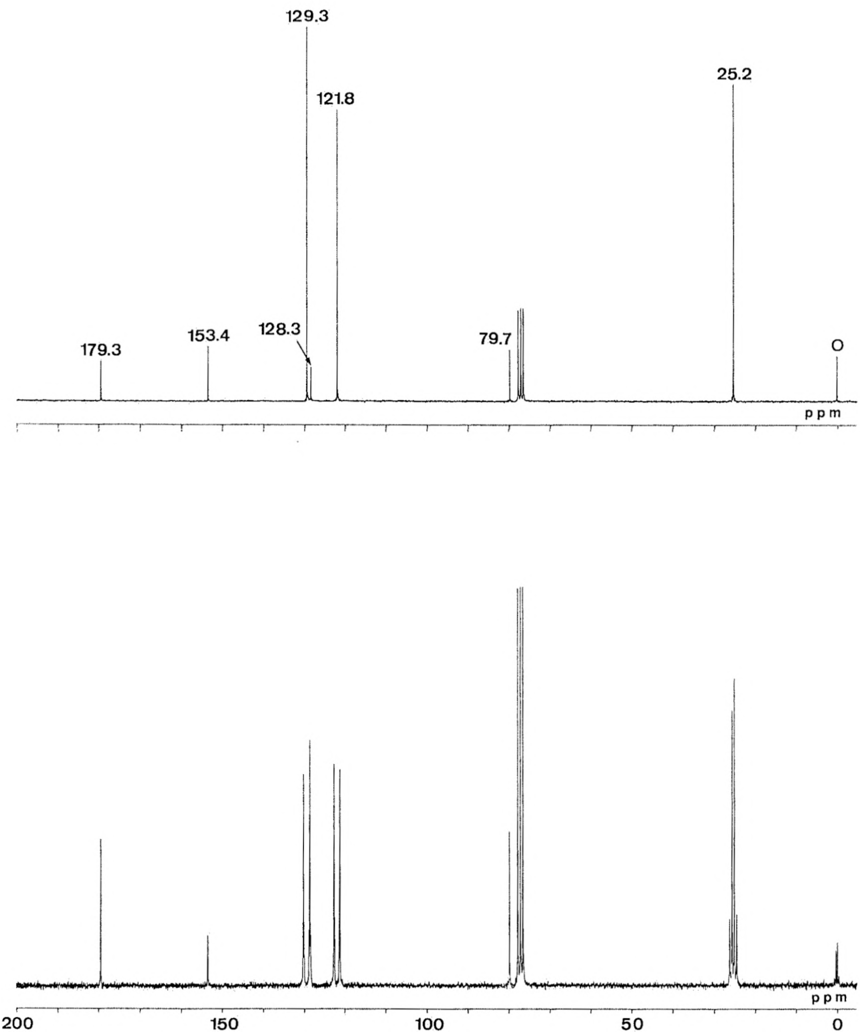
[1]H-NMR

Bruker Spectrospin WP-200 SY (200 MHz), aufgenommen in $CDCl_3$



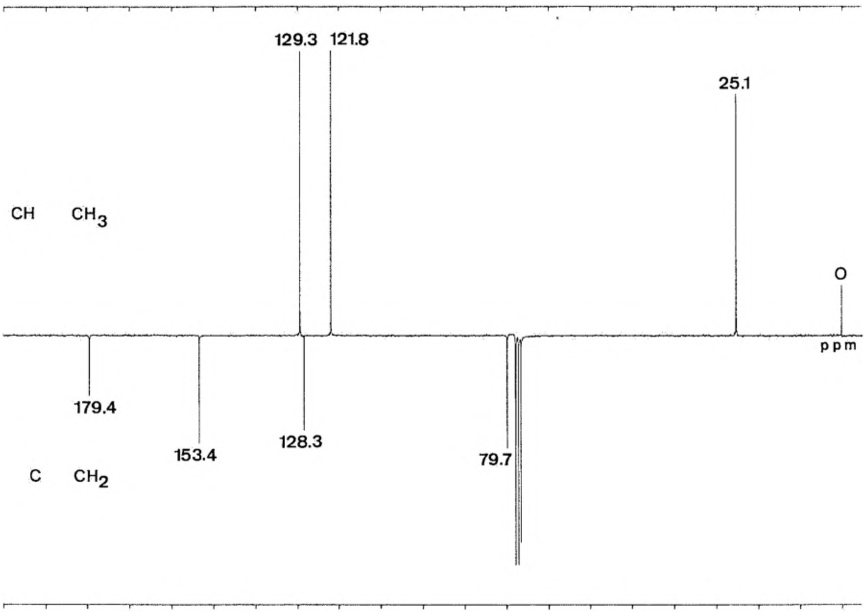
^{13}C-NMR

Bruker Spectrospin WP-200 SY (50 MHz), aufgenommen in $CDCl_3$
oben: breitband-entkoppelt
unten: off-resonance entkoppelt



^{13}C-NMR, SEFT

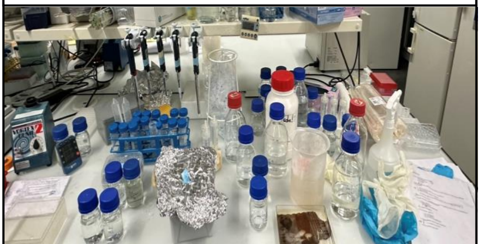
Bruker Spectrospin WP-200 SY (50 MHz), aufgenommen in $CDCl_3$



Modern Murder Mistery

Lisa Likhacheva

Schon seit mehreren Wochen findet Prof. Alessandra Amalfi ihre am Abend völlig aufgeräumte Bench immer wieder in diesem desolaten Zustand, wenn sie am Morgen wieder ins Labor kommt. Die Türen sind zugesperrt, jeder PhD-Student und PostDoc im Labor wurde gebrieft und passt auf. Aber jeder Mensch und jede Massnahme bleibt gegen die Entstehung von diesem Chaos machtlos.



Nur eine Lösung bleibt. Die zwei besten Privatdetektive, besonders bekannt für ihre Kompetenzen in Sachen (Super)natural Science werden engagiert.

Prof. Amalfi erklärt Herrn PDD (Privatdozent und –detektiv) La Plaza und Herrn PD Dr. Massvell die Essenz der sich ständig verschärfenden kritischen Lage.

Die renommierten Spezialisten sind zuerst auch überfordert. Freuen sich auch mässig auf eine Kollaboration. Der erste Vorschlag wird aber ausgearbeitet und implementiert: 24/7 Videoüberwachung!

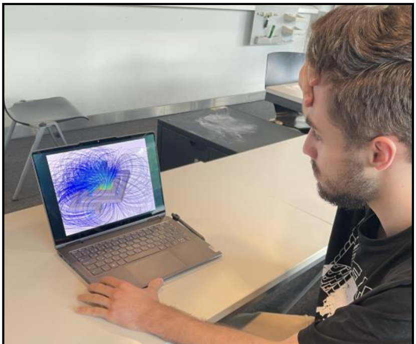
Konzentriertes Beobachten und eine rigorose Datenanalyse folgen. Auf den Aufnahmen ist genau ein Tatverdächtigen zu identifizieren: Bettina Bombacher, eine neue PhD-Studentin in der Amalfi Group.

Sie arbeitet bekanntlich gerne bis sehr spät am Abend. Befragt an ihrem Lieblingsort, der Zellkultur, findet Bettina den Vorwurf zuerst äusserst lächerlich.

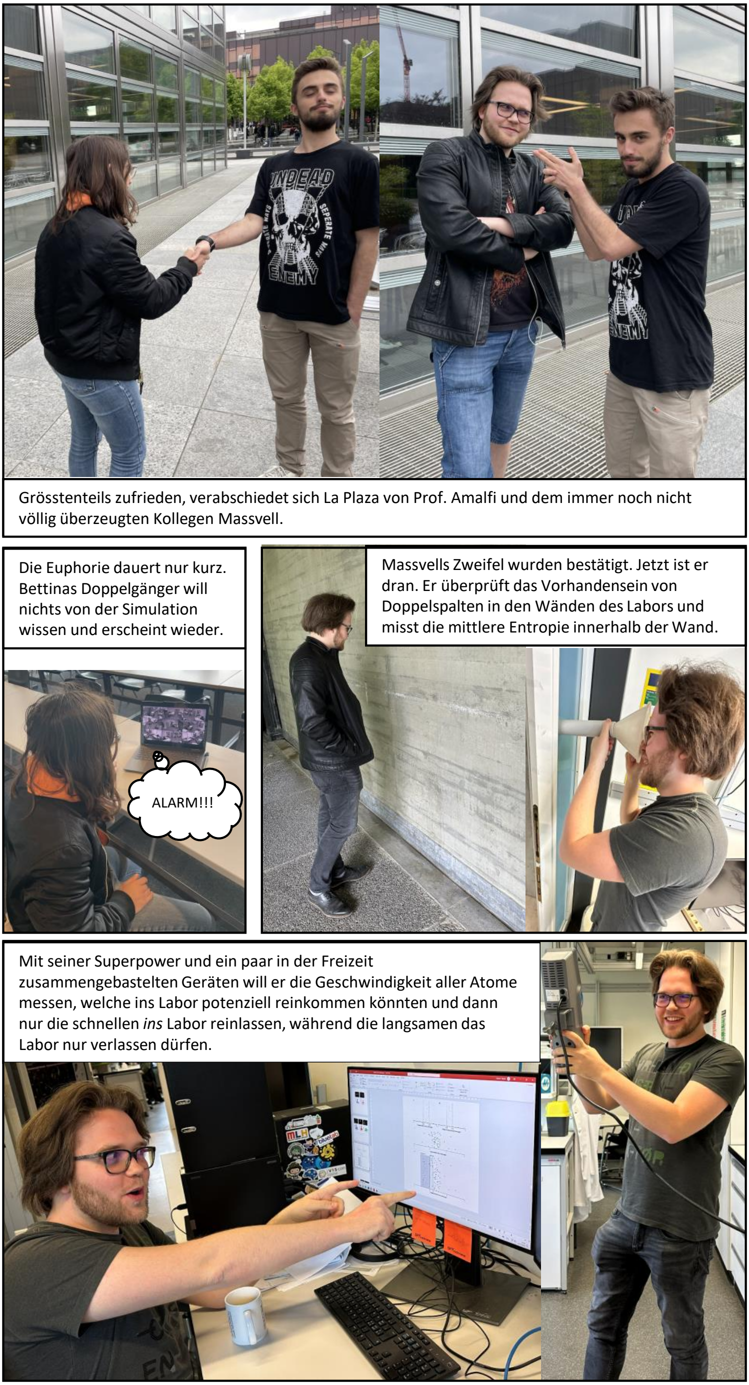
Die von La Plaza und Massvell gesammelten fotografischen Beweise sind aber äusserst schwierig zu ignorieren. Bettina hat aber keine Erinnerung an den rücksichtlos mantellosen Zellkultur-Betrieb nach Mitternacht.

Freja Frödd, eine Therapeutin und Analytikerin des Paranormalen in der Wissenschaft, führt ein Interview mit Bettina durch. Für sie ist die Diagnose sofort klar:

Bettina soll Social Distancing nach den COVID-19-Richtlinien respektieren. Der Doppelgänger soll von Massvell und La Plaza für eine neutralisierende Negotiation mit Dr. Frödd erwischt werden.



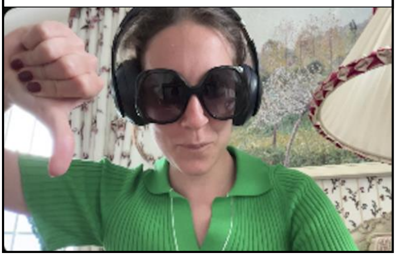
La Plaza fängt sofort an. Dank seiner Superpower, kennt er die Positionen und Impulse aller Atome im Universum. Er baut eine Simulation, um herauszufinden, wo und wann der böse Doppelgänger wieder zu erwarten ist.


Grösstenteils zufrieden, verabschiedet sich La Plaza von Prof. Amalfi und dem immer noch nicht völlig überzeugten Kollegen Massvell.
Die Euphorie dauert nur kurz. Bettinas Doppelgänger will nichts von der Simulation wissen und erscheint wieder.
ALARM!!!
Massvells Zweifel wurden bestätigt. Jetzt ist er dran. Er überprüft das Vorhandensein von Doppelspalten in den Wänden des Labors und misst die mittlere Entropie innerhalb der Wand.
Mit seiner Superpower und ein paar in der Freizeit zusammengebastelten Geräten will er die Geschwindigkeit aller Atome messen, welche ins Labor potenziell reinkommen könnten und dann nur die schnellen *ins* Labor reinlassen, während die langsamen das Labor nur verlassen dürfen.

Der Plan ist erfolgreich. Das bestätigen die Temperaturänderungen. Massvell ist schon am dritten Entwurf von seiner Nobelpreisrede.

Aber was reicht, um den 2. Hauptsatz der Thermodynamik zu zerstören, ist bei weitem nicht genug gegen die böse Bettina. Sie schafft es, trotz Massvells Gerät, ins Labor einzudringen. Diesmal fragt sie aber selber nach einem klärenden Gespräch, welches Dr. Frödd sofort organisiert.

Die böse Bettina sei der Schrödinger-Doppelgänger-Typ. Sie existiert manchmal, manchmal nicht und dann wieder. Sie wolle nur ein bisschen Spass haben und hat sehr expressive Meinungen zur Chemie-Basisprüfung und zur Länge der ETH-Sommerferien.



Dr. Frödd versteht sehr schnell, wo Massvells und La Plazas Ansätze gescheitert sind. Statt Thermodynamik und Statistik benötigt ein böser Doppelgänger manchmal nur ein bisschen Validation.

Nach einem langen und philosophischen Gespräch mit Dr. Frödd, ist die böse Bettina nicht mehr zu sehen. Das Labor bleit in Ruhe. Massvell bekommt eine Professur am IMPS. La Plaza erweitert seine Detektiv-Agentur und verlangt ab jetzt 500 Fr. pro Stunde. Bettina Bombach forscht weiter in der Amalfi Group. Dr. Frödd veröffentlicht ein sensationelles Buch über ihre Erfahrung. Es gibt ab diesem Jahr auch einen nach Dr. Frödd benannten Psychologie-Nobelpreis.

Prof. Alessandra Amalfi	Nonô Saramago
Herr PDD La Plaza	David Muñoz de la Espada
Herr PD Dr. Massvell	Simon Hauser
Bettina Bombacher und **Böse Bettina**	Lisa Likhacheva
Dr. Freja Frödd	Sevim Kahya

Return by Death

“Eine Möglichkeit der Schicksalsveränderung in Anime, Manga und Light Novel”

Simon Hauser Was wäre, wenn du die Kraft hättest, in die Vergangenheit zu reisen und das **Schicksal** von dir und der ganzen Menschheit zu verändern? Mit dieser Frage beschäftigen sich Wissenschaft, Philosophie und Popkultur schon sehr lange. Von “Star Trek” über “Zurück in die Zukunft” bis zu “Edge of Tomorrow” und “Und täglich grüsst das Murmeltier” existieren viele Beispiele, die Zeitreisen und Schicksal thematisieren. Bei “Star Trek” und “Zurück in die Zukunft” existiert die Technologie zur Zeitreise als Mittel, die gegenwärtige Existenz als eigene Instanz in die Vergangenheit zu schicken und dann **aktiv mit den vergangenen Ereignissen zu spielen**. Auf der anderen Seite sind bei “Edge of Tomorrow” und “Und täglich grüsst das Murmeltier” strengere Regeln vorhanden. Die Figuren reisen in regelmässigen Abständen zurück in die Zeit, wobei sich **die ganze Welt zurücksetzt**, während sich die Hauptcharaktere jeweils an alle alternativen Zukunftsszenarien erinnern können. Eine Geschichte, die genau diese Mechanik zur Spitze treibt, ist “Re:Zero Starting Life in another World”. Es ist ursprünglich eine Web Novel, ist dann als Light Novel lizenziert worden und hat neben einer Manga-Adaptation auch eine sehr erfolgreiche Adaptation als Anime erhalten. Nachdem ich per Zufall den Anime gefunden hatte und nach der ersten Staffel mehr wissen wollte, begann ich **in das Re:Zero Rabbithole hineinzufallen**.[1] Da diese Geschichte stark mit Schicksal in Verbindung steht, werde ich nun einige Aspekte vorstellen und erklären, wieso ich sie interessant finde.

Figure 8.1: Cover der Anime-Adaptation.

[1] Neben schon über 30 Bänden der Hauptreihe existieren noch eine Nebenreihe namens Re:Zero EX mit Nebencharakter-Backstories, mehrere Sammlungen von Kurzgeschichten, die zwischen den Hauptarcs spielen, Hauptcharakter Backstories, die nur als Limited Editions existieren und Sammlungen von Kürzestgeschichten, die den Illustration Books beiliegen. Ihr seht also, dass man viel Zeit verbringen kann.

Es geht um einen siebzehnjährigen Jungen namens Subaru Natsuki, der nicht zur Schule geht und die Manifestierung eines Losers auf der ganzen Bandbreite ist. Eines Tages, nachdem er aus einem Convenience Store hinausgeht, wird er in eine andere Welt[2] in die Hauptstadt eines Königreichs transportiert. Nun in der neuen Welt angekommen, fängt Subaru an sich umzusehen und merkt sehr schnell, dass alles komplett anders ist als in unserer Welt: Es gibt Magie, die Gesellschaft hat eine eher mittelalterliche Klassenstruktur, es existieren Fantasiegeschöpfe aller Art, wie Landdrachen, Halbmenschen und dämonische Kreaturen. Deshalb ist der liebe Subaru ziemlich aufgeschmissen und rennt von einer **katastrophal peinlichen Situation** in die nächste. Diese Vorfälle sind oft nicht nur peinlich, sondern auch noch sehr gefährlich, was unseren Protagonisten mehr als einmal in Lebensgefahr bringt. Deshalb ist es auch kein grosses Wunder, dass Subaru ziemlich schnell an sein Lebensende gerät. Auf der Spur eines Mysteriums gerät er in einen Hinterhalt und wird von einer Auftragsmörderin gnadenlos aufgeschlitzt. Für alle Beteiligten ist er nichts mehr als ein unwichtiger Nebencharakter, der komische Kleider trägt. Als nächstes Ereignis – ihr ahnt es wahrscheinlich schon – bekommt Subaru mitten in der Stadt sein Bewusstsein wieder und **kann sich an alle Events bis zu seiner Ermordung erinnern**. Super verwirrt und traumatisiert versucht er, das Erlebte irgendwie einzuordnen und der Sache auf den Grund zu gehen. Das fällt ihm aber ziemlich schwer, da er allerhand kognitiver Challenges bis zu diesem Zeitpunkt schon für eine Ewigkeit ignoriert hat. Deshalb lernt er nur ganz langsam, seine Erinnerungen an vorherige Versuche intelligent anzuwenden, um sein vermeintlich vorprogrammiertes Schicksal zu sterben, zum Besseren lenken zu können. Nach der ersten Hürde erwarten Subaru zahlreiche weitere Herausforderungen, die er zusammen mit seiner Fähigkeit und seinen neu dazu gewonnenen Freunden zu meistern versucht.

Figure 8.2: Subaru Natsuki in seinem Trademark-Outfit.

[2] Ein klassisches Setting, das in der Manga- und Anime-Welt als Isekai-Genre bezeichnet wird.

Subarus Fähigkeit in die Vergangenheit **an einen bestimmten Checkpoint zurückzureisen** hat den Namen “Return by Death”. Der Name beschreibt gleichzeitig die einzige Bedingung, die erfüllt werden muss, um die Fähigkeit zu aktivieren: Subaru muss sterben, um in die Vergangenheit zu reisen. Er behält aber seine Erinnerungen an alles, was bis zum Todeszeitpunkt passiert ist. Der Haken? Subaru erinnert sich an alles inklusive an die eventuellen **psychischen und physischen Qualen**, die der Prozess des Sterbens so mit sich trägt.[3] Diese beiden Aspekte sind meiner Meinung nach die perfekte Mischung für eine interessante Reinkarnations-Persönlichkeitsverbesserungs-Story. Die Möglichkeit, dass der Charakter jederzeit sterben könnte, beseitigt das Problem der Plot Armor. In einer klassischen Erzählung werden Hauptfiguren praktisch nie mit dem Schicksal zu sterben konfrontiert, wobei man in Nahtodsituationen dann nie wirklich 100 % sich darum sorgt, dass sie jetzt sterben könnten. Man sagt sich ständig Sachen, wie: “Ah, das Buch geht ja um die Person; die stirbt eh nicht.” Nicht aber mit “Return by Death”, wo man in jeder Nahtodsituation, aber auch nur in einer ganz normalen Alltagssituation sich **nie ganz sicher sein kann**, ob jetzt der Protagonist wirklich überleben wird. Zusätzlich ergibt sich aus den traumatischen Erinnerungen an die vorangegangenen Tode eine grosse Motivation für den Hauptcharakter **NICHT** zu sterben. Dadurch wiederum entsteht für den Protagonisten nach und nach eine stärker werdende **intrinsische Motivation seine negativen Charakterzüge zu verbessern** und jeden Versuch, eine Zeitschleife zu überwinden, so effizient wie möglich auszunutzen, ohne nur blöd herumzualbern.

Der Einstieg in diese riesige Geschichte ist ziemlich einfach. Man fängt einfach bei Band 1 an zu lesen und ist danach in einem nicht mehr endenden Strudel von Content gefangen. Wenn euch Fantasy, psychologische Thriller und Horroraspekte nicht gefallen, gibt es aber noch genug anderen Anime-Content, der mit Schicksal und/oder Reinkarnations-Schicksalsverbesserung zu tun hat. Zum einen will ich die **Fate-Series** erwähnen, die ein riesiger Content-Berg für sich alleine ist. Eigentlich wollte ich diesen Artikel dieser Reihe widmen, habe aber während meiner Recherchen bemerkt, dass mein Wissen und mein Interesse für die ganze Serie zu klein sind, dass sich ein interessanter Artikel daraus ergeben hätte. Es existiert aber ein lustiges Youtube-Video von Gigguk, das versucht,

[3] Und das Schlimmste ist, dass er niemandem davon erzählen kann, ohne dass er währenddessen mit weiteren unbeschreiblichen Qualen bestraft wird.

[4] https://www.youtube.com/watch?v=UzNSWmokCdU

den ganzen Wirrwarr zu erklären.[4] Für Leute, die mehr am ganzen Reinkarnationsthema interessiert sind gibt es zum Beispiel noch **Re:Creators, Re:Life, Re:Main und Re-Kan**, mit interessanten Aspekten des Storytellings.

The Most Powerful Chemists in the World

When Chemists Meet the World

Leif Sieben Chemistry is about the mastery of matter by man, but a surprising number of chemists went on to become leaders outside of the lab, too. Is chemistry more political than other sciences or is this correlation simply due to the uncommon talent our field attracts?

When you (a chemist yourself) think of the most powerful chemists in the world, you are perhaps envisioning someone like the editor-in-chief of *Angewandte* or *J.A.C.S.*, chemistry's two most prestigious journals. Incidentally both of whom also happened to have been your professors at this institute. Else you might have been thinking of this elusive class of living Nobel laureates in chemistry, who by virtue of their prize command nearly all the awe and attention of our little community. If your own inclinations learn more towards a version of *Realpolitik* or if you happen to (perhaps without your knowledge) adhere to Marxism, you might simply respond that the most powerful chemist you know is your own PI. No one, truly, exercises more direct power over you than your professor.

For the rest of the world which (so I am told) exists beyond the confines of this university, none of these considerations matter much. As much as it might hurt them to admit it – and you are most certainly advised not to tell them so directly – chemistry professors do not tend to be swarmed by adoring groupies except in their own laboratories. While the Nobel Prize is without a doubt the most well-known science award there is, ask any pedestrian on the street to name this year's winners and you will be met with silence, disinterest and the occasional "Albert Einstein". Scientific fame does not travel very far. Something similar could be said for the editors of our selective journals – the majority of people in the world would frankly not know how to even pronounce *Angewandte Chemie* even if forced to – although in their case the decision on which papers to publish can make or break careers in our field (just as in other fields) of science.

Over the past century, however, our own humble discipline has produced a respectable number of world leaders. It stands to speculate that chemistry, in the sense that it can be more applied and hence is more useful for society at large, instils the ideals of social responsibility and political initiative in its students. More likely, this is a bit too grandiose of a self-compliment and most of this correlation is simply due to self-selection. Most politicians have, may even *need to* have, a sense for reality and pragmatism. Such minds will probably be more inclined to a field with good job-prospects and clearly defined applications such as chemistry than theoretical particle physics. This might also explain the even greater abundance of engineers in modern politics.

No such thing can be said of university leadership, by the way. In the history of ETH, three out of five presidents studied physics (in addition to one mechanical engineer and one biologist) and two of eight rectors did as well. No chemists in sight. Surely this cannot have been for a lack of talent? As this column will hopefully prove, chemists' ambitions are simply larger than mere university office. As far as we are concerned, we are happy to leave the mundane tasks of daily administration to our colleagues in the physics department.

Chaim Weizmann

Chaim Weizmann (1874–1952) was born in a village in modern day Belarus. The third of fifteen children of a Jewish timber merchant, Weizmann left for Germany in 1892 to study chemistry first in Darmstadt and later in Berlin. He would complete his studies in Fribourg, earning a doctorate in organic synthesis on the topics of *1. Elektrolytische Reduktion von 1-Nitroanthrachinon. 2. Über die Kondensation von Phenanthrenchinon und 1-Nitroanth mit einigen Phenolen*. He would move to Geneva as *Privatdozent* for biochemistry where he would develop four patents for naphtacenequinone (**1**) derivatives which were useful as dyestuffs. It was the patents that compensated the lack of salary he received from the university. While still in Switzerland, Weizmann attended the Second Zionist Congress in Basel. Switzerland was a centre for the global Zionist movement at the time: the first and 15 of the 22 subsequent Zionist congresses were all held in Switzerland.

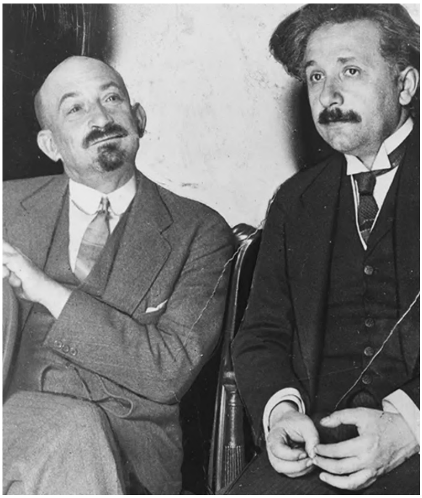
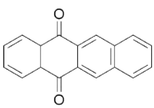


Figure 9.1: Chaim Weizmann (left) and Albert Einstein (right) during their fundraising visit to the Hebrew University of Jerusalem in 1921.

Weizmann then moved to the University of Manchester under William Henry Perkin Jr., the son of the well-known chemist famous for his eponymous OC II reaction and the synthesis of the first synthetic purple, mauveine (**2**). Weizmann taught himself English by reading the Bible and was soon recognised as an outstanding teacher. While in Manchester, Weizmann published 56 papers, exchanged with Ernest Rutherford and Robert Robinson (of the eponymous annulation reaction) but failed to secure tenure.

Weizmann's most famous scientific contribution though was the discovery of *Clostridium acetobutylicum Weizmann*, a bacterium capable of fermenting starch into acetone. In the First World War, acetone became enormously useful as an explosive propellant. In 1916, Weizmann was urged by Winston Churchill – then first lord of the Admiralty – to produce 30 000 tons of acetone. A lack of starch and logistic difficulties meant Weizmann would only end up producing 3852 tons, but the Weizmann process remained relevant beyond the war when its side-product butanol proved useful in drying car lacquers[1].



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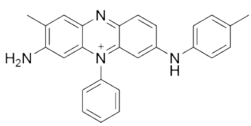

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Perhaps, in a different world, Weizmann would have returned to academia after the war. He was certainly a talented and productive chemist who felt he had to prove that he, as a Jewish alien, could be the equal of any British chemist. Most likely, his name would have gone down in the annals of chemistry, as the majority always does, for a genuine attempt with mostly incremental success. Most chemists today certainly have not heard of Weizmann's other two siblings, Anna and Moshe, who went on to become professional chemists. But just maybe, this world in which a Jew, nowhere in Europe, was ever fully equal to, nor fully safe from, the rest of society, deprived this very society itself of the breakthroughs that could have come had Weizmann stuck to chemistry alone. Alas, this world did call for Weizmann's talents – not as a scientist but as a statesman.

Weizmann had met Arthur Belfour, the Conservative Member of Parliament for Manchester at the time, in 1905. Belfour supported a Jewish state but was in favour of the then common idea of establishing it in Uganda. Belfour would later become Foreign Secretary during the First World War and, following relentless petitioning by Weizmann, led Britain to support the establishment of a Jewish State in Palestine on October 31, 1917, in a public statement known today as the Belfour declaration. A group of Jewish volunteers, known as the Jewish Legion, assisted the British in conquering Palestine from the Ottoman empire.

In 1921, Weizmann and Albert Einstein travelled to the British Mandate in Palestine to open the Hebrew University of Jerusalem. Weizmann would continue his work as a scientist in the years leading up to and during the Second World War. On May 14, 1948, the State of Israel was declared and promptly attacked by its Arab neighbours. A ceasefire in 1949 established Israel, against all odds, as an independent, Jewish state which joined the United Nations that same year. Chaim Weizmann would become Israel's first president. While he would not return to the lab bench during his life, one of Weizmann's most lasting contributions to the state of Israel was the establishment of a world-renowned research institute, nowadays known as the Weizmann Institute of Science.

Margaret Thatcher

Britain's longest serving prime minister from 1979 to 1990 first studied Chemistry at Oxford in 1943. Born to a hard-working and pious man, Margaret Hilda Thatcher, née Roberts (1925–2013) was a gifted if sometimes cocky pupil. After a fellow student of hers had spilled ink on the precious wooden floor of her historic school, she suggested cleaning the stain by pouring HCl on bleaching powder stolen from the school's lab which lead to the immediate and violent release of chlorine gas. It is a hopeful thought that at least some of those fellow students in one's AC 1 Praktikum with a near suicidal neglect of safety may one day reside in the halls of power and thus in a comparatively much safer place than in a chemical laboratory.

Figure 9.2: Margaret Thatcher as a research scientist in a photograph released for her 1951 election campaign in Dartford, England.

Thatcher would go on to specialise in X-ray crystallography under Dorthy Hodgkins working on the structure of the antibiotic gramicidin. Thatcher joined the Conservative party while still at university, but would first go on to work as a research chemist at BX Plastics and Imperial Chemical Industries. Both companies no longer exist. Thatcher was one of very few women in the chemical industry at the time but never wanted the fact that she was the first to distract from the fact that she was also the best at her job. Reportedly, she would later say that she was **prouder to have been the first woman scientist than the first woman as prime minister**.

Thatcher is probably best known for two accomplishments that could not be more different: first, as education secretary, she put a stop to free milk for school children, which many today and at the time deemed austere to an unnecessary degree, and secondly, the **victory in the Falkland wars over Argentina** in 1982. Under her premiership, trade unions waned and many state enterprises were privatised. Her **deregulation of the UK financial markets led to an economic boom** in the 1980s and re-established London as a **global centre of finance**. She did not support joining the EU in office but her hard stand against the Soviet Union and her close co-operation with the United States also helped bring about the **end of the Cold War**. Thatcher's legacy is controversial, when she died in 2013 many lauded her as the greatest prime minister of the post-war era but the news was also met with celebration and public displays of hatred. What is beyond doubt is that Margaret Thatcher was a headstrong and capable politician who **shaped the Britain we know today**.

So was her studying chemistry just fully accidental? For the most part yes. Thatcher would go on to **study law and never return to the laboratory** or show much interest in chemistry throughout her life. While it is true that her first position in power was as education secretary and that she did shape an important law on government **funding for science**, Thatcher's legacy lies elsewhere. Allegedly, she was very fond of the story of how Michael Faraday met the prime minister at the time William Gladstone: "When Gladstone met Michael Faraday, he asked him whether his work on electricity would be of any use. 'Yes, sir', remarked Faraday with prescience. 'One day you will tax it.'"[2]

Angela Merkel (and Joachim Sauer)

Angela Merkel (*1954) studied physics at the Karl Marx University of Leipzig from 1973 to 1978. During her studies, Merkel worked at a local bar as a side job. Although Merkel is mostly regarded as a physicist, she would eventually move into the **field of physical chemistry**. Her Master thesis was on the topic of the *Einfluss der räumlichen Korrelation auf die Reaktionsgeschwindigkeit bei bimolekularen Elementarreaktionen in dichten Medien*.

She would complete her PhD at the Central Institute of Physical Chemistry in East Berlin. Interestingly, she lived in Berlin in a building occupied by squatters with her second husband Joachim Sauer, who would later become a professor of physical chemistry at the Humboldt University in Berlin.

She received a PhD in quantum chemistry in 1986. As part of the dissertation process, Merkel had to attest her knowledge of ML – Marxism-Leninism that is – which unlike her thesis (*magna cum laude*) was only accepted as passing. After her PhD, she would move into the analytical chemistry division under Klaus Ulbricht, who would later also seek political office as mayor of Berlin Köpenick.

It was the fall of the Berlin wall however which "acted as the catalyst for Merkel's political career" as Wikipedia notes without any sense of irony. Merkel had a stellar political career being elected to the Bundestag in the first election of the reunified Germany and immediately being tapped as minister for Women and Youth by Helmuth Kohl. In 2005, Merkel became the first female and first scientist chancellor of Germany.

Very few world leaders can claim to have had much scientific training before their accession to power, Merkel however had veritable success and published at least five papers during her career as a scientist.[3–7] In 1988, she even published a first-author paper in J.A.C.S. on the evaluation of the rate constant for a gas-phase S_N2 reaction. Dr. Angela Merkel's (at least for the time being) official h-index is 3. But spare a thought for Merkel's second husband, Joachim Sauer, who despite being an acclaimed expert on Hartree-Fock methods (and boasting an h-index of 101), will perennially be known as "first gentleman" to the *Bundeskanzlerin*.

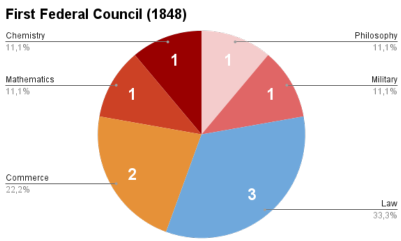
Figure 9.3: Prof. Dr. Joachim Sauer at the G8 summit in Heiligendamm, Mecklenburg-Vorpommern in 2007.

Pope Francis

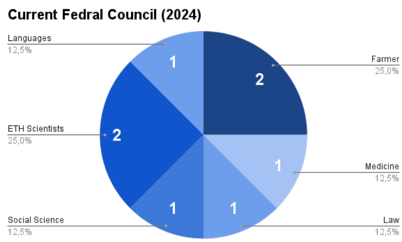
Little is known about the early life of Jorge Mario Bergoglio (1976*), who was elected Supreme Pontiff on March 13, 2013, as Pope Francis. Born in Buenos Aires to Italian immigrants, he was one of five children. The official website of the Vatican however does confirm that before choosing the path of priesthood, Bergoglio completed his training as a chemical technician.[8] About the reasons for this change of field one can only speculate.

Friedrich Frey-Herosé

Our own little confederacy (with generous counting) had two chemists as federal councillors in its 176 years of modern history. Ernest Chuard (1857–1942) was a chemical engineer and later professor at the University of Lausanne, but altogether a relatively unremarkable federal councillor. He was only **elected against his wishes** and went on to lead the department of the interior, gracing himself by overseeing an **expansion of the ETH** during his tenure. At the time, he was the only federal councillor who had not studied law. An entirely uncommon state of affairs given that more than half of all federal councillors in the history of Switzerland were lawyers.



Friedrich Frey-Herosé (1801–1873) studied chemistry at the Collège de France and would take over the chemical plants funded by his father. He is unrelated to the Frey brothers who would start the successful chocolate business, but the Frey corporation would buy up the chemical plants started by Frey-Herosé in 1887 which were used for chocolate production until the 1960s. Frey-Herosé rose to fame during the *Sonderbrundskrieg* of 1847 between the catholic cantons of Schwyz, Lucerne, Uri, Unterwalden, Zug, Freiburg and Wallis on one side and the liberal, urban and protestant cantons on the other side. He was the 6th federal council to ever be elected and hence among the first seven people to lead Switzerland under its newly ratified constitution in 1848. In 1854, he convinced Habsburg Austria to cease its embargo against Ticino, which was considered a sanctuary for Italian revolutionaries. Most importantly however, Frey-Herosé would **open the *Eidgenössische polytechnische Schule* on October 15 ,1855**, as a representative of the government. The actual idea for a polytechnical university, however, was due to the statistician and other original federal councillor Stefano Franscini.



The tenure of Frey-Herosé fell into a period of great intellectual diversity in the federal council in terms of academic background. This came despite the fact that the it was **politically completely homogeneous**: All seven members came from the liberal party. Today, the federal council again draws from a wide range of fields including two councillors (Beat Jans and Albert Rösti) who gained their degrees at this very institution. This is a welcome state of affairs and should lead to an informed and enlightened style of government. Given recent decisions however, on the European satellite programme Copernicus or of course concerning our own university's budget, for example, one wonders **whether they have already forgotten us**?

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Beethoven – Die Schicksalssinfonie

Was macht sie zum Mega-Hit der klassischen Musik?

Fiona Buchholz Viele Popsongs heutzutage werden nur mit drei Akkorden geschrieben. Doch auch die Künstler früherer Zeit wussten mit wenig Noten ein prägnantes Motiv zu komponieren. So auch Beethoven in der berühmten «Schicksalssinfonie» (Sinfonie Nr. 5) in c-Moll. Im Verlaufe der Sinfonie wandelt sich die Musik auf vielen Ebenen um, sodass eine ganze Geschichte – ein Schicksal – erzählt wird.

Vier Töne. Fünf Takte. So unverwechselbar.

Das reicht, um eine der berühmtesten Melodien der Welt zu kreieren. Die Rede ist von Beethovens Sinfonie Nr. 5 in c-Moll. Fast jeder hier in Europa hat zumindest den Anfang dieses Meisterwerks schon einmal gehört. Ob Beethoven damit wirklich «das Schicksal, das an die Pforte pocht» gemeint hat, ist umstritten. Als ich die Sinfonie live aufgeführt hören durfte, hat mich die Wucht dieses Stücks noch einmal mehr getroffen, als beim Hören einer Aufnahme. Doch **die Sinfonie startete gar nicht als Hit**. Als sie am 22. Dezember 1808 in Wien uraufgeführt wurde, rief sie nicht sonderlich viel Begeisterung hervor. Das lag aber vor allem an der kurzen Probenzeit des Orchesters, dem ungeheizten Konzertsaal und der allgemein angespannten Stimmung wegen des Krieges in Frankreich. Erst mit der Zeit, als die Sinfonie in verschiedenen Städten von geübten Orchestern aufgeführt wurde, fand sie **grossen Anklang beim Publikum**.[1]

Auf den ersten Blick besitzt die auch als «Schicksalssinfonie» bezeichnete Sinfonie kaum auffällige Merkmale. Die vier Sätze «Allegro con brio», «Andante con moto», «Allegro» und «Allegro – Presto» sind in der üblichen Reihenfolge schnell, langsam, tänzerisch und schnell. Auch die Besetzung des Orchesters kann man als durchschnittlich beschreiben. Auffällig ist nur die Molltonart. Beethoven schrieb nur **zwei seiner neun** Sinfonien in moll. Mozart sogar nur **zwei von vierzig**.[2]

Aber wie kam die Sinfonie zu ihrem Namen und was kann man aus der Musik herauslesen? Dazu muss man sich die Sätze etwas genauer anhören.

Im ersten Satz, klassisch nach der Sonatenhauptsatzform, folgen auf das bekannte Hauptthema, das etwas ruhigere Seitenthema und die Schlussgruppe. Danach folgt die Durchführung, wo das **Motiv musikalisch verarbeitet** wird und in der Reprise wird es dann abermals **stürmisch mit dem Hauptmotiv**. Der zweite Satz, das Andante, zeigt sich zunächst etwas ruhiger. Doch auch hier ist die Melodie wieder zu erkennen, es gibt aber auch einen Marsch-artigen Teil. Auch im dritten Satz herrscht düstere Stimmung, **die Hörner platzen immer wieder mit dem Hauptmotiv heraus**. In der Wiederholung scheint alles noch gespenstischer, aufgrund der leisen Spielweise, dem Pianissimo. Langsam kommt der Ton C hervor, beginnend in den Pauken, was sich dann letztendlich zur Tonart C-Dur entwickelt. Der dritte Satz geht **nahtlos in den vierten und letzten Satz über, was damals sehr ungewöhnlich war**. Auch hier geht es stürmisch zu und Beethoven übernimmt den ungewöhnlichen Übergang der Sätze noch einmal – ebenfalls höchst ungewöhnlich. Enden tut die Sinfonie in schnellem Tempo, bis die Schlussakkorde erreicht sind.[2]

Dass Beethoven sich beim Komponieren des berühmten Leitmotivs wirklich vorgestellt hat, dass «das Schicksal an die Pforte» pocht, **ist sehr umstritten**. Beethovens damaliger Sekretär Anton Schindler mag es wohl so von Beethoven erfahren haben, doch viele seiner Aussagen sind in der Forschung umstritten. Selbst wenn es um das Schicksal ging, dann vermutlich **das der Französischen Revolution**, welches Beethoven immer wieder beschäftigt hat. Darauf deuten auch einige Stellen in den Noten der Sinfonie hin, die **Revolutionsmusiken ähneln**. Ausserdem verweisen die Anfangstonart c-Moll und die Schlusstonart C-Dur auf den Gedanken aus dem lateinischen «per aspera ad astra», zu deutsch «durch die Nacht zum Licht», da moll-Tonarten eher **düster und traurig** klingen, während Dur-Tonarten **hell und fröhlich** sind.[2]

Abbildung 10.1: Ludwig van Beethoven.[3]

Auch wenn Beethoven die Sinfonie nicht über sein eigenes Schicksal geschrieben hat, hätte es definitiv ein dramatisches Werk verdient. Es ist nicht viel über Beethovens Leben dokumentiert, beispielsweise ist sein Geburtsdatum nicht überliefert. Nur das Taufdatum, der 17. Dezember 1770, ist bekannt. Beethoven wuchs in Bonn in einer Musikerfamilie auf. Gefördert wurde er vor allem von seinem Vater Johann, dessen Alkohlkonsum ihm die Karriere erschwerte. **Ein Musikstück über Beethovens Leben stelle ich mir am Anfang leise vor**. Zwischen vielen Harmonien in moll würden sich verspielte Elemente der Kindheit mischen. Schnell würde das Stück **musikalisch anspruchsvoll werden**, denn Beethoven lernte früh Klavier, Orgel und Violine,

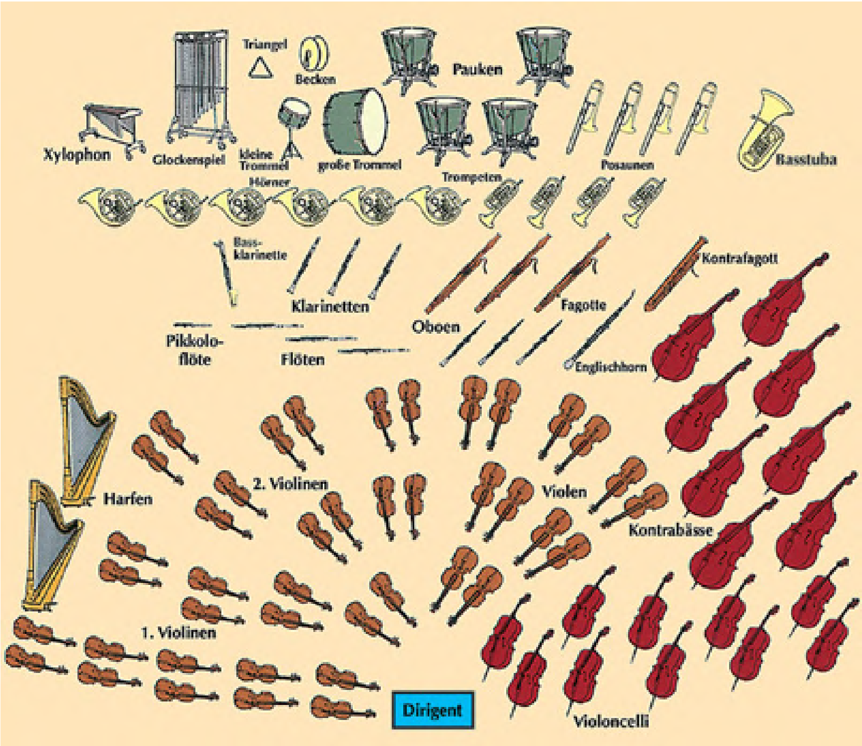

Abbildung 10.2: Besetzung eines Sinfonieorchesters.[4] In Beethovens Sinfonie Nr. 5 sind einige Instrumente wie Harfe, Tuba, Bassklarinette und Englischhorn sowie viele Schlaginstrumente nicht vertreten. Auch ist das Orchester insgesamt eher klein.[2]

gab öffentliche Konzerte und reiste mit 16 für das Studium nach Wien. Nach dem Tod seiner Mutter musste Beethoven die Reise allerdings beenden und kehrte zurück nach Bonn, kümmerte sich um den alkoholkranken Vater sowie seine jüngeren Brüder und studierte ab 1789 an der Bonner Universität. 1792 zog er dann wieder nach Wien und stieg durch seine Musik gesellschaftlich auf. Das Musikstück über sein Leben würde freier werden, durch verschiedene Tonarten modulieren, **den stetigen Rhythmus aber nicht verlieren**. Mal würden die Töne hochgehen, dann wären wieder die tiefen Streicher im Vordergrund, denn Beethovens Stücke waren **nicht immer sofortiger**

Erfolg. Manche, wie seine Oper «Fidelio», fanden erst einige Jahre nach der Uraufführung Anklang. Mit der Zeit würde das Musikstück **dunkler und harmonisch verzerrter** werden, denn Beethovens Schicksal nahm die schlimmste Bahn, die es für einen Musiker wohl gibt. Bereits mit 27 Jahren wurde er **schwerhörig** und mit 48 war er **taub**. Das hielt ihn aber nicht davon ab, weiter zu komponieren, darunter auch sein wohl bekanntestes Werk, die Sinfonie Nr. 9, die er allenfalls **nur in seinen Gedanken hören konnte**. Das würde in dem Stück über sein Leben mit einer anschwellenden Melodie und grossen Paukenschlägen gefeiert werden, bevor die **pompösen Schlusstakte** sein Ende in Szene setzen würden. Beethoven starb am 26. März 1827 mit 56 Jahren an Leberzirrhose. Zu seinem Begräbnis in Wien sollen wohl rund 20 000 Menschen gekommen sein. Das Musikstück würde dem Stil der Romantik entsprechen, die Beethoven durch seine Musik mitgeprägt hat. **Sein Stil war stets zeitlos und dramatisch** und er feilte viel an seinen Stücken, verbesserte sie immer wieder im Nachhinein.[3]

Dass Beethoven einen ausgezeichneten Sinn für zeitlose Musik hatte, ist kaum zu bestreiten, schliesslich werden seine Werke auch heute noch aufgeführt und begeistern zahlreiche Menschen auf der ganzen Welt. Die Sinfonie **lässt viel Raum für Interpretationen und vielleicht auch Gedanken an das eigene Schicksal**. Für mich persönlich ist es auch ein gutes Stück, um Frustration abzulassen, wenn ein Tag besonders schlecht gelaufen ist. Mit donnernden Tönen spielen mir die Streicher und Bläser die Wut aus der Seele, sodass mit den Schlussakkorden in C-Dur **die Frust in meinem Inneren durch das Licht erhellt wird**. «Per aspera ad astra».

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Could Bees Be Scientists?

An Essay on Biosemiotics

David Muñoz de la Espada Defining and measuring intelligence is an extremely fuzzy enterprise. We tend to overestimate ourselves and underestimate other species. Although most of us deny it, subconsciously, we are all somewhat anthropocentric. The focus on putting the human at the centre of the universe has led to some hindrance for science (e.g. Galileo Galilei and Charles Darwin). In this article, I attempt to show why putting ourselves in other animals' shoes is necessary for understanding intelligence.

> "You can't explain music meaningfully to a man who has never heard any."
>
> *John M. Pierce*[1]

Introduction

Could bees be scientists? This question popped into my head as I was thinking about what it means to be human and whether that's really a special attribute. If bees could be scientist – I mean in the abstract sense (i.e. ignoring some practical details), that could say a lot about our place in the universe. To be more precise, what I am asking myself is whether there is any possibility, however improbable, that a beaver or a dolphin or a bee could carry out equivalent cognitive processes – adjusting to scale, environment and physiology (e.g. opposable thumbs) – that involve doing science. We are looking for possibility, not probability – it is important to distinguish these two concepts.

I argue that Thomas Kuhn's notion of paradigm shifts[1] explains why we cannot prove that our brains are superior based on what we can do but if anything based on their potential (which is much harder to accurately estimate) since only a handful of key discoveries and inventions (e.g. fire, housing, algebra, ...) are everything that separate us from our simian cousins[2].

In other words, knowledge and intelligence are dynamic and cannot be constrained to a single point in time. Otherwise, we would have to declare that with regard to political thinking, bee brains were superior to ours until the Greeks founded the first democratic state, given that they had already evolved a robust democratic system for making decisions[3,4]. We would also have to state that baby brains are in most ways inferior (ignoring small physiological changes) to adult brains, as they can't carry out the majority of adult tasks. This does not make much sense, given that their po-

[1] Thomas Kuhn's theory suggests that science evolves similarly to punctuated equilibrium. A new paradigm can only arise once there is enough evidence against the prevailing paradigm – leading to choppy progress.

tential is much greater than that of adults and that we all belong to the same species.[2]

Information theory

To start to answer the title's question, a digression to information theory is needed. Information theory was first properly established by Claude Shannon in 1948 and has truly revolutionised telecommunications. Suppose we have a random ergodic variable $X \in \{0, 1\}$, such that $P(0) + P(1) = 1$, where the probabilities themselves can take any specific values. We simulate a random sequence (e.g. 0100010010111011010010101001...). Depending on the initial system probabilities, we might be able to find a much more efficient way of encoding the sequence (compression). For this we need to define the Shannon entropy and how it applies to $P(0)$ & $P(1)$.

How efficient the compression[3] is depends on the Shannon entropy of the stochastic process, which depends on the system probabilities according to the following definition:

Definition 11.1. (Shannon entropy) $H_s(X) = -\sum_i p_i \log_2(p_i)$

This concept is very closely related to the definition of entropy that is taught in thermodynamics (Boltzmann entropy) and is a function of the number of different possible arrangements ($S(\Omega) = k \log \Omega$). The logarithm refers to the amount of bits needed to encode the system (in the case of a base-2 system, but the constant k makes them all technically equivalent). So if entropy is said to be a function of disorder and the disorder in the universe always rises, then information is being inserted into the universe, making a compressed description longer. The above formula for entropy applies only when all the states are equally probable. If they are not, then an appropriate generalisation is the Gibbs entropy, which is the same formula as the Shannon entropy but with an extra parameter (a constant).[4]

2 As a sidenote, I find it worth mentioning that the system by which bees vote is pretty similar to how cellular automata (CA) try to solve the majority problem. The majority problem tries to simulate democratic voting on a lattice of zeroes and ones using only local rules. It has been proven that there are no CA that can successfully solve this problem on all possible lattice configurations[5]. One of the main additions in the bee democratic system is the presence of $n + 1$ classes when discussing n options: options are $1 : n$ and *undecided*. The process by which bees make a decision is probabilistically irreversible (they tend towards not remaining undecided). This last sentence, though relatively obvious, is important for programming a CA that models their behaviour.

3 We will see shortly that the more context that is shared, the more efficient the compression.

4 I will not be proving why it is an appropriate generalisation, as it is not relevant to the main argument. However, you may find an excellent and simple explanation in Shannon and Weaver's text *The Mathematical Theory of Communication*.

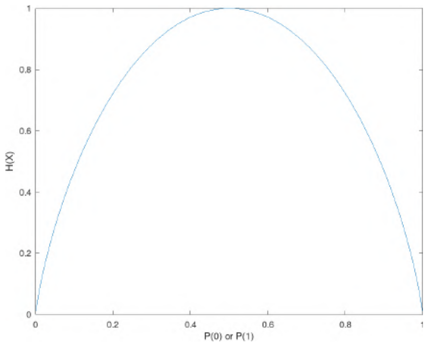

Figure 11.1: Binary Shannon Entropy Plot.

For the binary example, the formula reduces to $-(\log_2(P(0)) + \log_2(P(1)))$, which produces the following symmetric graph, where the entropy is maximised at the centre, where both probabilities are equal, given that your expectations of the results do not in any way help you compress the sequence. You can picture this as the number of probable configurations (your "surprise") is maximised when $P(0) = P(1) = 0.5$. While it is impossible to losslessly compress a two-state system even when $P(0) \neq 0.5$, the longer the message, the better any optimal compression algorithm works (it approaches the Shannon entropy at the limit) by arranging the data into blocks (e.g. $0/1 \rightarrow 00/01/10/11\ldots$)[5].

So why mention all of this? This article supports the theory that intelligence depends on an individual species' context. The context flowchart below (Figure 11.3) shows how questions are generated and when answers are found, they expand the overall context. The more context two people share, the easier it is for them to communicate (i.e. the lower their joint entropy or the lower the "surprise"). Cryptography tries to achieve the opposite. The higher the entropy, the more "surprise" and the less that is known about the message. The one-time pad encryption mechanism, for example, can achieve perfect encryption if all n states (e.g. all 26 letters) are independent and equally probable ($1/n$). A letter from the encryption key (C) is added to its corresponding letter in the message (M), giving us the encrypted message (E). In this scenario, without the key communication would be impossible. In this regard, the key would be the context and the more of it that is shared between the two parties the more they understand each other.

Communication and language

This article also sustains that context $\approx$ language (here language takes a very broad meaning, as you can imagine). When communicating one's findings, spoken or written language is used, which should be able to accommodate all of the knowledge. This is frequently aided by the use of images.

When discovering/inventing a new phenomenon, it is often the case that new

5 An example is Huffman coding.

M	R	E	N	D	E	Z	V	O	U	S	A	L	E	X	A	N	D	E	R	P	L	A	T	Z
C	X	F	G	Q	D	Z	M	D	G	J	Y	U	F	K	D	F	B	N	C	E	R	U	P	I
E	P	K	U	U	I	Z	I	S	B	C	Z	G	K	I	E	T	F	S	U	U	D	V	J	I

Figure 11.2: One-time pad example.

words are invented or "built" (e.g. table + tennis = table tennis). One then associates this with a mental image of the sport. However, in order to understand the concept of table tennis, one must first know what tables and preferably also tennis are. This is well described by Piaget's and Papert's constructionism[6]. One could argue that some foreign language could accept "table tennis" as a loanword for the sport without most people understanding its etymology, but it would make no difference as the rules would still have to be learnt. This includes the fact that the sport is played on a table with a net.

Acquiring knowledge

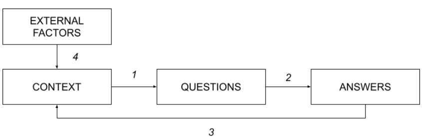

Figure 11.3: Context flowchart.

Our context (i.e. language) is updated (3) when we find answers (2) to the questions (1) that have been generated by the context. This leads to a structure that builds upon itself. In addition to his, one must also take into account external factors (4), such as a teacher who guides their students towards the right questions and subsequently the correct answers.

This theory relates naturally to Kuhn's notion of paradigm shifts mentioned at the beginning. When a subgraph of one's knowledge is deemed invalid by contradictory information, one seeks to replace the gap left by adopting a new theory that is still coherent with the rest of the graph.

If a person understands a bee's context (i.e. how they communicate with each other), it might become possible to give them information that could build on top of what they already know. For example, they might already be able to add/subtract in terms of flowers they like or dislike (even if only approximately)[6]. Farmers could then try

6 Their theory states that one learns by building on top of what one already knows. They also state that one cannot learn apparently arbitrary rules and conventions without understanding why and how they apply (learning by proof).

to use them to gauge the fertility of their fields.

Conclusion

In the end, getting us to understand each other mostly boils down to semantics and some sympathy. Just because we can't communicate with each other directly, doesn't mean that they are not capable of extremely advanced mental processes, which are just interpreting the world in their own particular and useful-for-them way. At some point, they might be more serendipitous than us and make an incredible discovery from which we could all profit (e.g. pollinating a new flower which turns out to produce a superfood for us). Most importantly, try to keep an open mind and learn as much as you can from nature – she's been here longer than any single one of us.

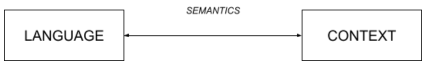

Figure 11.4: Semantics relation.

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Who Said It? Vol. II

Sevim Kahya Nachfolgend sind einige Aussagen aus früheren Exsis herausgepickt worden. Du hast vier Multiple-Choice-Optionen, aus denen selbstverständlich nur eine korrekt ist.[1] Die anderen drei, obwohl falsch, verweisen tatsächlich auf Autoren und Artikel aus früheren Ausgaben in den entsprechenden Exsis. Falls dich eines der Themen interessiert, kannst du sie auf der VCS-Website bei «Exsikkator» nachlesen! Viel Spass :)

1. «Es ist eben sehr wahrscheinlich, dass unwahrscheinliche Sachen geschehen.»
   (a) Léona Dörries über Serendipity im *Strategie*-Exsi
   (b) Mathias Wittwer über die Chaostheorie im *Chaos*-Exsi
   (c) Carole Walther in einer Buchkritik zum «Sea of Tranquility» im *Zyklus*-Exsi
   (d) Prof. Dr. Exsikkator im *Zeit*-Exsi

2. «Es ist ein grosser Aufwand für alle beteiligten Leute, aber das Resultat ist trotzdem nicht gut.»
   (a) Lisa Likhacheva bei der GV-Reportage im *Strategie*-Exsi
   (b) Daniel Schiller über Basisprüfung-Statistiken im *Zyklus*-Exsi
   (c) Dr. Erich Meister in einem Interview im *Toleranz*-Exsi
   (d) Daniel Spathelf über die Zeit des Krieges im *Trend*-Exsi

3. «Die riesigen Probleme, die wir heutzutage haben, lassen sich ja auch nicht im Alleingang lösen.»
   (a) Timo Stühlinger über eine ETH für Alle im *Liebe*-Exsi
   (b) Nonô Saramago über egoistischen Altruismus im *Strategie*-Exsi
   (c) Aurora Leuenberger über «Muse» im *Musik*-Exsi
   (d) Joel Fischer über Zeitmessung mit *E. coli* im *Zeit*-Exsi

4. «Chemie gilt als eines der schwierigsten Fächer zu lernen.»
   (a) Charlotte Müller über Alkohol in 21 Dimensionen im *Raum*-Exsi
   (b) Prof. Togni in einem Interview im *Zyklus*-Exsi
   (c) Anna Heck über die Zukunft der ETH im *Strategie*-Exsi
   (d) Stefan Schären über die Übersicht des Unsichtbaren im *Glasnost*-Exsi

[1] Die Lösungen findest du auf Seite 63.

5. «Klingt doch ziemlich beeindruckend, findet ihr nicht auch?»
   (a) Alexander Schoch über Jazz im *Zeit*-Exsi
   (b) Lisa Likhacheva über berühmte Chemiker und Musiker im *Musik*-Exsi
   (c) Simon Hauser über grenzenlose Phantasien im *Fantasie*-Exsi
   (d) Janik Schüttler in Präsi labert im *Blau*-Exsi

6. «Solche Projekte sind notwendig, sie führen uns die grosse Diversität und die eigene Normalität vor Augen.»
   (a) Aurora Leuenberger über einen exemplarischen Artikel im *Strategie*-Exsi
   (b) Isabel Nigsch über Möpse im *Mops*-Exsi
   (c) Lukas Heckendorn in einer Filmkritik von «Intolerance» im *Toleranz*-Exsi
   (d) Nonô Saramago über ADHS an der Uni im *Turbulent*-Exsi

Glückskeks-Synthese

Schicksalhafte Zubereitung

Aysan Yilmaz Ich erinnere mich gerne an mein Austauschjahr in Long Island, NY, im Jahre 2019. Da war ich bei der (absolut coolsten) chinesisch-ägyptischen Gastfamilie zu Besuch. Ich kann mich ehrlich gesagt nicht daran erinnern, **jemals etwas anderes getan zu haben ausser zu essen**. Dazu gehörte auch das gelegentliche Essen beim chinesischen Takeout, das natürlich immer mit einem Glückskeks einhergeht. Aber man kann die Kekse mit der folgenden Methode selbst herstellen.

Fun Fact: Vor meinem Aufenthalt in den USA hatte ich noch nie einen Glückskeks gegessen, also habe ich mir den Text meines ersten Glückskeks aufgehoben, der lautete: «Wenn du jemandem ein Versprechen gibst, halte es».[1]

Chemikalien	3 grosse Eiweisse
	Saccharose (75 g, 1 eq., 0.22 mol)
	geschmolzene **Butter** (50 g)
	Vanilleextrakt (1.5 g)
	Mandelextrakt (1.5 g)
	Wasser (45 mL, 11.4 eq., 2.5 mol)
	Mehl (140 g)
Utensilien	Waage
	Rührschüssel (oder Becherglas, Magnetrührer und Rührfisch in Kreuzform)
	Ofen
	Muffinform
	Wasserbad
	Spatel

Durchführung

Allgemeines

Die aufgelisteten Äquivalente der Reaktanden dürfen problemlos verdoppelt werden, wenn man sich gegen Ende des Semesters oder während der Lernphase **nach mehr Glück sehnt**. Du bist Chemieingenieur*in? Dann darfst Du auch einen (Semi-)Batch Reactor verwenden!

[1] *Anmerkung der Redaktion:* Und die Chefredakteurin war sehr froh, dass die Autorin den versprochenen Artikel auch wirklich geschrieben hat ;)

Vorbereitung

Der Ofen wird auf 464 K vorgeheizt und das Blech mit Backpapier ausgelegt. An dieser Stelle ist es wichtig zu erwähnen, dass die Fortunes (die Texte im Keks) bereits fertig sein müssen. Falls Du nicht deine eigene erfinden willst, kannst Du auch die aus der nächsten Exsi-Seite rausschneiden.

Der Teig

Das Eiweiss wird mit dem Zucker in einer Rührschüssel **schaumig geschlagen**. Dazu empfiehlt sich eine Rührschüssel mit einem Mixer, aber auch ein Becherkolben mit einem kreuzförmigen Rührfisch wäre möglich. Die Butter wird über einem warmen Wasserbad geschmolzen und zur Eiweiss-Zucker-Mischung gegeben. Vanilleextrakt, Mandelextrakt und Wasser werden hinzugefügt. Als Letztes wird das Mehl hinzugefügt und so lange gerührt, bis eine **homogene Masse entsteht**.

Die Kekse formen

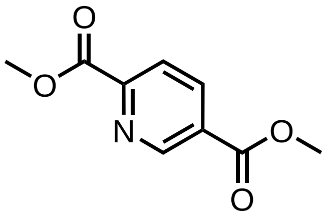
Ein Esslöffel des Teigs wird auf das Backblech gegeben und zu einem **Kreis** mit einem Durchmesser von etwa 7–8 cm ausgestrichen. Die Backzeit beträgt 7–8 min und die Kekse sollten eine **goldbraune Farbe** haben. Es sollten nicht mehr als drei Kekse auf einmal gebacken werden. Die Kekse können nur geformt werden, **solange sie noch warm sind**. Der Keks wird zu einem Halbkreis gefaltet und die Fortune werden hineingetan. Der Halbkreis wird auf den Rand einer Tasse gelegt und die Enden werden nach unten gefaltet, sodass eine **Glückskeksform entsteht**. Damit die Kekse ihre Form behalten, werden sie vorübergehend in einem Muffinblech aufbewahrt.

Your curiosity will lead you to unexpected and exciting places.	Prepare for a period of accelerated growth and learning.
Your keen observations will lead to great insights.	A chain reaction of good luck is coming your way.
You will be as unstoppable as a photon in a vacuum.	Change is inevitable, except for vending machines.
Help! I am being held prisoner in a fortune cookie factory.	This cookie is never gonna give you up, never gonna let you down.
All fortunes are wrong except this one.	You will be hungry again in one hour.
An Eureka moment is in your near future.	You will eat a fortune cookie.
He who laughs at himself never runs out of things to laugh at.	You will live long enough to open many fortune cookies.
The fortune you seek is in another cookie.	Think like a proton: always positive.
You are not illiterate.	Actions speak louder than fortune cookies.
If at first you don't succeed, skydiving is not for you.	You matter. Unless you multiply yourself by c^2, then you energy.
Your future is both bright and dull until observed.	We don't know the future, but here's a cookie.
Your future is as bright as a supernova.	You are the catalyst for your own success.
Entropy always increases, but so does your wisdom.	Your potential energy is waiting to be converted into kinetic greatness.
Success is like a chemical reaction; it requires the right conditions.	You will discover a new element in your personality: resilience.
You will soon find yourself in a state of perfect equilibrium.	Prepare for a wave of good energy to collide with your path.
Your hypothesis about success will soon be proven correct.	A gravitational attraction will bring someone special into your orbit.
Expect to find solutions to problems that seemed unsolvable.	You will soon make a groundbreaking discovery in your own life.
Even the smallest particle can create big ripples in every other quantum field.	A major breakthrough in your work is just around the corner.

Lösungen

Spektrenrätsel *Fluss*-Exsi

Das Molekül im letzten Spektrenrätsel war Dimethylpyridin-2,5-dicarboxylat.



Who Said It

Frage	Antwort
1	(a)
2	(c)
3	(c)
4	(a)
5	(d)
6	(b)

Zoo

Bennet Burmeister

Hoch oben auf dem Baldachin sitzt kreischend schon ein Storch.
Erfragt hat ihn noch niemand hier, doch ist er trotzdem bereits horch.

Tief unten in der Zwillingsbar zischt leise eine Schlang.
Der Lügen wahre Imposanz ist keinesmanns Verlang.

Rechts reckt und streckt die Katz sich nun auf ihrem Weg zum Fad.
Noch weiß keiner ganz genau, welch Wollknäuel sie wohl mag.

Nur eins ist längst für alle klar, da gibt es kein Vorbei,
links wird die alte Katze stehen und oben Storches grüner Hals entzwei.

Halt! Wartet auf die Katz der Mönch mit Futter in der Hand.
Denn ist manchmal allein Position, die all Verdammnis noch abwand.

Drum mag es scheinen. Sein. Gewesen.
Doch ist es nur an uns, daraus die Odyssee zu schreiben.

Horoscope

Discover What the Stars Have In Store for You

♊ Gemini

May 21–June 20

With your dual nature, you're like a particle and a wave at the same time. Embrace your quantum quirkiness and let your curiosity lead the way. Just remember, even Schroedinger's cat eventually makes up its mind. Don't be afraid to collapse the waveform and choose a path.

Virgo ♍

August 23–September 22

Your attention to detail is as precise as a laser beam. But beware of getting lost in the optical illusion of perfection. Sometimes you need to step back and appreciate the big picture. Like a kaleidoscope, life is full of patterns and possibilities waiting to be discovered.

♋ Cancer

June 21–July 22

Your emotions ebb and flow like the tides of the ocean. Just remember, it's okay to ride the waves, but don't get stuck in the undertow of your feelings. Like a crab shedding its shell, it's time to let go of what's holding you back and embrace the unknown. Who knows, maybe you'll discover a whole new world under the next rock.

Libra ♎

September 23–October 22

You're the cosmic diplomat of the zodiac, always striving for balance and fairness. But remember, sometimes the scales need to tip in unexpected directions. Embrace the chaos and find beauty in the asymmetry. Like a chaotic pendulum, life's unpredictability can lead to the most fascinating journeys.

♌ Leo

July 23–August 22

You shine brighter than a supernova in the cosmic sky. But be careful not to burn too hot too fast. Remember, even stars need to conserve their energy. Take some time to recharge your celestial batteries and bask in the glow of your own greatness. After all, Rome wasn't built in a day, and neither was the Milky Way.

Scorpio ♏

October 23–November 21

Your intensity is as strong as the gravitational pull of a black hole. But beware of getting sucked into your own darkness. Remember, even black holes emit radiation. It's time to shine a light on your hidden depths and embrace the brilliance within. Who knows, you might just discover a whole new universe of possibilities.

♐ Sagittarius

November 22–December 21

You're as adventurous as a probe exploring the outer reaches of the solar system. But remember, even astronauts need a tether to ground them. Don't be afraid to explore new horizons, but stay connected to your roots. Like a comet blazing through the sky, you have the power to leave a trail of inspiration wherever you go.

♑ Capricorn

December 22–January 19

Your ambition is as vast as the universe itself. But even the tallest mountains have valleys. Embrace peaks and pitfalls of your journey, for they are what make your ascent so exhilarating. Like a cosmic mountaineer, you have the strength and determination to reach the summit of your dreams.

♒ Aquarius

January 20–February 18

You're as innovative as a scientist in a laboratory filled with bubbling beakers. But remember, not every experiment yields immediate results. Embrace the process and trust in your unconventional methods. Like a mad scientist, you have the power to revolutionize the world with your brilliant ideas.

Pisces ♓

February 19–March 20

You're as dreamy as a nebula floating in the cosmic ether. But remember, even clouds need to rain sometimes. Don't be afraid to let your emotions flow like a cosmic river. Like a fish swimming against the current, you have the power to navigate the depths of your soul and emerge stronger than ever.

Aries ♈

March 21–April 19

Get ready to ignite like a Bunsen burner in a chemistry lab. Your energy is set to skyrocket, but remember, not every experiment needs to end with a bang. Take a moment to hypothesize before you react. After all, even Einstein had his off days before discovering the theory of relativity.

Taurus ♉

April 20–May 20

Your stability is as reassuring as the laws of physics. But don't get too comfortable in your gravitational pull. It's time to step out of your comfort zone and explore uncharted territories. Who knows, you might just discover a new element to add to your periodic table of life.

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