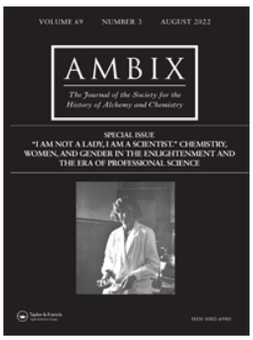

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Enabling Circumstances: Women Chemical Engineers at the Norwegian Institute of Technology, 1910–1943

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The Norwegian Institute of Technology (NTH) was the first of its kind when it opened doors in Trondheim in 1910. For the first time, engineers who were perceived as central to the country's industrial development could be educated in Norway. Of the 4,311 students admitted to NTH before 1940, twenty were women who embarked on the course in chemical engineering. In this prosopographical study, I aim to examine closely the first cohorts of women engineers in Norway, their motivations for studying chemical engineering, their career opportunities and choices and the extent to which they were supported by mentors. Sixteen women who completed their degrees have been investigated, and the lives and careers of three women who represent three common chemical industries in Norway during the first third of the twentieth century are studied in depth. I argue that the special place of NTH in Norwegian society prompted ambitious women to seek careers in chemical engineering. Because these candidates' competence was highly valued, they overcame the barriers otherwise experienced by women in Norwegian society in the early twentieth century.

In 1910, the Norwegian Institute of Technology (Norges tekniske høiskole, NTH) was finally opened in Trondheim nearly seventy years after an institution for higher technical education had first been proposed. The king was present, flags waved. Shops and schools were closed so that the people of Trondheim could take part

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in the celebration. Modern technology was demonstrated when more than 1,000 lamps were lit when darkness fell. Only five years had passed since the dissolution of the country's union with Sweden, which had begun in 1814, replacing 400 years of Danish rule. The nation was new, and the festivity in Trondheim marked not only the first institute of technology in the country but also an era of independence. For the first time, Norway would train its own engineers. A total of 103 proud and excited students were the first candidates to embark on academic and technical studies in Norway.

Similar to the equivalent institution in Sweden, NTH was expected to serve not only public but also private industrial needs.[1] The technical education that was offered was therefore linked to the rapid industrialisation that took place in Norway at the turn of the century, especially in the electrotechnical and electrochemical industries, which could benefit from recently installed hydroelectric power. The academically trained NTH engineers, or *diplomingeniører* as they were called in Norwegian, were expected to establish new industries and were regarded as a central force in the building of the country. They were part of an elite who would be instrumental in bringing prosperity to the new nation-state.

Figure 1 shows a photograph of the first students, their professors and some prominent guests during the inauguration ceremony in September 1910. The hall was filled with proud men in suits. However, if we examine the photograph closely, we detect one woman standing against the wall with a male companion. The image offers a glimpse into the solemnity of the occasion and the feeling of being among "the flower of the youth of the country," as engineer Georg Brochmann expressed in 1935.[2] The image also helps us grasp what it might have felt like to be the only woman among an elite who was expected to shape the future of Norway. The woman's name was Aslaug Urbye, and she was indeed the only female student enrolled at NTH in 1910. The next three women who were admitted started their studies five years later in 1915. In total, fifty-eight, or 1.3%, of the 4,311 students admitted to NTH before 1940 were women. Twenty of these students were registered in chemistry.[3]

In the 1940s and 1950s, the number of women who were admitted to the chemistry course at NTH increased tremendously; in fact, the number of female students admitted in the 1950s was almost equal to the total number of women enrolled during the first three decades. The number of women enrolled in chemistry more

[1] See the centenary history of NTH and the other forerunners of NTNU: Thomas Brandt and Ola Nordal, *Turbulens og tankekraft: Historien om NTNU* (Oslo: Pax, 2010), chapter 4. On the Swedish case, see Boel Berner, "Explaining Exclusion: Women and Swedish Engineering Education from the 1890s to the 1920s," *History and Technology* 14 (1997): 7–29.

[2] Georg Brochmann, *Studentersamfundet i Trondhjem gjennem 25 år. Et bidrag til norske studenters historie* (Oslo: Nasjonalforlaget, 1935), 4. All quotes are translated from the Norwegian into English by the author unless otherwise indicated.

[3] Brandt and Nordal, *Turbulens og tankekraft*, Appendix, 489–90 (compiled by Aslaug Mølmen, who I also thank for access to the raw data, including how the share of women was distributed over the different study courses).

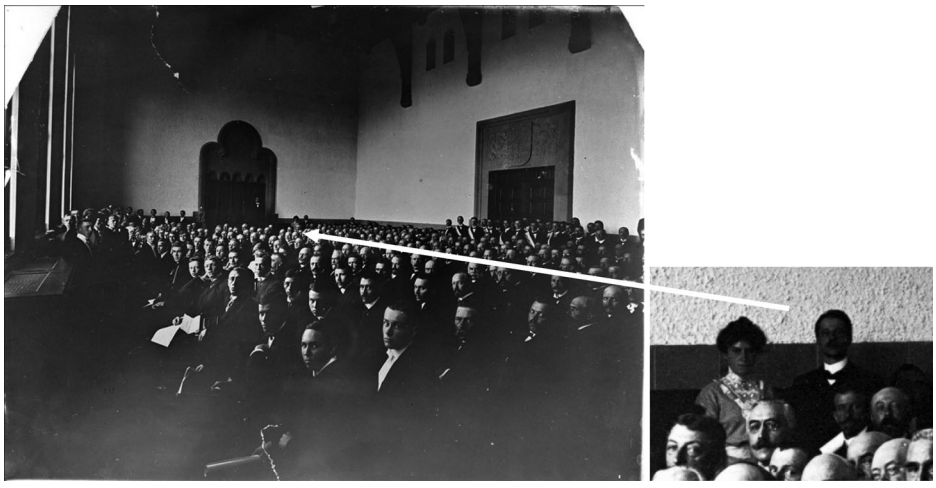

FIGURE 1. The inauguration of the Norwegian Institute of Technology in September 1910. In addition to the 103 students and their professors, several prominent guests were present. Only one student was female (enlarged excerpt): the chemistry student, Aslaug Urbye. She is standing along the wall to the left with a male companion, most likely her older brother, Jakob, who was studying law. Photo credit: Fredrik Hilfling-Rasmussen/NTNU University Library.

than doubled from the 1940s to the 1950s.[4] The first 30 years in the history of NTH, when women were few, are therefore significant with respect to women's participation in technical chemistry, or chemical engineering, as I will refer to it hereafter.[5] During this early period, some women were the only female student in their entire year, not only in chemistry but in all areas of study; moreover, few possibilities to participate in social activities existed for women engineers. It might also be argued that the first decades of NTH's existence were a formative period during which prospective engineers paved the way for a profession that had hitherto not been formed in and for a Norwegian context. As rector Sem Sæland (1874–1940) stated in his inauguration address in 1910, at NTH "new paths and new

[4] The majority of the women were admitted to the chemistry or architecture courses; however some chose to study electrotechnics, civil engineering or machine engineering. Seventy-two women studied chemical engineering during the 1960s and 1970s. The total share of female students at the NTH (including those who studied architecture) was stabilised at above 4% in the mid-1960s, exceeding 10% from the mid-1970s (Brandt and Nordal, *Turbulens og tankekraft*, 489–90; associated raw data). At the Royal Institute of Technology (KTH) in Sweden, the number of women increased in the 1950s to finally exceed 5%. A total of forty-three women engineers were educated at KTH between 1924 and 1962. Berner, "Explaining exclusion"; Boel Berner, "Women engineers and the transformation of the engineering profession in Sweden today," *Knowledge and Society* 12 (2000): 293–318.

[5] "Chemical engineering" in the American sense of the term was not introduced at NTH until after World War II. Before this, like in the German *Technische Hoschulen* the (technical) chemistry syllabus consisted of both courses in industrial chemistry and technical courses on electrical machines, house construction and hydraulic structures, to guarantee that the candidates had sufficient technical competence to fill the needs of a small technical firm. In the American model, emphasis was instead placed on technical management and unit operations, that is, principles that chemical operations had in common, irrespective of their nature. Nevertheless, to stay close to the Norwegian term *diplomingeniør* and to avoid using different terms in the text, I will use "chemical engineer" and "chemical engineering" about the pre-war years in this article.

possibilities for our industry [must be] created."[6] New industries created the need for new knowledge and skills, and new roles that the newly hatched engineers should fill. The new engineers needed to shape their identities and define their roles within the profession. This was especially true for the few women who became engineers during this period.

In 2006, Sally Gregory Kohlstedt stated in her reflections on women in science and technology in the twentieth-century US: "But we do need to understand where women and gender fit into these twentieth-century stories of scientific and technological accomplishments and to produce new, inclusive and more complex accounts that acknowledge both women's achievements and the discrimination they faced."[7] Moreover, the industrialisation rate and circumstances differed from country to country, as did the development of (male) professional cultures and the extent to which women's participation in it was enabled. Therefore, studies from different countries are needed.[8] This article attempts to understand what motivated women in Norway to choose chemical engineering, what their circumstances were, what they experienced as female engineering students and where their studies took them afterward. For the first half of the twentieth century, I was fortunate to have access to brief collective biographies of men and women in Norway, which are excellent resources for further studies.[9] This biographical material clearly indicates that the women who were admitted before 1940 came from a variety of backgrounds and had very different careers. Indeed, as Margot Fuchs also found for the first generations of women students and engineering graduates from the *Technische Hochschule* in Munich, there was no typical "woman engineer" in the early twentieth century.[10] Yet, commonalities exist.

To understand the variety of experiences of—and also similarities between—women in Norway who studied chemical engineering and tried to enter the job market as trained engineers from the late 1910s to the mid-1940s, I have been inspired by prosopographical approaches to the history of science, albeit not those based on large populations that have been analysed quantitatively. As suggested

[6] Cited in Annette Lykknes and Joakim Ziegler Gusland, *Akademi og industri: Kjemiundervisning og -forskning ved NTNU gjennom 100 år* (Trondheim: Fagbokforlaget, 2015), 139.

[7] Sally Gregory Kohlstedt, "Sustaining gains: Reflections on women in science and technology in the twentieth-century United States" in *Removing Barriers: Women in Academic Science, Technology, Engineering, and Mathematics*, ed. Jill M. Bystydzienski and Sharon R. Bird (Bloomington: Indiana University Press, 2006), 23–45 (on 23).

[8] One comparative history of women engineers is provided in Annie Canel, Ruth Oldenziel and Karin Zachmann, eds., *Crossing Boundaries, Building Bridges: Comparing the History of Women Engineers 1870s–1990s* (London: Routledge, 2004). The importance of the different economies and contexts for understanding women's place in engineering is highlighted in the book's introduction (pp. 1–10). No case study has been provided for Norway.

[9] Valuable sources for biographical entries include Bjarne Bassøe, ed., *Ingeniørmatrikkelen. Norske Sivilingeniører 1901–55 med tillegg* (Oslo: Teknisk Ukeblad, 1961) (for engineers); Georg Brochmann, ed., *Vi fra NTH: De første ti kull, 1910–1919* (Stavanger: Dreyers forlag, 1934) and O. Delphin Amundsen, ed., *Vi fra NTH: De neste ti kull, 1920–1929* (Oslo: Dreyers forlag, 1950) (for graduates from the NTH from the first 20 years), and *Studentene fra [year]*, a series of biographical memoirs collected 25/30 and 50 years after matriculation in Norway (see references to specific volumes elsewhere).

[10] Margot Fuchs, "Like Fathers–Like Daughters. Professionalization Strategies of Women Students and Engineers in Germany 1890s to 1940s", *History and Technology* 14 (1997): 49–64.

by Lewis Pyenson in 1977, prosopography in the history of science is a promising way of understanding "the ordinary scientist," their aspirations, career, education, attitudes and struggles.[11] The individuals examined in a prosopographical study belong to a group of people who share common characteristics;[12] in my case, they were in the first generation of female chemical engineers trained at NTH. One might argue that this fact alone makes them special rather than ordinary. However, the women engineers who graduated from NTH were "ordinary" in the sense that they have not before attracted the interest of historians—and they have not been noticed because of their scientific or professional merits.[13] Of the twenty women who were enrolled in chemistry before 1940, I have chosen to study the life stories of the sixteen who completed their studies (Figure 2).

To be a woman enrolled in a technical study in the early twentieth century must have required not only determination but also support from family and mentors.[14] This might have been particularly pertinent at NTH because its ambition was to establish new industries and it thus appealed to students who aspired to become industrial managers or entrepreneurs—a typically male occupation from which women were channelled away.[15] I argue that the position of NTH in Norwegian society in fact prompted ambitious women to seek careers in chemical engineering because their competence was highly valued. In addition to factors such as personal determination, socio-economic and family facilitation, supportive mentors and positive everyday arrangements, the field of chemistry was perceived as highly suitable to women, which I will elaborate on below. These women were able to succeed despite the many barriers generally experienced by women in society, and mentorship and networks enabled their possibilities to enter engineering studies, and get relevant work.

Women, chemistry and higher education in Norway

The first woman who was admitted to NTH in 1910, twenty-one-year-old Aslaug Urbye (1889—1978, Figure 1), first studied chemistry at the only university in the country, the Royal Frederick University (today, the University of Oslo). However, it is clear that she rather wanted to study at a technical school. After her matriculation

[11] Lewis Pyenson, "'Who the guys were': Prosopography in the history of science", *History of Science*, 15 (1977): 155–88 (on 179).

[12] K. S. B. Keats-Rohan, "Introduction: Chameleon or Chimera? Understanding Prosopography," in *Prosopography Approaches and Applications: A Handbook,* ed. K. S. B. Keats-Rohan, Prosopographica et Genelogica 13 (Oxford: Occasional Publications, UPR, 2007), 1–32.

[13] For another study of women in chemical industry in the twentieth century, see Joris Mercelis' article in this special issue.

[14] Even women who graduated as engineers in the 1970s report about the support and encouragement of family, friends and teachers. Laura Ettinger, Nicole Conroy and William Barr II, "What Late-Career and Retired Women Engineers Tell Us: Gender Challenges in Historical Context," *Engineering Studies 11* (2019): 217–42.

[15] Brandt og Nordal, *Turbulens og* tankekraft, 115; Ruth Oldenziel, "Decoding the Silence: Women Engineers and Male Culture in the U.S., 1878–1951," *History and Technology* 14 (1997): 65–95; Joanna Behrman, "Manuals, Handbooks, and Recipes" in *Between Making and Knowing: Tools in the History of Materials Research*, ed. Joseph D. Martin and Cyrus C. M. Mody (Singapore: World Scientific, 2020): 73–82.

FIGURE 2. The first sixteen female chemical engineers who graduated from NTH (graduation year indicated). In order of appearance, left to right: Margot Dorenfeldt, Randi Holwech, Karin de Lange, Nanna Isaachsen, Liv Tessem, Jørgine Stene, Turid Wik, Elisabeth Pedersen, Karen Backhe, Marthe Hermine Eckbo, Anne Lene Thoresen, Liv Urbye, Inger Ryssdal Graff, Astrid Gilstad, Anna Marcelie Johansen, Elsa Margrete Stensrød. Sources: NTNU University library, Schrøder/Trøndelag Folk Museum (Stene), *Vi fra NTH* (Holwech, Isaachsen, Wik).

in 1907, she had applied to study technical chemistry at the lower technical school in Kristiania (*Kristiania tekniske skole*). She went to the university when the director of the technical school refused to accept her because she was a woman, and left when she was able to resume the technical path and study at NTH.[16] In the summer of 1909, she was employed as a laboratory assistant at the test laboratory of a fertiliser factory, Norsk Hydro, at Notodden. She later took a similar position at the Notodden Saltpetre Factory, where she met her husband-to-be Harald Helberg, who was her boss. Indeed, her studies at NTH commenced after she had met him, which suggests that she was determined to pursue her studies even after marriage. However, she left NTH after one and a half years, officially because she was taken ill with an eye disease.[17] That she was getting married might have been a contributing factor, but it could not have been decisive, based on the determination she had shown earlier. Indeed, we should not underestimate the importance of her experiences as a woman at NTH. More than forty years later, she confided in an engineer who rented a room in her house about how she had been met by her male

[16] "Helberg, Aslaug, født Urbye" in *Studentene fra 1907: biografiske opplysninger samlet til 25-års jubileet 1932*, ed. Ragnar Ullman (Oslo: Grøndahl, 1932), 165.
[17] "Helberg" in *Studentene fra 1907*.

peers at the institute. She still recalled how uncomfortable she had felt when other students marked her entrance into the lecture hall by scraping against their desks.[18] Aslaug Helberg, as she was called after she was married in 1912, had five sons and lived most of her life near the industrial site of Rjukan, where Hydro established a saltpetre factory, which her husband helped build.[19] This environment helped her remain close to the profession she had once aspired to; however, there are no records showing that she had been engaged professionally in the chemical industry after leaving NTH.

At the time Urbye enrolled at NTH, few women were in higher education. Twenty-eight years had passed since women had gained the right to matriculate, but many had not pursued their studies at a university or the equivalent. At the turn of the century, women comprised only 2–3% of the students at Royal Frederick University, and in 1925, the number had reached 12%. More than half of the women at the university studied medicine.[20] At NTH, it would take three and a half years from when Urbye left until the next three women were enrolled at the institute—two in chemistry and one in architecture. In fact, 35% of the female students who were admitted to NTH before 1949 studied chemistry, while 59% chose architecture. These two courses continued to be the most popular for women at NTH, as they had been for women auditors and students at a lower technical school in Trondheim (*Trondhjem Tekniske Læreanstalt*).[21] Chemistry and architecture have also attracted women in other countries.[22] Architecture, it was argued, appealed to women's sense of beauty and constituted a niche where women could contribute to better housing and thus to social equalisation.[23] It was also the least technical of the study courses offered at technical schools. Chemistry was indeed a practical subject, but its arena was the laboratory rather than the shop floor, a division that Ruth Oldenziel has referred to as "the single most important delineator between men and women in engineering."[24] In the nineteenth century, in comparing the laboratory with the kitchen, it was argued that chemical work would help women become better housekeepers, cooks, wives and mothers.

[18] The story has been retold by the engineer who stayed in her house and published in his memoirs: Norolf Henriksen, *Hydranten. Lang arbeidsdag i industrien* (Notodden: Telemark trykk, 2013): 16–17. See also Lykknes and Gusland, *Akademi og industri*, 103–5.

[19] Per Roger Lauritzen, *Claus Helberg: Veiviser i krig og fred* (Oslo: Den norsk turistforening, Boksenteret forlag, 1999): 12–15. Claus Helberg was Urbye's son and a famous partisan during World War II.

[20] Jan Eivind Myhre, *Universitetet i Oslo: Kunnskapsbærerne 1811–2011. Akademikere mellom universitet og samfunn* (Oslo: Unipub., 2011), 126, 128 and 186.

[21] Aslaug Mølmen, *Kvinnelige pionerer: En studie av 21 kvinnelige teknikere ved Trondhjem Tekniske Læreanstalt 1883–1915* (master's thesis, NTNU, Trondheim, 2008), 100.

[22] Berner, "Explaining Exclusion" (Sweden); Fuchs, "Like Fathers–Like Daughters" (Germany); Oldenziel, "Decoding the Silence" (US, chemistry).

[23] Berner, "Explaining Exclusion".

[24] Oldenziel, "Decoding the Silence," 83. Synnøve Liaaen Jensen, the first female full professor at the Norwegian Institute of Technology (appointed in 1970), stated in an interview that she chose chemistry because it was the least technical of the engineering subjects at NTH. Lykknes and Gusland, *Akademi og industri*, 408. There are, however, also examples where the laboratory has been presented as a masculine space; see Claire Jones, "'All Your Dreadful Scientific Things': Women, Science and Education in the Years around 1900," *History of Education* 26 (2017): 162–75.

Moreover, attributes such as accuracy, thoroughness and hygiene were considered female and highly relevant in chemistry.[25]

Chemistry was one of five technical courses (in addition to architecture) offered at NTH in Trondheim, and it was the only study course that was also offered at the Royal Frederick University in Kristiania. However, the two courses were distinct. The mandate of NTH was that all candidates receive the best possible technical training to enable them to work as chemical engineers in industry, so all students were trained in technical fields in addition to theoretical courses in chemistry, physics, mechanics and mathematics.[26] At the university, most students enrolled in chemistry courses studied pharmacy or medicine. The majority of those who specialised in chemistry became teachers. No technical courses *per se* were offered.[27] The chemistry course at NTH was therefore a new addition to chemistry education in the country, and it was tailored to the budding chemical industry. I therefore do not investigate women in Norway who studied chemistry in general, but those who chose the chemical engineering course.

To understand the size of NTH, we can compare it with the *Technische Hochschule* in Berlin, one of the most popular *Hochschulen* in Germany, which served as a model for NTH. While the *Hochschule* in Berlin had 3,000 students during the academic year 1910–1911, the student population in Trondheim amounted to one hundred students per year, reaching a total of 400 by 1913. In 1920, however, NTH accepted as many as 700 students.[28] As a national institute of technology with the special responsibility of supplying the country with engineers, NTH decided to expand; even so, only two-thirds of the students who had applied were admitted. In 1917, for example, ninety students were rejected, fifty of whom had applied for the chemistry course, which indicates the popularity of the chemistry course at NTH.

Eight females graduated from the chemistry department at NTH between 1919 and 1930, while only three female students specialised in chemistry at a master's degree equivalent level at the university between 1907 and 1930 (compared with twenty-nine men).[29] Overall, women comprised less than 8% of all students who

[25] Margaret Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore: Johns Hopkins University Press, 1982), 68; Anders Lundgren, "Women and Analytical Chemistry: Reflection on the Chemical Skill Needed for Investigating the Elements" in *Women in their Element: Selected Women's Contributions to the Periodic System*, ed. Annette Lykknes and Brigitte Van Tiggelen (Singapore: World Scientific, 2019): 124–33; Mølmen, *Kvinnelige pionerer*, 26–27 and 104.

[26] See also note 5.

[27] Around 1920, disputes arose about who had the right to educate industrial chemists, the university, NTH, or both. It ended with a division of labor with respect to teaching, but the two institutions had to accept competition with regard to research. See Annette Lykknes, "Fighting for Modern Teaching and Research Laboratories in Norway: The Chemistry Laboratory in Political Dispute around 1920" in *The Modern Laboratory and the Changing Nature of the University, 1850–1950*, ed. Klaas van Berkel and Ernst Homburg (Amsterdam: Amsterdam University Press, forthcoming).

[28] Reinhard Rürup, ed., *Wissenschaft und Gesellschaft. Beiträge zur Geschichte der Technischen Universität Berlin 1879–1979* (Berlin: Springer-Verlag, 1979), vol. 1, 3–47 (esp. 14) and 570–1; Brandt and Nordal, *Turbulens og tankekraft*, 101; Lykknes and Gusland, *Akademi og industri*, 194.

[29] Aslaug Mølmen, raw data (NTH, see note 3); *Kvinner på universitetet 100 år* (Oslo: Universitetet i Oslo, 1984), 124.

graduated with an academic degree in natural science or mathematics in Norway between 1910 and 1939, while their share of candidates in humanistic subjects reached 21% in the same period.[30] There were only a few women in the science and technical fields in higher education elsewhere in Europe. At the *Technische Hochschule* Berlin, for example, forty-eight (or 1.6%) of the total of 3,000 students were women in the academic year 1910–1911, which was the first year that women were accepted. By 1914, seventy female students were studying at *Technische Hochschulen* all over Germany.[31] This is the year before the first three women who completed their degrees at NTH were admitted.

Three women have been selected as cases to represent the population of sixteen women engineers from Trondheim in this study. They represent important branches in early twentieth century Norway, and the three types of industry most chemical engineers went to in the first decades after NTH was established: the pulp and paper industry, the electrochemical industry, and the foodstuff industry.[32] The three cases are also used to elucidate different kinds of networks the women used to enter or remain in the field; their fathers, their husbands, or other forms of mentorship. Each case is followed by two tables, one which includes the women in my population who worked in the same industry as the main character; the other displays women who shared other characteristics—fathers as engineers, work experience from chemical industry, or marriage with another engineer. The first story I will present and discuss is that of Margot Dorenfeldt, the very first woman to graduate as chemical engineer from NTH.

Her father's daughter: Margot Dorenfeldt (Holtan) and the pulp and paper industry

Margot Dorenfeldt (1895–1986, Figure 3), who had specialised in inorganic chemistry and electrochemistry, graduated from NTH in 1919 with very good grades. She was the daughter of Lauritz J. Dorenfeldt (1863–1932), an engineer educated at the *Technische Hochschhule* in Berlin. Margot's grandfather, Lauritz Dorenfeldt Jenssen (1837–1899), founded the Ranheim Cellulose Factory in Trondheim in 1884, and left the management of the factory to his oldest son, Margot Dorenfeldt's father, in the late 1880s and early 1890s.[33] Lauritz Dorenfeldt Junior is known to have played a key role in the development of cellulose production in Norway and its expansion into paper production.[34] He soon went to Germany, where he assumed the position of technical director in a cellulose factory in Rheindürckheim at

[30] Myhre, *Universitetet i Oslo: Kunnskapsbærerne,* 151.
[31] Rürup, *Wissenschaft und Gesellschaft,* 570–71; Fuchs, "Like Fathers–Like Daughters," 54. For more on women chemists in Germany before 1925, see Jeffrey Johnson, "German Women in Chemistry, 1895–1925 (Part 1)," *N.T.M.* 6 (1998): 1–21.
[32] Lykknes and Gusland, *Akademi og industri*, 140–44.
[33] Gerd Søraa, *Ranheim papirfabrikk. 125 år som hjørnesteinsbedrift* (Trondheim: Peterson Ranheim, 2009), 18–29.
[34] Ingar Kaldal, "Lauritz J Dorenfeldt" in *Norsk biografisk leksikon* at snl.no. https://nbl.snl.no/Lauritz_J_Dorenfeldt (accessed 25 March 2021).

FIGURE 3. Margot Dorenfeldt (1895–1986) was the first chemical engineer to graduate from NTH. She enrolled in 1915 and graduated in 1919. Photo credit: NTNU University Library.

Worms; here Margot was born in 1895. In 1902, Lauritz J. Dorenfeldt returned to Norway and established himself as a consultant for the pulp and paper industry in Kristiania, the capital. This branch of industry expanded greatly in Norway during the last quarter of the nineteenth century, and it was reckoned to be a promising industry at the time when NTH was established.

Margot Dorenfeldt would eventually find work in the pulp and paper industry, but her first job was at the chemistry laboratory at Royal Frederick University, where she started as an assistant in 1920. Later the same year, she was promoted to amanuensis, which included both research and teaching.[35] While at the University in Kristiania, Dorenfeldt undertook investigations into the atomic weight of chlorine together with the Norwegian radiochemist and associate professor Ellen Gleditsch, and published the results in English and French.[36] In 1922, Dorenfeldt

[35] "Holtan, Margot, f. Dorenfeldt" in *Vi fra NTH: De første ti kull*, 240–1.

[36] Margot Dorenfeldt, "Relative Determinations of the Atomic Weight of Chlorine in Bamle Apatite." *American Chemical Journal* 45 (1923): 1577–79; Ellen Gleditsch, Margot Dorenfeldt Holtan and Ole Wilhelm Berg, "Determinations du poids atomique du mélange isotopique de plomb de la cleveite de Aust-Agder, Norvège," *Journal de chimie physique et de physic-chimie biologique* 22 (1925): 253–63. For some context on this work, see Annette Lykknes, Lise Kvittingen and Anne Kristine Børresen, "Ellen Gleditsch: Duty and Responsibility in a Research and Teaching Career, 1916–1946," *Historical Studies in the Physical and Biological Sciences* 36 (2005): 131–88.

was granted a scholarship by the university to study at the *Collège de France* in Paris, where she married Eugen Holtan the following year. Holtan was a chemical engineer who had graduated from NTH in 1917, studied further at Strassburg University and *École de Chauffé* in Paris from spring 1921 and ran experiments at *Sociéte de Recherche et de Perfectionnements industriels*, a factory producing optical materials, at the time of Margot Dorenfeldt's arrival. In November 1923, when back in Kristiania, she gave birth to a daughter, Sally (named after her mother-in-law) and eleven years later a son, Lauritz, who was named after his grandfather and great grandfather.[37]

Family connections were indeed close. Dorenfeldt's father remained an influential engineer in the pulp and paper industry in Norway, and she might have been inspired by him when she chose to study chemical engineering at NTH. However, she was also supported by her mother, Aagot Bødtker (1869–1963), who had been auditor at the (lower) technical school in Trondheim in the 1880s, where she had taken classes in (technical) chemistry. According to a family legend, Bødtker was encouraged by her future husband to take these classes so that she could understand his work and converse with him about technical matters. Lauritz J. Dorenfeldt had studied to become a machine engineer at the same technical school before pursuing further studies in Germany. When Bødtker married Dorenfeldt in 1890, she gave up her professional life and became a homemaker. However, she was active in women's associations and promoted women's rights.[38]

There are no records of Margot Dorenfeldt's recollections of her time at NTH. However, in the history of the student society in Trondheim, she was recorded as the first woman to be elected to the society board in 1917. While at first glance, this record seems an appreciation of her presence in live debates at the society as well as in the student bulletin *Under Dusken* (*Under the Tassel*), Dorenfeldt did not feel this way. She had not been present at the meeting where she had been elected, nor had she been asked if she was willing to join the board. She therefore refused to join. *Under Dusken*, on its part, noted her withdrawal as an example of women's ambiguity; on the one hand, women wanted the right to serve on boards like their male peers, but, on the other hand, they did not feel obliged to take office when this was offered to them. If one dared to criticise them, one could be accused of harassment, they claimed.[39] According to historian Jan Thomas Kobberrød, this sarcastic tone was common among the students, and a sign that the male students respected women from NTH more than women in general.[40] Nanna Isaachsen (1898–?), who graduated in chemistry a few years after Dorenfeldt (Table 1b), was among the women who remembered the evenings in the Student society with great pleasure.[41]

[37] "Holtan, Margot Dorenfeldt" in *Studentene fra 1914. Biografiske opplysninger samlet til 50-års jubileet 1964* (Oslo: Aas & Wahl boktrykkeri, 1964), 118–9.
[38] Mølmen, *Kvinnelige pionerer*, 52–54.
[39] Jan Thomas Kobberrød, *Engasjement og begerklang: Studentersamfundet i Trondhjem 1910–2010* (Trondheim: Tapir akademisk forlag, 2010), 153–4.
[40] Kobberrød, *Engasjement og begerklang*, 155–6.
[41] "Hasund, Nanna Isaaachsen" in *Vi fra NTH: De første ti kull*, 345.

As for Margot Dorenfeldt, she remained an active debater in student debates, for example by contributing critical comments about the engineering profession and their participation in social politics, in *Under Dusken*.[42]

In the 1920s, while in Kristiania, Margot Dorenfeldt took part in a public dispute about which institution had the right to educate chemists in Norway. There were not enough funds to grant new laboratories both to the University and NTH in the economically difficult 1920s, and this led to competition between the two institutions.[43] Like her father, Margot Dorenfeldt spoke in favour of university training in chemistry and not leaving the responsibility for the training of chemists for industry exclusively to NTH. This was a somewhat surprising stance of someone with a degree in chemical engineering from NTH, and she was criticised in *Under Dusken* for close ties with her father. However, Dorenfeldt stated boldly that she was "proud to belong to the clan made up of my father and myself!"[44] Seemingly, being her father's daughter was part of her identity.

Margot Dorenfeldt Holtan, her married name, would remain professionally connected to both her father and her husband. In the 1930s, she did occasional secretarial work for her father, for which she felt her training at NTH had been very useful.[45] For short periods, she even worked as substitute chief chemist at the Tofte Cellulose Factory, where her husband worked for almost two decades and for which her father served as board member for decades and as chairman until he died in 1932.[46] According to her own records, she also published scientific work with her husband.[47] In 1946, she was employed at the Ministry of Industry, where she was later promoted to principal officer for the pulp and paper office. The Ministry of Industry was instrumental in establishing government/state industry in the rebuilding phase of the country after World War II.[48] Her work was certainly appreciated; towards the end of her career, Margot Dorenfeldt Holtan served as a board member of councils for funding related to the pulp and paper industry and the timber industry, as well as chair of one of them, and she became a board member for the Paper and Fibre Research Institute (PFI), which was not a common position for a woman at the time.[49] She was the only one of the women

[42] Margot Dorenfeldt, "Ingeniørene og sosialpolitikken," *Under Dusken* 5, no. 5 (1919): 1–3. Responses and further comments can be found in other issues from March 1919.

[43] See also note 27.

[44] Margot Dorenfeldt, "Le chien qui saute," *Under Dusken* 8, no. 9 (1922): 9. On the debate, see Lykknes, "Fighting for Modern Teaching and Research Laboratories" (forthcoming).

[45] "Holtan" in *Vi fra NTH: De første ti kull*, 240.

[46] Information about Margot Dorenfeldt (Holtan) and Eugen Holtan's careers: Bassøe, *Ingeniørmatrikkelen*, 220. On Lauritz J. Dorenfeldt's office on the board, see Aage Berg Hanssen, *Cellulosefabrikken på Tofte gjennom 100 år (1897–1997)* (Tofte: Norske Skogindustrier ASA, 1997), 16–17.

[47] "Holtan" in *Vi fra NTH: De første ti kull*, 240. I have not been able to identify joint publications. However, Margot Dorenfeldt also published independently, see, e.g., Margot Dorenfeldt-Holtan, "Über die Löslichkeit des Quicksilbersulfides in verdünnter Salzsäure," *Zeitschrift für anorganische und allgemeine Chemie* 208 (1932): 76–80.

[48] Knut Are Tvedt, "Industridepartementet", in *Store norske leksikon* at snl.no., https://snl.no/Industridepartementet (accessed 25 March 2021).

[49] "Holtan" in *Studentene fra 1914*. Another example of a Norwegian female chemical engineer who served as board member for industrial organisations, though a bit later than Dorenfeldt Holtan, was Sonja Smith-Meyer Hoel, who from 1974 was president of the Norwegian Association for Industrial Patent Engineers and vice president of the

engineers from this study who worked in the pulp and paper industry (Table 1a) and one of two in her year. On average, one candidate per year went to this branch of industry.[50]

In addition to Margot Dorenfeldt, three women in my population had fathers who were engineers (Table 1b): Randi Holwech, Martha Eckbo and Anna Marcelie Johansen. Nanna Isaachen's father was a professor of dietetics and is included because he held a research position in a science field. Most of the other women had fathers with high positions in other areas of society. Similarly, Margot Fuchs found that female students at the *Technische Hochschule* in Munich 1890–1940s came from families within the commercial, industrial and educational elites.[51] Although many also had strong and encouraging mothers, the women engineers who left records remembered the fathers, not the mothers, as the main patrons and promoters of their technical careers. It is likely that the Norwegian women chemical engineers who had fathers as engineers looked up to them and that their support and experience made it easier for the daughters to choose chemical engineering. To them, the engineering profession was not abstract; they had observed how their fathers practised their professions and might even have taken part in work-related discussions with them.

Randi Holwech (1890–1967), who never married, however, led a completely different career than her father, abandoning chemistry to work as an artist after a research stay at Marie Curie's laboratory in Paris and a few years as a laboratory chemist. In addition to her father who was an engineer of intercommunication systems she had a brother who was a chemical engineer educated at the *Technische Hochschule* Karlsruhe who might have inspired or guided her in her choice to study at NTH.[52] He even took her in when he established his own chemical laboratory in 1924. Randi Holwech might be an example of what Fuchs and Oldenziel called "borrowed identities": that the fathers' (or brothers') interests guided them to the extent that some of these women took their fathers' professional identities for their own.[53] A privileged family background and good grades from NTH was not enough to make her identify as a chemist or chemical engineer, even an opportunity to work with double Nobel prize awardee Marie Curie could not make Holwech pursue the chemical and technical path. Indeed, Holwech seems to have been a talented artist and was fortunate to be able to pursue her artistic career and thus follow her passion in life. In 1961 she was privileged to have one of her

[49] *Continued*
European Federation of Agents of Industry in Industrial Property. She has been described as one of the earliest influential women in the Norwegian industry. See Annette Lykknes, "Sonja Smith-Meyer Hoel: Chemical Engineer in the Ferrosilicon and Aluminium Industry in Norway" in Lykknes and Van Tiggelen, *Women in their Element*, 405–14.

[50] Lykknes and Gusland, *Akademi og industri*, 141–3.

[51] Fuchs, "Like Fathers–Like Daughters".

[52] Like Dorenfeldt, Holwech specialised in inorganic chemistry and electrochemistry. "Holwech, Randi" in *Vi fra NTH: De første ti kull*, 240–1. Information about her father and brother is taken from Bassøe, *Ingeniørmatrikkelen*, 222 and the DigitaltMuseum photo database: https://digitaltmuseum.no (accessed 22 June 2022).

[53] Fuchs, "Like Fathers–Like Daughters"; Oldenziel, "Decoding the Silence".

TABLE 1A

MARGOT DORENFELDT (HOLTAN) WAS THE ONLY WOMAN FROM MY SAMPLE WHO WORKED IN PULP AND PAPER LABS OR INDUSTRY DURING HER CAREER. SHE STARTED WITH SECRETARIAL WORK FOR HER FATHER, LATER WORKED FOR HER HUSBAND, AND GRADUALLY EARNED A MORE INDEPENDENT STATUS IN THIS BRANCH OF INDUSTRY.

Name	Period	Role Industry/lab
Margot Dorenfeldt (Holtan)	Occasionally during the 1920s, 1930s and possibly until mid-1940s	Secretarial work, substitute head chemist, Tofte Cellulose Factory
	1946/1953 onwards	Employee/Principal officer, pulp and paper office of the Ministry of Industry
	1960s	Various offices related to pulp and paper industry and associated research institute

TABLE 1B

WOMEN WHO GRADUATED AS CHEMICAL ENGINEERS FROM NTH 1919–1943, AND WHOSE FATHERS WERE ENGINEERS OR SCIENCE PROFESSORS. MARRIED NAMES IN PARENTHESIS.

Name	Graduated year	Career after graduation
Margot Dorenfeldt (Holtan)	1919	Assistant/amanuensis to associate professor Ellen Gleditsch at the Royal Frederick University 1920–1923, studies at *Collège de France* 1922–23, homemaker, secretarial work for her father, substitute head chemist at Tofte Cellulose Factory, Ministry of Supply from 1947 (head of office from 1953)
Randi Holwech	1919	Studies at Marie Curie's laboratory in Paris 1919–20 (with the help of associate professor Ellen Gleditsch), secretary to chemist Dr Lennart Forsén at Sorbonne university, chemist at Royal Frederick University and at her brother, Wilhelm Holwech's chemical laboratory (from 1924). Abandoned chemistry ca. 1925, studied art in Norway and Europe, career as an artist (painter)
Nanna Isaachsen (Hasund)	1922	Assistant at the Norwegian Agricultural University College at Ås 1923–1925, later homemaker
Martha Hermine Eckbo (Blakstad)	1936	Chemist at Freia chocolate factory 1937-1939, chemist at the Ministry of Supplies 1940–1943, later homemaker
Anna Marcelie Johansen (Gustavsen)	1943	Chemist at Jahre chemical factories in Sandefjord 1943–1950, Sandar factories 1951, homemaker 1952–1958, Jotun factories from 1958

watercolour paintings exhibited in the prestigious National Gallery in Oslo (formerly, Kristiania).[54]

Holwech never married. All the other women whose fathers were engineers or professor did, and left work to become homemakers after a few years in service. Anna Marcelie Johansen Gustavsen (1919–?) returned to chemical industry after six years of absence. Martha Hermine Eckbo Blakstad (1913–1997) worked in chemical industry early in her career. Interestingly, the one in our sample whose

[54] Her pride in her accomplishments seems, however, to have been overshadowed by the daily harassment she reported to have been subject to over the "last 15 years", that is, since the war ended. "Holwech, Randi Aletta" in *Studentene fra 1911. Biografiske opplysninger samlet til 50-årsjubileet 1961* (Bergen: J.D. Beyer A.S. Boktrykkeri), 93. See also Bodil Sørensen, "Randi Holwech" in *Norsk kunstnerleksikon* at snl.no., https://nkl.snl.no/Randi_Holwech (accessed 28 June 2022).

father was a professor, Nanna Isaachsen, might have served as inspiration and patron in her career choices too – not to work in industry, but in a university college lab. In fact, for two years Isaachsen worked as private assistant for one of her father's colleagues in an chemical analysis lab at the Norwegian Agricultural University College, before dedicating herself to family life with her husband and two children.[55] In the next section I will present Liv Tessem who exemplifies the many women who worked in chemical industry during their careers, many of whom did not come from engineering or science families but who nevertheless managed to get a foot in industry.

The chemical engineer at the plant: Liv Tessem and the electrochemical industry

Liv Ranfrid Tessem (1900–1987, Figure 4) was born in Steinkjer, a town north of Trondheim, into a middle-class family. She grew up in a large flat with a grocery shop on the ground floor, which her father kept. The flat housed Liv Tessem, her two siblings and parents, as well as maids and clerks, who helped with the business. When she was ten years old, she moved to Trondheim to go to school and live with her aunt. Her father wanted his daughter to have the best opportunities and urged her to go. After middle school, she moved to Hamar, 400 kilometres further south, to continue her studies at the cathedral school, a renowned gymnasium. Apparently, she had applied too late to be admitted to the cathedral school in Trondheim. Since she originally planned to study philology, she matriculated in Latin; therefore, when she decided to change fields completely and study at NTH, she needed to complement her education with natural science and mathematics before applying. In 1977, at the age of seventy-seven, she was interviewed for a history project about life and work in the Trøndelag region. I therefore had access to her reflections on and recollections of her life and experiences.[56] When asked why she had chosen NTH, she first stated that it seemed "fun" to study there, but later in the interview, she emphasised that she had applied because of the prospect of better job opportunities.

In reality, the job market was tight in the 1920s. The period before the outbreak of World War I had been a golden age for the electrochemical and electrometallurgical industry in Norway, and in 1913, this branch of industry comprised 18% of the export income in the country.[57] This branch of the chemical industry recruited most chemical engineers during the first ten years after NTH was established.[58] However, as an exporting nation, Norway suffered in the post-World War I years, and newly trained engineers had difficulty finding work in the 1920s. The

[55] "Hasund, Nanna (Isaachsen)" in *Vi fra NTH: De første ti kull*, 345.

[56] NTNU University Library, A-0379 Arbeiderminnesamlingen, F- transkriberte intervju, Fm sosialhistorisk med tyngdepunkt Trøndelag, L0016 Trondheim Lademoen, HIMT nr. 485 Liv Tessem, Bånd nr. 144. (Liv Tessem interviewed by Kjell Gunnar Holm), hereafter "interview Tessem".

[57] Arne Sellæg, *A/S Ila og Lilleby Smelteverker 50 år* (Trondheim: Verkene, 1988), 14.

[58] Lykknes and Gusland, *Akademi og industri*, 140–2.

FIGURE 4. Liv Tessem at the chemistry laboratory at NTH during her study years (left) and at the materials testing laboratory at NTH, where she worked from 1953. Previously, she had worked for 24 years at a smelting plant. Photo credit: NTNU University Library and Schrøder/Trøndelag Folk Museum.

state of the market is reflected in the number of students who applied and were admitted to NTH. While twenty-five students had been admitted to the chemistry course in 1920, only seven enrolled two years later. In 1924, when Liv Tessem began her studies, the number of chemistry students at NTH had reached the modest number of fifteen. However, while the depression was over in most countries in 1923–1924, in Norway, the national crisis continued until the new international crisis in 1930. Unemployment peaked in 1926 and 1927 just before Tessem was ready for the job market.[59]

Tessem was fortunate. Just one week after she graduated, she was offered a position at a local smelting plant thanks to her metallurgy professor, Harald Pedersen (1888–1945). In the mid-1920s, he had bought a former brick works at Lilleby, where he initiated the production of ferrosilicon, and in 1928 he bought the closed smelting plant at Ilen, where he established the production of ferrochrome. In 1937, he merged the two factories to establish Ila and Lilleby Smelting Plants Limited.[60] There were close ties between NTH and professor Pedersen's business. His laboratories were well-equipped, as Tessem recalled, and until 1942, he had rented out laboratories to NTH, which needed rooms for chemical and metallurgical work because of the increase in the student population.[61]

[59] Fritz Hodne og Ola Honningdal Grytten, *Norsk økonomi 1900–1990* (Oslo: Tano, 1992), 96 and 104.

[60] Jan Thomas Kobberrød, "Metallurgien ved Bergavdelingen før 1945" in *Bergingeniørutdanning i Norge gjennom 250 år*, ed. Anne Kristine Børresen and Jan Thomas Kobberrød (Trondheim: Tapir akademisk forlag, 2007), 103–18 (on 110).

[61] Sellæg, *Ila og Lilleby Smelteverker*, 18; interview Tessem.

Tessem began at Lilleby, where she analysed raw materials such as quartz and iron ore, and ferrosilicon. Seventy people were employed at the two factories when she started to work there,[62] but it was difficult to operate in the 1930s, and many workers lost their jobs. Pedersen's factories were fortunate because they used inexpensive waste heat from the municipality. However, because of the instability of this power source, production was unpredictable; throughout the 1930s, Pedersen had to reduce operations during the winters. A strike in 1937 added to the commotion and insecurity of this period.[63] Tessem was lucky to remain employed, but recalled that she felt personally involved with the electricity issue because her uncle was the director of the power plant. Whether the close ties with the professor or the uncle was part of the reason for keeping her, or that she probably earned less than her male companions, one can only speculate.[64] Irrespective of the reason, since she was one of the employees who remained at the plant, she was able to do "investigations" that had not been possible earlier, during quiet periods.[65] In fact, Tessem worked at the company until 1953, when she took a position at the materials testing laboratory at NTH, which tested materials for the private industry and the public sector.[66] She never established a family of her own.

Liv Tessem was the only woman in the chemistry department in her year when she arrived at NTH. There was one female student who enrolled in architecture the same year. As noted, the classes were small (fifteen in Tessem's case), but the sense of being the only woman was nevertheless strong. Tessem remembered being alone in chemistry for two years rather than one, which was, in fact, the case. Indeed, she found it difficult to take part in student activities in her spare time because she was the only woman in the group. The subsequent year, three women enrolled in chemistry, but Tessem does not seem to have socialised with them, nor with her male classmates. Tessem's preferred form of recreation was hiking in the woods with a female friend on weekends.[67]

When asked about her experiences as a woman at NTH and at Lilleby, Tessem said that it was generally good and that she did not find that being a woman in these environments was challenging. This resonates with what Elisabeth Erika Pedersen (1904–?, Table 2b), one of the women who enrolled the year after Tessem, stated about her student days: She described the tone among the students in the lab as congenial, and that the socialising with her peers taught her to appreciate and tolerate criticism—which was clearly addressed with respect.[68] Tessem did not

[62] Figures from 1929.
[63] Sellæg, *Ila og Lilleby Smelteverker*, 20–21; Haakon Odd Christiansen, ed., *Trondheim bys historie. Supplementsbind* (Trondheim: Trondheim kommune, 1973), 234 and 239.
[64] On women's lower wages, see Rossiter, *Women Scientists in America*, 253–4; Fuchs, "Like Fathers–Like Daughters".
[65] Interview Tessem.
[66] Bassøe, *Ingeniørmatrikkelen*, 511; Roland Wittje, *Accoustics, Atom Smashing and Amateur Radio: Physics and Instrumentation at the Norwegian Institute of Technology in the Interwar Period* (PhD diss., NTNU, 2003), 118.
[67] Interview Tessem.
[68] "Pedersen, Elisabeth Erika" in *Vi fra NTH: De neste ti kull,* 297.

mention any negative episode with her peers either, however she recalled an uncomfortable experience at NTH in one of the (economy and law) professors' classes: "He did not like women, and this was especially unpleasant to me since I was the only one, so I stopped attending his lectures."[69] The men in her class supported her in this choice, but she was anxious about the prospect of facing the professor during an eventual oral exam. Fortunately for her, the assessment form was a written exam that year. At the smelting plant, the only "trouble" she recalled in 1977 was an episode when a laboratory assistant had refused to fetch a respirator for her because he did not accept taking orders from a woman. Only one other woman engineer in my population worked in a smelting plant (Table 2a).

All but three of the women worked for some time in chemical industry. Like Tessem, Turid Wik (1905–1987, graduated in 1929) and Anne Lene Thorsen (1910–?, graduated in 1936) worked for their entire lives in the industry or research establishments. They even led international careers; Wik spent a few years in an agricultural laboratory in Illinois, US and Thorsen worked in a meat-freezing company in Argentina. Probably such careers were possible because they never married. Elisabeth Erika Pedersen (mentioned above), who graduated in 1930 also never married, but never went into chemical industry. She tried different jobs, in state and private laboratories, and laboratories in university colleges. Karin Danielsen (1897-?, graduated in 1921) who married but did not have any children, worked for most of her career in the margarine industry.[70]

Interestingly, the women in my sample who had children took leave to become homemakers for periods of time, and when they returned, they often took what Margaret Rossiter referred to as "womanly" work. Karen Backhe (Ronæss, 1913–1992, graduated in 1936), for example, worked for nine years in the detergent industry before she left to take care of her children, born in 1941 and 1944. In 1948, three years after she became a homemaker she gave birth to a third child. The couple divorced in 1952, and Backhe took work in the library at NTH from 1954 onwards.[71] Else Margrete Stensrød (1918–?, graduated in 1943) also never returned to chemical industry but started working as a secondary school teacher after her leave, as did Astrid Gilstad (1919–1996, graduated in 1943)—a common choice for many women scientists in the first half of the twentieth century.[72] It might be that work in public libraries and schools was considered

[69] Interview Tessem.

[70] "Lange, Karin de" in *Ingeniørmatrikkelen,* 297; "de Lange, Karin" in *Studentene fra 1917: Biografiske opplysninger samlet til 30-årsjubileet 1947*, ed. Bjørn Hougen, 155–6; "Pedersen, Elisabeth" in *Ingeniørmatrikkelen*, 398.

[71] On "Womanly" or feminine jobs, see Margaret Rossiter, "Which Science? Which Women?" *Osiris* 12 (1997): 169–85. On chemical librarianship as women's work, see Margaret Rossiter, "Chemical Librarianship: A Kind of 'Women's Work' in America," *Ambix 43* (1996): 46–58. Biographical information about Karen Bakhe (Ronæs) is taken from "Ronæss, Karen" in *Ingeniørmatrikkelen*, 424 and "Ronæss, Barbara Annette Karen Anker" in *Studentene fra 1932. Biografiske opplysninger, statistikk og artikler samlet til 25-års jubileet i 1957*, ed. Tryggve Juul Møller (Oslo: Oscar Andersens Boktrykkeri, 1957), 312.

[72] Rossiter, *Women Scientists in America*, 262; Oldenziel, "Decoding the Silence". For biographies of Else Margrete Stensrød and Astrid Gilstad (Løvås), see "Stensrød, Elsa Margrete" in *Ingeniørmatrikkelen*, 484; "Stensrød, Elsa Margrete" in *Studentene fra 1938: Biografiske opplysninger, statistikk og artikler samlet til 25-årsjubileet 1963*, ed. Tryggve Juul Møller (Oslo: Oscar Andersens Boktrykkeri, 1963), 490; "Løvås, Astrid Gilstad" in

TABLE 2A

WOMEN FROM MY SAMPLE WHO WORKED IN ELECTROCHEMICAL INDUSTRIES DURING THEIR CAREERS.

Name	Period	Industry/lab
Liv Ranfrid Tessem	1928–1952	Ila and Lilleby smelting plant
Anne Lene Thorsen	1936–1937, 1939–1944	Arendal smelting plant

TABLE 2B

WOMEN WHO GRADUATED IN CHEMICAL ENGINEERING FROM NTH BETWEEN 1919 AND 1943 AND WHO WORKED IN INDUSTRY OR AT ANOTHER CHEMICAL LABORATORY NOT PART OF A UNIVERSITY OR UNIVERSITY COLLEGE FOR MORE THAN ONE YEAR. MARRIED NAMES ARE IN PARENTHESIS.

Name	Graduated year	Career after graduation
Margot Dorenfeldt (Holtan)	1919	See Table 1b
Karin Danielsen (de Lange)	1921	Studied mineralogy, geology, petrography at Bergen Museum 1923–24, bacteriology at Hansa brewery 1925–26 and in Copenhagen autumn 1930 Temporary teaching positions 1922–23, assistant with a mycologist 1924–25, chemical engineer at the Margarin factory Norway Ltd. from 1925, in Bergen until 1930, thereafter in Oslo (Kristiania – name change in 1925), assisted a professor in investigations on soil and oyster 1926–29
Liv Ranfrid Tessem	1928	Ila and Lilleby smelting plant 1928–1952, Material testing laboratory, NTH, from 1953
Turid Wik	1929	Lade factories 1929–1930, Lilleborg factories' oil mill 1930–1937, Lilleborg factories central laboratory 1937–1950, Northern Regional Research lab, Peoria Illinois, USA, 1951–1952, researcher at Norwegian Defence Research Establishment (FFI) from 1952
Jørgine Stene (Sørensen)	1929	Private assistant at NTH 1929–1935, Nidar Chocolate Factory 1936–1938, worked with her husband from 1939
Elisabeth Erika Pedersen	1930	Private assistant at NTH 1930 and for a medical doctor 1931–1939, scientific assistant at the State hatchery 1936–1946 and at Norwegian Agricultural University College 1946–1956, staff engineer at the chemical lab of Norwegian State Railways from 1956
Karen Bachke (Ronæss)	1936	Elgsæter factories 1936–1945, main library at NTH from 1954
Martha Hermine Eckbo (Blakstad)	1936	See Table 1b
Anne Lene Thorsen	1936	Arendal smelting plant 1936–1937 and 1939–1944, Compania Swift de La Plata, Argentina 1937–1939, University pharmacological institute 1944–1949, State labour inspection authority, Larvik, 1949–1951, State explosives control from 1951, senior engineer from 1956
Liv Urbye (Fernholt) (niece of Aslaug Urbye)	1939	Persil Factory, Moss 1939–1942, scientific assistant at the University of Oslo from 1954
Astrid Gilstad (Løvås)	1943	Assistant engineer, Norwegian Agricultural University College 1943–1946, laboratory engineer Nidar Chocolate Factory 1946–1958, homemaker from 1958, teacher from 1960
Anna Marcelie Johansen (Gustavsen)	1943	See Table 1b
Else Margrete Stensrød	1943	Assistant engineer, Norwegian Fruit Aroma 1943—1946, laboratory engineer, Protan Ltd. 1944–49, homemaker 1949–1958, (upper) secondary school teacher from 1958. Courses in chemistry in Stockholm 1959, teacher course in Bergen 1962

more compatible with having a family, than working in industry. Marriage could be decisive for women engineers in different ways. The last case I will analyse is a woman engineer who married another engineer and collaborated with him in science.

The married collaborator: Jørgine Stene (Sørensen) in organic and food chemistry

Jørgine Stene (1905–1997) grew up with her parents and four siblings on a farm just outside of Trondheim. She matriculated from Trondheim cathedral school in 1925 and enrolled at NTH later the same year.[73] Studying at NTH might have been a convenient choice because it allowed her to stay with her family instead of paying for a room in a new town, but it also must have required some dedication to study in a technical field. Sources provide little information about her interests in chemistry and engineering before she began her studies, but her excellent exam results at NTH show that she certainly mastered chemistry.[74] After her graduation in 1929, Jørgine Stene worked for six years as an assistant to a professor of technical-organic chemistry (Figure 5), the nutritional chemistry expert Sigval Schmidt-Nielsen (1877–1956), with whom she studied vitamin A in fish.[75] During this period, she sojourned in Lund, Sweden, to study chemical physiology under one of Schmidt-Nielsen's contacts, Professor Thorsten Ludvig Tunberg (1873–1952).[76] While working for Schmidt-Nielsen, she met her husband-to-be, Nils Andreas Sørensen (1909–1987), who was a graduate student in the same lab. He completed his engineering degree in 1933, a few years later than Stene.[77]

From 1936 to 1938, Stene (Sørensen from 1936) worked as a chemical engineer at the Nidar Chocolate Factory in Trondheim. The factory had been established in 1912, had begun production three years later, and it is still in operation. The foodstuff industry was among the branches that regularly attracted the first ten generations of chemical engineers enrolled at NTH, in addition to the electrochemical

[72] *Continued*
Ingeniørmatrikkelen, 330; "Løvås, Astrid" in *Studentene fra 1939: Biografisk opplysninger, statistikk og artikler samlet til 25-årsjubileet 1964*, ed. Tryggve Juul Møller (Oslo: Oscar Andersens Boktrykkeri, 1964), 373–4.

[73] Biographical information about Jørgine Stene Sørensen is based on the following sources: Bassøe, *Ingeniørmatrikkelen*: 505; Synnøve Liaaen Jensen and Arne Jensen, "Jørgine Stene Sørensen", *Adresseavisen* 23 April 1997 (and an extended draft given to the author by Liaaen Jensen); Aase Rye Alertsen, "Jørgine Stene Sørensen, fra et takknemlig medmenneske" in *Proffen. Nils Andreas Sørensen: En minnebok*, ed. Ketil Motzfeldt, Synnøve Liaaen Jensen and Thorleif Anthonsen (Trondheim: Tapir Uttrykk, 2009), 73–80.

[74] Raw data on female students collected by Aslaug Mølmen for the centenary of NTNU in 2010.

[75] Extended draft of Liaaen Jensen and Jensen, "Jørgine Stene Sørensen".

[76] "Sørensen, Jørgine Stene" in *Studentene fra 1925. Biografiske opplysninger og statistikk samlet til 25-års jubileet 1950* (Oslo: Bokkomiteen, 1950), 353. On Schmidt-Nielsen and his network, see Kari Tove Elvbakken and Annette Lykknes, "Relationships Between Academia, State and Industry in the Field of Food and Nutrition: The Norwegian Chemist Sigval Schmidt-Nielsen (1877–1956) and his Professional Roles," *Centaurus 58* (2016): 257–80.

[77] For biographical information about Nils Andreas Sørensen, see *Sørensiader. Et festskrift til professor dr.techn. Nils Andreas Sørensens 67-årsdag—hovedsakelig skrevet av ham selv* (NTH, 1967); Motzfeldt et al., *Proffen*; Jensen, Synnøve Liaaen, "*Nils Andreas Sørensen*" in *Norsk biografisk leksikon* at snl.no., https://nbl.snl.no/Nils_Andreas_S%C3%B8rensen (accessed 23 June 2022).

FIGURE 5. Jørgine Stene as a research chemist at NTH in 1932. For another photo of Stene in the same series, see the cover photo of this special issue. Photo credit: Nils Lystad.

industry and the pulp and paper industry. However, although Nidar experienced growth in the first decade, like other branches of industry, chocolate producers struggled in the 1920s. In addition to consumers' lack of means to buy luxury goods, a special chocolate tax was introduced in 1922, which further worsened the situation. As much as 30% of the cost of chocolate was added as a tax to increase the states' finances. Many other taxes were introduced during the same period. Reduced sales of products led to hard competition among chocolate producers, and in 1929, new share capital had to be introduced at Nidar to avoid bankruptcy. Nevertheless, the 1930s—when Stene Sørensen was working at Nidar—have been characterised as the most innovative period in the factory's history.[78] One of the products that was developed during this period was Stratos, a porous chocolate that remains popular today.[79] Stene Sørensen was among the engineers who developed the Stratos chocolate bar (Figure 6).

In 1937, the year after Jørgine Stene married her former lab mate Nils Andreas Sørensen, he was awarded the technical doctoral degree in chemistry, and in 1939, Sørensen was appointed full professor of organic chemistry at NTH after a period spent in a qualifying position. From that year on, Stene Sørensen no

[78] Stig Kvaal and Per Østby, "En høyt skattet sjokolade. Om innføringen av sjokoladeskatten i 1922, og hva den førte med seg," *Historisk tidsskrift* 96 (2017): 152–75.

[79] Stig Kvaal and Per Østby, "Something Old, Something New, Something Stolen, Something Blue: Designing a Chocolate Bar" in *Scandinavian Design: Alternative Histories*, ed. Kjetil Fallan (London: Berg, 2012), 171–87.

FIGURE 6. Jørgine Stene Sørensen (on the right) with engineer colleagues Jørgen Holmsen and Johan Christensen (on the left) at the Nidar Chocolate Factory in 1937. Both Holmsen and Sørensen were involved in the development of the porous chocolate "Stratos". Photo credit: Schrøder/Trøndelag Folk Museum.

longer pursued a career in chemical industry, but worked instead with her husband at the department of organic chemistry at NTH, and she never returned to industry or other independent employment. In 1938, Professor Sørensen and his wife travelled to Heidelberg to work with the renowned chemist Richard Kuhn (1900–1967), who one year later would be awarded the Nobel Prize in Chemistry for 1938. Stene Sørensen collaborated with her husband and Kuhn on the study of astaxanthin, the carotenoid responsible for the pink colour in salmon and lobster. A joint publication appeared in *Berichte der deutschen chemischen Gesellschaft* in 1939.[80]

Having published with a Nobel laureate must have been inspiring and rewarding, probably leading to increased opportunities for funding new projects. One project that the Sørensens initiated immediately following World War II was the study of polyacetylenes in composite plants, which the couple grew just behind the chemistry building at NTH. The chemical constituents of plants in Norway was chosen because it was considered less expensive and therefore feasible to study. The couple identified, isolated, purified, and determined the structure of these

[80] Richard Kuhn, Jørgine Stene and Nils Andreas Sørensen, "Über die Verbreitung des Astaxanthins im Tier- und Pflanzenreich, " *Berichte der deutschen chemischen Gesellschaft* B72 (1939): 1688–701.

FIGURE 7. The Sørensen couple studying the IR-spectre of a naturally occurring acetylene compound in the 1950s. Photo credit: Nils Lystad.

polyacetylenes (Figure 7), which brought international recognition and a series of publications. Over the years, Jørgine and Nils Andreas Sørensen co-authored twenty-five articles in total. Because of her contribution to the projects of other students in the lab, on which they were invited to publish independently, a former student asserted that Jørgine was involved in many more publications than she was actually credited for.[81] That she was first author of the majority of the publications with her husband indicates that she was central to the joint work—although the public image of collaboration displayed through publications can serve a representation purpose and might conceal how labour was distributed in real life.[82]

Despite her achievements, she described herself as her "husband's scientific collaborator."[83] In fact, Jørgine Stene Sørensen's work in her husband's lab was largely unpaid. However, she was sometimes paid by external funds that her husband had secured for his research projects. Although the position itself was temporary, Stene Sørensen's role as collaborator with her husband must be considered permanent. As an always available resource in the research group, Stene Sørensen

[81] Alertsen, "Jørgine Stene Sørensen."

[82] See for example Donald L. Opitz, Annette Lykknes and Brigitte Van Tiggelen, "Introduction" in Annette Lykknes, Donald L. Opitz and Brigitte Van Tiggelen, ed., *For Better or For Worse? Collaborative Couples in the Sciences* (Basel: Birkhäuser Verlag, 2012), 1–15; Jean-Jacques Dreifuss and Natalia Tikhonov Sigrist, "The Making of a Best-seller: Alexander and Jane Marcet's *Conversations on Chemistry*" in Lykknes et al., *For Better or For Worse*, 19–32; Brigitte Van Tiggelen and Annette Lykknes, "Ida and Walter Noddack Through Better and Worse: An *Arbeitsgemeinschaft in Chemistry*, in Lykknes et al, *For Better or For Worse,* 103–47. The order of authorship in joint publications was counted for a short text on the Sørensen couple for Lykknes and Gusland, *Akademi og industri*, 288–9.

[83] "Sørensen, Jørgine Stene" in *Vi fra NTH: De neste ti kull*, 306.

could take on temporary jobs on demand. One year, she served as laboratory leader of the newly established Norwegian Institute for Seaweed Research (NITT). She also took another typically "female" job as host at scientific dinner parties in the couple's home. Moreover, she was active in the Trondheim Branch of the Norwegian Chemical Society as well as in the Botanical Association, serving the scientific community in this way. In 1957, she was appointed member of the Norwegian Academy of Technological Sciences, a testimony to her standing as independent researcher in the technical sciences. The Sørensens did not have any children.

Ten of sixteen women in my population worked part of their careers in organic or foodstuff industries (Table 3a). These branches were therefore the most popular of the chemical industries among the first generation of women engineers. It is not a surprising result, since food, beverages and detergents were fields to which women belonged in the views of many.[84] Interestingly, exactly these branches of industry provided two of the women engineers from NTH with opportunities internationally. Three of the women, Stene Sørensen included, worked in chocolate factories.

Table 3b lists the five women in my sample who married engineers who were educated at NTH, three of whom were chemical engineers. As noted, Karen Bachke, who married and later divorced a peer from NTH, continued working in the chem-

TABLE 3A

WOMEN FROM MY SAMPLE WHO WORKED IN ORGANIC OR FOODSTUFF INDUSTRIES OR LABS DURING THEIR CAREERS.

Name	Period	Industry/lab
Karin Danielsen (de Lange)	1925 onwards	Chemical engineer at the Margarin factory Norway Ltd.
Turid Wik	1929–1930	Lade factories
	1930–1937	Lilleborg factories' oil mill
	1937–1950	Lilleborg factories central laboratory
	1951–1952	Northern Regional Research lab, Peoria Illinois, USA
Jørgine Stene (Sørensen)	1936–1938	Nidar Chocolate Factory
Elisabeth Erika Pedersen	1936–1946	Scientific assistant at the State hatchery
	1946–1956	Scientific assistant at Norwegian Agricultural University College
Karen Bachke (Ronæss)	1936–1945	Elgsæter factories
Anne Lene Thorsen	1937–1939	Compania Swift de La Plata, Argentina
	1944–1949	University pharmacological institute
Martha Hermine Eckbo (Blakstad)	1937–1939	Chemist at Freia chocolate factory
	1940–1943	Chemist at the Ministry of Supplies
Liv Urbye (Fernholt) (niece of Aslaug Urbye)	1939–1942	Persil Factory, Moss 1939–1942
Astrid Gilstad (Løvås)	1943–1943	Assistant engineer, Norwegian Agricultural University College
	1946–1958	Laboratory engineer Nidar Chocolate Factory
Anna Marcelie Johansen (Gustavsen)	1943–1950	Chemist at Jahre chemical factories
	1951 onwards	Sandar factories

[84] Margaret Rossiter states that women scientists in the 1920s and 1930s in the USA had most success in the food and home products industry. Rossiter, *Women Scientists in America*, 258.

TABLE 3B

ENGINEER COUPLES: WOMEN WHO GRADUATED AS CHEMICAL ENGINEERS FROM NTH BETWEEN 1919 AND 1943 AND MARRIED ENGINEERS. MARRIED NAMES ARE IN PARENTHESIS.

Name	Graduated year	Career after graduation
Margot Dorenfeldt (Holtan)	1919	See Table 1b
Jørgine Stene (Sørensen)	1929	See Table 2b
Karen Backhe (Ronæss) (divorced in 1952)	1936	See Table 2b
Liv Urbye (Fernholt) (niece of Aslaug Urbye)	1939	See Table 2b
Inger Ryssdal (Graff)	1943	Assistant test farm Holt near Tromsø for a short while; homemaker from 1944

ical industry until her second child was one year old, but took "womanly" work when she sought employment after a break. Liv Urbye (1915–2002), who also married a fellow engineer who was educated at NTH (but not in chemistry), continued her career, except for a twelve-year leave, during which time she was probably a homemaker. Interestingly, she was the niece of the first female student at NTH, Aslaug Urbye, whom I introduced at the beginning of this article. It is possible that Aslaug Urbye's story prompted Liv Urbye to pursue the career her aunt never had. Inger Ryssdal (1918–2014), who married a mining engineer, however, left working life shortly after she graduated from NTH.

Discussion

Sixteen women graduated as chemical engineers from NTH before 1944. Like the young men who were admitted to NTH, these women knew they were privileged. In addition, they must have felt special because they were part of a minority of women at the institute and were often the only woman in their year. In 1934 and 1950, biographical entries of students in the two first decades (until 1930) were published under the title *Vi fra NTH* (we from NTH), signalling the identity of "we," distinct from other youth in Trondheim and from other students in Norway. The majority were young males who saw themselves as men of their time who would later take up important, well-paid positions in society.[85]

To what extent were the women included in the collective identity of "We from NTH," as students and later in working life? Judging from the first volume, which included biographies of students in the first ten years (1910–1920), they were not seen as part of the "we." Indeed, in his reminiscence, the first leader of the student society, Edgar B. Schieldrop (1891–1965), remarked that only one person in the class could not grow a beard, referring to Aslaug Urbye, who had never

[85] Brandt og Nordal, *Turbulens og tankekraft*, 119.

completed her studies.[86] Unfortunately, there is little archival material that might help shed light on how the women who came after Urbye experienced being a woman at NTH. However, the sources we have on some of the women in this study indicate that some managed to position themselves as "one of the guys," to borrow Amy Bix's phrase.[87] However, as women engineers in groups dominated by men, they might in some circumstances have taken roles as what Rosabeth Moss Kanter has denoted "tokens," that is, being regarded as representatives or symbols of women as a group, rather than individual engineers or engineering students.[88] Consequences of being looked upon as tokens include increased visibility and increased polarisation. Being "one of the guys" could be one strategy to blend in rather than being extra visible as women.

Margot Dorenfeldt can perhaps be described as someone blending in, in the sense that she became an intrepid debater in the student bulletin. On the other hand, as a woman she was probably more visible than her male peers, and her election to the board of the student society without her consent might be an expression of exactly a token effect; she was noticed more than her male peers because she was one of few women. Indeed, it is plausible to ask whether the same courtesy could have been extended to a male student. Elisabeth Erika Pedersen, on her side, found that the atmosphere in the lab in her student days was congenial, and the tone respectful even when criticism was raised. As Jan Thomas Kobberrød has suggested, the male student population in Trondheim seems to have accepted and respected their female peers more than women elsewhere in the town and in society.[89] The light teasing that some of the women after Aslaug Urbye's time experienced can be understood as exactly a sign of respect, and an act of appreciation. It is possible that the male engineers brought this attitude with them into their working lives.

One purpose of conducting prosopographical analyses is to identify common traits within a population. One characteristic that many of the first generation of women engineers at NTH shared was that they were helped by family members or mentors. There are many examples of women who have been supported by fathers and brothers in their pursuit of higher education. The first woman to matriculate in Norway, for example, was able to do so because her father raised the issue on her behalf.[90] In Switzerland, a similar initiative was taken by a group of mothers.[91] Fathers, brothers, and mothers have also served as role models and

[86] Edgar B. Schieldrop, "Vi fra 1910," in *Vi fra NTH: De første ti kull*, 7–10 (on 7).

[87] Amy Sue Bix, *Girls Coming to Tech! A History of American Engineering Education for Women* (Cambridge, MA: MIT Press, 2013), 17. "Acting like one of the boys" is also described in contemporary studies, as a strategy for women engineers to "undo gender". See Abigail, Powell, Barbara Baghilhole and Andrew Dainty, "How Women Engineers Do and Undo Gender: Consequences for Gender Equality," *Gender, Work and Organization* 16 (2009): 411–28.

[88] Rosabeth Moss Kanter, "Some Effects of Proportions on Group Life; Skewed Sex Rations and Responses to Token Women," *The American Journal of Sociology* 82 (1977): 965–90, reproduced in *Small Groups: Key Readings in Social Psychology*, ed. John M. Levine and Richard L. Moreland (New York: Psychology Press, 2006), 37–54.

[89] Kobberrød, *Engasjement og begerklang*, 155.

[90] Anna Caspari Agerholt, "Kampen om adgang til høiere utdannelse" in *Kvinnelige Studenter 1882–1932* (Oslo: Gyldendal, 1932), 41–78 and 52–63.

moral supporters.[92] Aslaug Urbye was accompanied to the male-only inauguration ceremony at NTH by a man who was most likely her brother. Liv Tessem remembered that her father wanted her to have a good education and sent her off to go to school in other towns. Five of the women even had fathers who were engineers or science professor, who could support their choices and provide them with employment or good contacts. They also had first-hand experiences with the profession their daughters aspired to and could identify with work-related issues that were not related to gender. Margot Dorenfeldt also had a mother who had studied technical chemistry, who was interested in the field and knew what it was like to be a woman in a technical and male-dominated environment. Family background mattered irrespective of parents' professions, however, and women who enrolled at NTH all came from privileged backgrounds. With the exceptions of Jørgine Stene and Astrid Gilstad, whose fathers were farmers, all women in this study were from a middle-class or upper middle-class background.

If women did not grow up in an engineering or scientist's family, it was possible to marry into one. For women who were already employed when they married, marriage could however be a threat to their careers, while for others, it provided an impetus.[93] Indeed, one well-known way of obtaining support to do research for women in chemistry, as in other sciences, was through marriage. For Dorenfeldt Holtan, both her father and her husband provided her with opportunities in the pulp and paper industry. Stene Sørensen benefited from her chemistry professor husband's network, which brought her in contact with a Nobel laureate and gave her access to a lab and research funds. For Karen Bachke, her engineering career stopped when she had children and divorced her engineer husband.[94] Taking on work in the university library was probably a meaningful and relevant job and at the same time work that was easier to combine with being a single parent.

Unsurprisingly but nevertheless interesting: Most of the women who stayed in chemical industry for many years never married: Liv Tessem, Turid Wik, Elisabeth Erika Pedersen and Anne Lene Thorsen remained single and therefore escaped the "ideology of marriage," and with it, the difficulties of combining family life and a career.[95] Instead they were free to travel abroad to take the opportunities they were offered. Anna Marcelie Johansen, whose father was an engineer, was the only one

[91] Natalia Tikhonov, "Le rôle des parents dans l'accès de jeunes filles à l'enseignement supérieur en Suisse à la fin du XIXe siècle" in *Lorsque l'enfant grandit: Entre dépendance et autonomie*, ed. Jean-Pierre Bardet, Jean-Noël Luc, Isabelle Robin-Rouiero and Catherine Rollet (Paris: Presses de la Sorbinne, 2002), 505–20.

[92] Women engineers who graduated from college in the 1970s have also highlighted the importance of encouragement by family members, friends, teachers or counsellors for their decision to pursue engineering. Ettinger et al., "What Late-Career and Retired Women Engineers Tell Us."

[93] Lykknes et al., *For Better or For Worse?*

[94] The Swedish botanist, chemist, and geologist Astrid Cleve, who collaborated with her husband Hans von Euler-Chelpin, also lost her career as a consequence of divorce. Kristine Espmark and Christer Nordlund, "Married for Science, Divorced for Love: Success and Failure in the Collaboration Between Astrid Cleve and Hans von Euler-Chelpin" in Lykknes et al., *For Better or For Worse?*, 81–102.

[95] Pnina G. Abir-Am and Dorinda Outram, "Introduction" in *Uneasy Careers and Intimate Lives: Women in Science, 1789–1969*, ed. Pnina G. Abir-Am and Dorinda Outram (New Brunswick, NJ: Rutgers University Press, 1987), 1–16.

who returned to the chemical industry permanently after a period as a homemaker in the 1950s. She had one child. Johansen even pursued her studies by taking additional courses in Stockholm and Freiburg in the 1960s. Liv Urbye got a research assistantship at the University of Oslo when she returned from her leave.

Another kind of mentorship that emerges from the sixteen cases from NTH, is that of the professor and his student. Liv Tessem's metallurgy professor, for example, helped her get a job in the chemical-metallurgical industry during the difficult 1920s. Turid Wik, who graduated in 1929, was in the fortunate situation of having obtained an assistantship with one of her chemistry professors immediately after graduation, which likely helped her gain a foothold in the soap/fat industry in Trondheim, similar to Jørgine Sørensen. The first two women chemical engineers graduating from NTH, Margot Dorenfeldt and Randi Holwech, were even sponsored by a female professor, Ellen Gleditsch, who helped them obtain positions, either at the university or in Marie Curie's laboratory in Paris. Renate Tobies and Annette Vogt also found that patronage relationships were crucial for women to get positions in industrial laboratories in the early twentieth century.[96]

As assumed at the beginning of this prosopographical project, no typical female engineer was educated at NTH during the first three decades of its history. Nevertheless, some factors unite the first cohorts of women chemical engineers who graduated after NTH's establishment in 1910: their privileged socio-economic backgrounds, support, inspiration or patronage from fathers, mothers, husbands, or professors. Although a few might have "borrowed" their fathers' identities and selected a study that they were not passionate about, for most of the women engineers who had access to this kind of mentorship, patrimonial patronage and matrimonial sponsorships guided their professional careers.[97] The seven women engineers whose fathers or husbands were not from within science and engineering had nevertheless support from their families, on top of dedication of their own.

What distinguishes the stories of the Norwegian women engineers in this period from those of women in other countries are the special circumstances surrounding the establishment of the Norwegian Institute of Technology and the expectations it raised in society. The candidates who embarked on an engineering course at NTH, who outnumbered the women who chose to study chemistry at the university, were well aware of the privilege and status that were associated with being among "the flower of the youth of the nation," and the responsibility for building the new nation-state that would lie on their shoulders. Like other women on new ground, those who studied at NTH needed to be determined, and in some circumstances even steadfast and fearless, but they also needed people who supported and encouraged them. I suggest that the barriers associated with women and engineering mobilised ambitious women who had role models and sponsorship within their

[96] Renate Tobies and Annette B. Vogt, „Introduction" in Renate Tobies and Annette B. Vogt, ed., *Women in Industrial Research* (Stuttgart: Franz Steiner Verlag, 2014), 1–24.

[97] The terms "patrimonial patronage" and "matrimonial sponsorships" are borrowed from Oldenziel, "Decoding the silence".

families because of the elite status and opportunities to which an engineering education led. Studying chemistry was considered scientific work that was suitable for women, whereas the realm of dirt associated with the shop floor was seen as more masculine. I therefore conclude that studying chemical engineering at NTH was an "enabling historical circumstance"[98] that potentially led to an exciting and socially beneficial occupational pathway.

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[98] Lisbeth Koerner, "Women and Utility in Enlightenment Science," *Configurations* 3 (1995): 233–55.