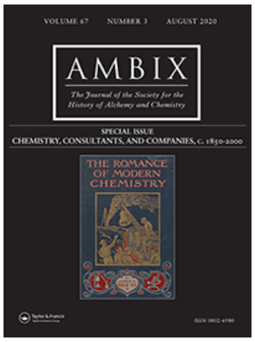

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The Chemistry Professor as Consultant at the Norwegian Institute of Technology, 1910–1930

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The Norwegian Institute of Technology (NTH) was established in Trondheim in 1910, shortly after the country had gained its independence from Sweden. The establishment of NTH coincided with the beginning of large-scale industry in Norway, and expectations were high as to what the Institute could contribute in terms of competence to establish new industries. Its professors were expected to be not just teachers or academics, but also to be involved in projects with industry. Consultancy was one way of exercising authority in relevant areas, and to acquire experience with industrial projects. Historical accounts about NTH often mention that its professors were consultants for industry, but what this entailed is rarely discussed. In this paper, I will investigate how two chemistry professors, appointed around 1910, formed their roles as consultants: Peder Farup, who experimented with the pigment titanium white for the successful company Elektrokemisk (now Elkem) in the 1910s; and Sigval Schmidt-Nielsen, who became the country's authority on nutrition, and served both the state and the margarine industry as a consultant from World War I into the 1930s. I will argue that both Farup and Schmidt-Nielsen created "hybrid careers," using a concept introduced by Eda Kranaki in 1992.

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Introduction

The expectations were high when the Norwegian Institute of Technology, *Norges tekniske høiskole* (NTH), was founded in Trondheim in 1910.[1] It was the first time that Norwegians could train as engineers at such an advanced level in their own country, some forty years after *Technische Hochschulen* had been established in Germany, and almost seventy years since it had first been proposed that a polytechnic institution should be established in Norway. The new institute was much celebrated: the king was present at the inauguration, flags were waved, and schools and shops were closed so that the people of Trondheim could take part in the festivities. A century earlier, the country's first university, the Royal Frederick University at Kristiania (later named the University of Oslo), had been founded, at about the same time as the country gained its independence from Denmark. When NTH was founded, Norway was still young and bursting with national pride. In 1896 the scientist and explorer Fridtjof Nansen was celebrated as a national hero upon his return from his polar expedition to the Arctic and became a symbol of what the new nation state could achieve.[2] It was an era of optimism, not only because of the country's recently gained independence, but also because of the belief that its prosperity would be based on knowledge production and industrial development. The establishment of NTH coincided with the emergence of a large-scale Norwegian industry based on hydro-electric power, and the utilisation of ore and metal smelting as well as electrochemistry were considered particularly promising. Like the university, which had become important for educating the experts and leaders the new nation needed in the early nineteenth century, NTH would play a central role in industrial development from the early twentieth century by training the professionals necessary to establish new industries, and build the new country.[3] Naturally, its professors would have a role in fulfilling this purpose.

How should this ambition be achieved in practice? The rector Sem Sæland, in his very first speech at the inauguration of NTH in September 1910, declared that in order for the Institute to become more than a teaching institution, it must be used as a site for experimentation and independent work. New possibilities for industry

[1] As Thomas Brandt discusses, the translation of NTH is problematic. Brandt, who co-authored the history of NTH for its centenary in 2010, prefers "Technical College" to "Norwegian Institute of Technology," which references the Anglo-American standards adopted after World War II. I will use the latter (abbreviated to NTH) because it is the most widely used translation in the international literature, and also because "Technical College," in my view, does not capture the Institute's academic ambitions voiced both when the Institute was being planned, and when it was eventually established. See Thomas Brandt, "1968 as a Turning Point in Trondheim's University History," in *University Jubilees and University History at the Beginning of the 21st Century*, ed. Pieter Dhondt (Leiden: Brill, 2015), 129–62.

[2] Robert Marc Friedman, "Nansen, National Honour and the Rise of Norwegian Polar Geophysics," in *Perspectives on Scandinavian Science in the Early Twentieth Century*, ed. Reinhard Siegmund-Schultze and Henrik Kragh Sørensen (Oslo: The Norwegian Academy of Science and Letters, 2006), 85–100; Robert Marc Friedman, "Civilization and National Honour: The Rise of Norwegian Geophysical and Cosmic Science," in *Making Sense of Space: The History of Norwegian Space Activities*, ed. John Peter Collett (Oslo: Scandinavian University Press, 1995), 3–39.

[3] Thomas Brandt and Ola Nordal, *Turbulens og tankekraft: Historien om NTNU* (Oslo: Pax, 2010); Annette Lykknes and Joakim Ziegler Gusland, *Akademi og industri: Kjemiutdanning og -forskning ved NTNU gjennom 100 år* (Bergen: Fagbokforlaget, 2015).

had to be created at NTH, he proclaimed.[4] A contribution from engineering professors to industrialisation was in keeping with the traditions of the *Technische Hochschulen* in Germany, on which NTH was modelled, and many professors in Germany were involved in commercial work of some kind, in architecture, (photo)-chemistry, mechanical engineering, and electrical engineering.[5] Consulting seems to have been a common activity of professors in many countries, and a fairly widespread one.[6] However, consulting practices developed within national contexts; at NTH they responded to the industrial needs of the country.

In order to shed light on the budding consultant practices at the Institute, I have selected two of the first professors to be appointed in chemistry at NTH as case studies. Their careers were rather different: Peder Farup was a consultant in the electrochemical industry and was involved with the development of the titanium white pigment, while Sigval Schmidt-Nielsen assisted the government with chemical and nutritional expertise during a shortage of fats during World War I, and later served as a consultant for, among others, the margarine industry. I will look at how they shaped their work both as professors and as consultants in the early decades of the Institute, how they approached their occupation as consultants, and to what extent these roles answered the expectations articulated even before NTH was inaugurated. I will use Eda Kranakis' idea of "hybrid careers," which characterises engineer-scientists or scientist-engineers as not having a primary and secondary field between which they alternate, but rather hybrid repertoires of practices that encompass both academic and industrial activities.[7] Hybrid careers bring together elements from different realms into new coherent fields or practices, which then become stimuli to creativity and innovative knowledge. Furthermore, such careers can become rooted in organisational structures, allowing new practices to become socially reproduced. To what extent, then, did the two professors, Farup and Schmidt-Nielsen, succeed in establishing for themselves such hybrid careers?

Since the Institute was newly established, the ways in which these professors would fill their roles as professors was open to interpretation. Each had to find his path between, and his identity within, academe and industry in Norway. Comparing Farup and Schmidt-Nielsen, I will argue that, although Schmidt-Nielsen

4 NTNU Central Archive (NTNU Hovedarkivet), Rector Speeches, Sem Sæland's speech at the enrolment 15 September 1910.

5 Wolfgang König, "Engineering Professors as Entrepreneurs: The case of Franz Releaux (1829–1905) and Alois Riedler (1859–1936)," *History and Technology* 33 (2017): 53–69; Joris Mercelis, "Commercializing Academic Knowledge and Reputation in the Late Nineteenth and Early Twentieth Centuries: Photography and Beyond," *History and Technology* 33 (2017): 23–52.

6 Joris Mercelis, Gabriel Galvez-Behar and Anna Guagnini, "Commercializing Science: Nineteenth- and Twentieth-Century Academic Scientists as Consultants, Patentees, and Entrepreneurs," *History and Technology* 33 (2017): 4–22; Anna Guagnini, "Ivory Towers? The Commercial Activity of British Professors of Engineering and Physics, 1880–1914," *History and Technology* 33 (2017): 70–108.

7 Eda Kranakis, "Hybrid Careers and the Interaction of Science and Technology," in *Technological Development and Science in the Industrial Age*, Boston Studies in the Philosophy of Science, ed. Peter Kroes and Martijn Bakker, vol. 144 (Dordrecht: Springer, 1992), 177–204.

adhered more closely to traditional scientific ideals than Farup,[8] both professors succeeded in bridging, even mixing, industrial and academic realms. By bringing together complementary competencies and skills from their training and experience, they created new repertoires of practice that contributed to legitimise NTH as a higher education institution for scientific and technical training in service to the nation-state. These new repertoires could be passed on to new generations of candidates educated at NTH, thus creating spaces for emerging hybrid fields adjusted to a Norwegian industrial and national context.

Peder Farup: electrometallurgy and titanium pigments

Peder Farup (1875–1934) was the first chemistry professor to be appointed at NTH. Along with professors from other fields he was employed as early as November 1909, almost one year before the inauguration of the Institute. During his first year, Farup's main task was the equipment of the chemistry laboratories and the preparation of the curriculum for the first academic year, which started in autumn 1910.[9]

Farup had been selected from five applicants for the professorship of inorganic chemistry. He had originally trained as a pharmacist, but after a few years of practice, he decided, like many Norwegians before him, to go to Germany for further study. As he explained many years later, he had discovered the relatively new science of physical chemistry and decided to pursue a PhD in this field.[10] In 1902 he completed his PhD under one of the founders of physical chemistry, Walther Nernst, who was at Göttingen at the time. In the following year, Farup also worked with another pioneer in physical chemistry for a few months, the 1901 Nobel laureate Jacobus van't Hoff, in Berlin.[11] These international authorities gave Farup a sound scientific training; and his many scientific publications as well as his "energy" and ability to develop scientifically were emphasised by the committee that assessed him for the professorship. He was reckoned to be gifted both in science and technology, a modern chemist with a "strong urge to do independent research."[12]

Before coming to NTH and Trondheim, Farup had been an assistant at the metallurgical laboratory of the university in Kristiania, where he was working for professor Johan H. L. Vogt. In 1907, two years before Farup took up the professorship in Trondheim, both he and Vogt were appointed to a government committee, which had been created at the instigation of the former owner of an iron foundry, Albert

8 Sigval Schmidt-Nielsen, "Kan reagensglass anvendes ved studiet av industrielle problemer? Foredrag ved Svenska Pappers- & Cellulosaingeniörsföreningens möte i Stockholm 29 February 1926," *Svensk Papperstidning* (1926): 7–8 [22 pp.], NTNU University Library, Samlede Verker (collected works; offprint), compiled by Sigval Schmidt-Nielsen, 7 vols. Hereafter Samlede Verker.

9 Lykknes and Gusland, *Akademi og industri*, 87–91.

10 "Farup, Peder," in *Studentene fra 1904. Biografiske oplysninger samlet til 25-års jubileet 1929* (Oslo: Grøndahl & Søn, 1929), 103.

11 Gunnar Nerheim, "Farup, Peder," in *Norsk biografisk leksikon*, ed. Jon Gunnar Arntzen, vol. 3 (Oslo: Kunnskapsforlaget, 2011), 71; Lykknes and Gusland, *Akademi og industri*, 90–91.

12 Riksarkivet (Public Record Office, hereafter RA), Ministry of Church and Education, 2. Skolekontor E, E-Sakarkiv ordnet etter emne, Ea-Universiteter og høyskoler, Norges Tekniske Høyskole, L0092: Ansettelser I Kjemi 1909–1909, Saksmappe, "Utnevelse av dr.philos: Peder Farup til professor i kemi ved den tekniske höiskole."

Hiorth, and his son Fredrik, and which would report on the possibilities of electro-metallurgical production of iron in the country. The idea of the production of iron had been revived following the development of large-scale hydro-electric power stations and the establishment of electrochemical and electrometallurgical industries around the turn of the twentieth century. After the closure of the iron works from the 1860s to the 1880s, large amounts of iron ore had been exported, and the products refined from them – iron and steel – imported. With a new smelting technology, cheap hydro-electric power, and an abundance of iron ore, the time seemed ripe for iron production on Norwegian ground, which could demonstrate that independent Norway was a modern industrial nation. Furthermore, such an industry could be a model for other electrochemical or electrometallurgical industries in the country.[13]

The electrometallurgical committee consisted of three experts with complementary areas of expertise: the electrical engineer Christian August Thorne, geologist and metallurgist Johan H. L. Vogt, and Farup, the chemist. Farup was suggested as a valuable member for the committee by Vogt, who appreciated Farup's experience with chemical analysis and chemical processes at high temperature, and the scientific and technological skills he had acquired through his training and experience at the metallurgical laboratory.[14] In 1911, the committee recommended the production of raw iron in Tyssedal, on the west coast of Norway. However, the technology failed, stranding the project, and the smelting plant closed in 1913, after less than two years of production.[15]

Nevertheless, the comprehensive work that had been conducted by the electrometallurgical committee turned out to be useful for other projects. During their investigation into iron production the committee became aware of the large deposits of titanium-rich iron ores, known by the name of ilmenite (Figure 1), in the south-western part of the country. Ores rich in titanium were not suitable for the production of iron, so the question arose: how could one use the titanium content of these ores? Industrialists such as San Eyde, the founder of The Norwegian Electrochemical Industry Corporation (hereafter Elektrokemisk), were looking for new uses for hydro-electric power. Natural resources had always been important for the country's economy, and the new power plants gave rise to new opportunities for the use of these resources. Elektrokemisk, founded in 1904, would be a symbol of this new industrial era in Norway.[16] To take advantage of the wide occurrence of titanium in Norway, the three industrialists Sam Eyde, Albert Petersson and Gustav Jebsen decided to hire Farup to benefit from his analytical-chemical expertise in separating

[13] Frode Sæland, "Titansaken – Peder Farup, Gustav Jebsen og innovasjonen titanhvitt 1907–1920," in *Kulturvern ved Bergverk 2010: Rapport fra et nasjonalt seminar på Modum*, ed. Per Øyvind Østensen (Kongsberg: Norsk Bergverksmuseum, 2011), 5–32; Lykknes and Gusland, *Akademi og industri*, 153–54. See also Anne Kristine Børresen, "Drømmer av stål. A/S Norsk Jernverk fra 1940-årene til 1970-årene" (PhD thesis, University of Trondheim, 1995).

[14] Lykknes and Gusland, *Akademi og industri*, 154.

[15] Anne Kristine Børresen, *Bergtatt: Johan H. L. Vogt – Professor, rådgiver og familiemann* (Trondheim: Tapir akademisk forlag, 2011), 295–6; Sæland, "Titansaken – Peder Farup." For the committee's reports, see Den elektrometallurgiske komité, *Elektrisk jern- og staalsmeltning: Første del av indberetning* (Kristinia: Aschehoug & Co., 1911); J. H. L. Vogt, *Norges jernmalmforekomster: Anden del av indberetning* (Kristiania: Aschehough & Co., 1910).

[16] Knut Sogner, *Skaperkraft: Elkem gjennom 100 år* (Oslo: Messel forlag, 2008).

FIGURE 1 Ilmenite, rich in iron and titanium, was the starting material for the production of titanium white pigment, which was co-organised by Peder Farup, professor at NTH. The samples shown in the picture are from the historical collections of the Department of Chemistry at NTNU. © NTNU/ Åge Hojem, NTNU University Museum.

titanic acid from the ore and determining its relative weight in samples. This work began while Farup was still working for the electrometallurgical committee. Sometime during the winter of 1908/1909 Farup discovered that the ore could produce red and yellow pigments with very good coverage. The colours could not be obtained from iron alone, so that they were referred to as "titanium colours" or "iron-titanium colours."[17]

These initial investigations for Eyde, Petersson, and Jebsen turned out to be crucial for Farup's research at NTH and beyond. During his first semester at the Institute, together with Jebsen (who became his collaborator), Farup set out to investigate the possibility of the industrial production of titanium red and yellow pigments. This work was at first conducted at the research station in Kristiania that belonged to Eyde's company Elektrokemisk, and in 1910 that work resulted in three patents for Farup relating to the production of titanium colour pigments.[18] In February 1910, to start the process of commercialisation, Eyde, Jebsen, Petersson, and Farup founded A/S Norske Titanfarveverker (Norwegian Titanium Works, Inc.) as a subsidiary of Elektrokemisk. The company took ownership of Farup's patents. Another company was established to ensure the availability of raw material for the production of the titanium pigments. Farup developed and tested the chemical processes for the production of titanium colours, including crushing, separating, roasting, elutriating, and drying. He also began to plan an elutriation apparatus.[19] In the end, however, the production of yellow and red titanium pigments was too

17 Lykknes and Gusland, *Akademi og industri*, 153–57.
18 Sæland, "Titansaken – Peder Farup."
19 This information was retrieved from an unpublished article "Titansaken" by Frode Sæland, whom I would like to thank for providing me with a copy of the same. The process is also described in Lykknes and Gusland, *Akademi og industri*, 157.

expensive to be profitable. Norwegian titanium red could not compete with iron red on the market, and the production of titanium yellow was not commercially worthwhile either. Nevertheless, Farup continued working on these pigments from his laboratory in Trondheim. In parallel with these investigations, Jebsen coordinated investigations into the production of titanic acid and white, as well as light titanium colours. Farup and Jebsen found the coverage of titanium white to be reasonably good but not good enough, besides it produced a yellow undertone. Therefore the development of processes for its production was not prioritised at first.[20] However, experimentation continued as a side project.

Throughout 1911, his first full calendar year of teaching at NTH, Farup was busy working on the yellow pigment and must have been absent over long periods from his duties at NTH.[21] In the following year he expanded his investigations and mainly worked on three projects: the production of sulphuric acid (also from ilmenite), the production of titanic acid and white titanium colours, and the production of non-white titanium colours.[22] Titanium white pigment was considered worth developing further since there was a large demand for white pigments worldwide. The two main competitors, lead white and zinc white, both had disadvantages – lead white was toxic, and zinc white achieved poor coverage – so the idea was to fill this gap in the market with titanium white.[23] During 1912–1913, Farup developed a method that seemed promising, with extremely good coverage, especially in oil.[24] However, the process was found to be so complicated and expensive, and its potential so low, that A/S Norske Titanfarveverker had to close down in September 1913. Elektrokemisk, the mother company, took over. Farup's expertise, however, was valued as much as before, and Elektrokemisk contracted him as a consultant.

Farup's new contract was lucrative. He nearly doubled his income – to his annual income of 4500 Norwegian kroner as professor was added another 4000 Norwegian kroner from Elektrokemisk – and in return he applied his expertise to ideas presented to him by the company, or to his "own inventions."[25] The development of a process for the production of titanium white continued, now under the name "the titanium case." From 1914–1915 onwards, however, new engineers were hired to work on this project and Farup, who could not devote all his time to working for Elektrokemisk, was no longer in command. He contributed to subprojects such as enriching titanic acid, and testing the durability of the white colour, but he also

[20] Sæland, "Titansaken" (unpublished manuscript).

[21] Archives of the Norsk Bergverksmuseum (the Norwegian mining museum, hereafter BMV-A), Peder Farups etterlatte papirer [papers from Peder Farup] 1910–1930, box 1, diverse rapporter, "Indberetning I: Titangult," January 1912.

[22] Reports in BMV-A, Peder Farups etterlatte papirer 1910–1930, box 1, diverse rapporter; box 2, rapporter og korrespondanse; box 3.1, korrespondanse. See also Lykknes and Gusland "Akademi og industry," 157–58.

[23] See Laurence Lestel, "The Banning of White Lead: French and International Regulations," in *Hazardous Chemicals: Agents of Risk and Change, 1800–2000*, ed. Ernst Homburg and Elisabeth Vaupel (New York and Oxford: Berghahn, 2019), 87–106.

[24] BMV-A, Peder Farups etterlatte papirer 1910–1930, box 2, rapporter og korrespondanse, "Meddelelse III."; G. Jebsen, "Den nye norske titanhvitt-industri," *Tidsskrift for kemi* 17 (1920): 41–58.

[25] BMV-A, Peder Farups etterlatte papirer 1910–1930, box 3.5, korrespondanse, Avsendte brev Elektrokemisk, Promemoria for Kontrakt mellom Professor Farup og Det Norske A/S for Elektrokemisk industri.

worked on other projects.[26] In 1916, for example, Farup was involved with at least four projects for Elektrokemisk: the titanium case, the dry reduction of iron ore, soot powder, and briquetting. Most of his investigations were carried out over the course of several years.[27] In the end, titanium white turned out to be a product worth its while, and the company Titan Co., which was established in 1916, became the world's first manufacturer of titanium white based on the so-called sulfate process.[28]

By the time the process was scaled up and developed for commercial use, Farup had resigned from his position as a professor at NTH. His health was declining, and when faced with the choice between teaching and innovation it was probably easier for him to opt for the latter. Moving to Kristiania also brought him closer to his family. There, he established a private research laboratory and continued as a consultant for Elektrokemisk until he died,[29] working mainly on iron reduction and sulfuric acid.[30] In 1925 he re-entered academia, this time as professor of pharmacy at his *alma mater* in Oslo, the former Kristiania. Seven years into his second professorship, however, he resigned and started practising as a pharmacist again. In 1934 he died from tuberculosis of the lungs.[31]

The two professors I have selected for my case studies practiced in distinct areas of chemistry, and led quite different careers. As we have seen, Peder Farup worked as consultant on the development of a new commercial product, held patents for his inventions and left NTH after only a decade. In contrast, Sigval Schmidt-Nielsen practiced at the Institute almost all his life, and exercised his authority as expert to give advice, develop a fat substitute, and control products for state and industry.

Sigval Schmidt-Nielsen: whale margarine and the fats industry

In 1913 Sigval Schmidt-Nielsen (1877–1956) was the fourth chemistry professor to be appointed after the establishment of NTH. The professorship was in technical-organic chemistry, one of two professorships in *technical* chemistry. In contrast to the professorships in organic chemistry and inorganic chemistry, those in technical-organic and technical-inorganic chemistry were concerned with technical processes for chemical industries. The position for which Schmidt-Nielsen applied included nutritional chemistry and the conservation of nutrients; the sugar, starch, and yeast industries; the colourings, fat and, oil industries; destructive distillation; and petroleum and explosives. When he was evaluated for the professorship, Schmidt-Nielsen was particularly praised for his expertise in the enzyme and yeast industries,

26 Lykknes and Gusland, *Akademi og industri*, 159–60.
27 BMV-A, Peder Farups etterlatte papirer 1910–1930, box 3.4, G. Jebsen to P. Farup, 17 April 1916; box 3.2, Farup to Elektrokemisk, 23 April 1916.
28 Gunnar Nerheim, "Jebsen, Gunnar," in *Norsk biografisk leksikon* (Foreningen SNL, 1999–2005; online ed., 2009), https://nbl.snl.no/G_Jebsen (accessed 4 June 2020); Sæland, "Titansaken" (unpublished manuscript).
29 BMV-A, Peder Farups etterlatte papirer 1910–1930, box 4, diverse rapporter, H. Olsen to P. Farup, 19 December 1919.
30 Frode Sæland, private communication, 15 April 2019.
31 Bjørn Johannessen, "Peder Farup – vår første professor i farmasøytisk kjemi," *Cygnus* 6 (2001): 15–26.

in canned food, fish products, and nutrition.[32] Like Farup, initially he was busy setting up his research and teaching laboratories, and establishing a study programme within his field. He thus found little time for research.

Before coming to NTH, Schmidt-Nielsen had trained in technical chemistry at the Trondhjems Tekniske Læreanstalt (Trondheim Technical School) and held short-term posts in government institutions before taking up further study in microscopy, bacteriology, microbiology, and physiological chemistry in Kristiania (Oslo), Stockholm, Uppsala, Copenhagen, as well as in Germany, Belgium, and Switzerland. In 1901 he completed a doctoral thesis at Basel on fermentation and fats in herrings,[33] and between 1904 and 1907 was lecturer at Stockholms Högskola (Stockholm University College) in the new discipline of biochemistry. In Sweden, he met and married the Swedish physicist Signe Sturzen-Becker (1878–1959), who would be his collaborator, and they subsequently moved to Kristiania, where Sigval Schmidt-Nielsen had been appointed assistant lecturer at the university.

In 1908 Schmidt-Nielsen's responsibilities were expanded, and he was given the role of "state chemist" in affiliation with the Department of Hygiene at the university, which had from the very beginning strong ties with the health authorities.[34] As state chemist he would be involved, among other things, in analyses of drinking water and questions related to the adulteration of, or hygiene requirements for, food. In his work Schmidt-Nielsen always considered health concerns over industrial needs, and was concerned particularly with probity in food production and in the food trade. The consumer should trust, he believed, that the product he bought was what it promised to be.[35] For twenty-four years he was engaged in work on the establishment of food control legislation in Norway, which legislation was eventually passed in 1933, twenty years after he had been appointed to professor at NTH.[36] As we shall see, his work as a state chemist would continue while he was a professor. In his capacity as a professor of technical-organic chemistry he became the country's authority on nutritional chemistry, which led him to take on new roles in the service of both the state and industry. And while Farup left the Institute after ten years, Schmidt-Nielsen would serve there until he retired in 1945. This gave him time to settle as consultant for both the state and industry, and consolidate his authority.

One of the roles he took on was as an expert on fats during and after World War I. Embargoes and submarine warfare had resulted in the scarcity of edible fats and

[32] RA, Ministry of Church and Education, 2. Skolekontor E, E-Sakarkiv ordnet etter emne, Ea-Universiteter og høyskoler, Norges Tekniske Høyskole, L0112: Ansettelser, poster 13, no. 2, mappe "Vedkommende professoratet i teknisk-organisk kemi ved den tekniske høiskole."

[33] 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, 1900–1950," *Centaurus* 58 (2016): 257–80.

[34] Elvbakken and Lykknes, "Relationships Between Academia, State and Industry."

[35] Elvbakken and Lykknes, "Relationships Between Academia, State and Industry," Annette Lykknes and Kari Tove Elvbakken, "Vitenskap for politikk – om bidrag til matkontroll og matforsyning," *Norsk statsvitenskapelig tidsskrift* 34 (2018): 155–73. In these articles, we have elaborated on Schmidt-Nielsen's role as "state chemist".

[36] Kari Tove Elvbakken, "Offentlig kontroll av næringsmidler, institusjonalisering, apparat og tjenestemenn" (PhD thesis, University of Bergen, 1997).

fats for technical use. Some goods were rationed from 1914 onwards, and a state monopoly for the trade in cereals was introduced in 1915. Furthermore, the country required an expert on fish and cod liver oil, which had been used for medicinal purposes since the 1850s.[37] As a consequence, a Ministry of Provisioning came into being in 1916, and in the following year two successive "fats committees" were set up by the Norwegian government. Schmidt-Nielsen was appointed as the chair of both committees.

The first committee recommended that the state should take over the trade in fats, and that a separate directorate for fats should be founded. Established in 1918, the directorate was responsible for the purchase of cod liver oil and other fish oils, as well as for sale of fats to margarine factories, before they were closed down in 1921.[38] Since the need for technical fats could be filled with products from the two fats producers in Norway, Vera fedtraffineri (hereafter Vera) and De Nordiske Fabriker (hereafter Denofa), the main task for the second fats committee was to find a way to produce an edible product based on domestically accessible fats. One outcome of this work was the recommendation that marine oils, and whale oil in particular, made possible by hydrogenating the oils, be used to produce margarine.

Experiments with hydrogenated whale fat had been conducted in Norway before the work of the fats committee began. A method for the catalytic hydrogenation of organic compounds had been developed by the French chemist Paul Sabatier with the help of Jean-Baptiste Sendérens and students, for which Sabatier was awarded one half of the Nobel Prize for chemistry in 1912.[39] In the same year, Denofa applied to the Ministry of Agriculture for the permission to hydrogenise whale fats, at first for technical use only. At the same time, experiments investigating the nutritional value and physiological effects of edible hydrogenated whale fats were conducted in Stockholm and Copenhagen, whereupon Norwegian experts concluded that the product was not harmful to humans. However, the margarine manufacturers were sceptical.[40] In 1917 it was up to the Schmidt-Nielsen-led committee to come up with an authoritative recommendation, not only to allow production, but also to give advice on how to prepare a viable product.

Until then, marine fats had been hydrogenated at 40°C, which apparently produced good but hard fats. The addition of oils would make them softer, but these oils had to be imported from abroad, which made it impossible to pursue this line of production. Hydrogenation at lower temperatures would, however, make the fats less durable.[41] Schmidt-Nielsen and fellow committee members were asked to carry out further experiments and issue official instructions for preparing the

37 Elvbakken and Lykknes, "Relationships Between Academia, State and Industry."

38 Bente Hartviksen, "Statens fettdirektorat 1918–1921," in *Håndbok for Riksarkivet*, ed. Knut Johannessen, Ole Kolsrud and Dag Mangset (Oslo: Ad Notam Gyldendal, 1992), 330–31.

39 Henri B. Kagan, "Victor Grignard and Paul Sabatier: Two Showcase Laureates of the Nobel Prize for Chemistry," *Angewandte Chemie, International Edition* 51 (2012): 7376–82.

40 Lykknes and Gusland, *Akademi og industri*, 164–65.

41 NTNU University Library, Spesialsamlingene, privatarkiv nr. TEK1, Sigval Schmidt-Nielsen, box 30, S. Schmidt-Nielsen to Statens Fettdirektorat v/direktør H. Hauan, 18 March 1918.

hydrogenated whale fat. In the end, light hydrogenation (32°C) was the solution recommended by the committee, and Schmidt-Nielsen circulated detailed instructions for the procedure.[42] The manufacturers need not be sceptical any longer, as using hydrogenated marine fats was the only opportunity to produce margarine during wartime. In fact, Schmidt-Nielsen's and the fats committee's authority was so respected that the margarine manufacturers impatiently waited for their instructions, as demonstrated by a telegram from the director of the Directorate for Provisioning a few days before the instructions were issued.[43] Discussions on the use of whale fats continued in the press; among the issues raised was the question whether the hydrogenated fats contained harmful toxins or fatty acids. Schmidt-Nielsen, using his expertise in this area, argued against such claims.[44] Indeed, whale margarine filled the need for edible fats during the fats shortage, but would be known and always remembered for its unmistakable (bad) taste. The whale margarine was even referred to as "the factories' and housewives' despair."[45] Nevertheless, whale margarine was considered to be an important technological step forward and a crucial substitute for butter and frying fats. And Schmidt-Nielsen was proud to proclaim that he stood behind the product.[46]

In addition to issuing instructions to the producers of margarine in the country, once production had started, Schmidt-Nielsen took on the role of controller for the product, thus following the entire production process closely. He analysed samples of the lightly hydrogenated fats for their nickel content (the catalyst) and fatty acids, and checked the quality of the product.[47] However, this did not happen without tension. Indeed, the fats committee, chaired by Schmidt-Nielsen, had also been allocated the task of dividing the responsibilities between the two fats producers in Norway, Denofa and Vera. Following a thorough investigation, Vera was selected as the sole producer.[48] It had been Schmidt-Nielsen's intention to involve both fat producers in production, but Denofa had insisted on being the sole producer, and furthermore, was not willing to produce lightly hydrogenated fats, since it thought this would "harm the [factory's] reputation" as a product

[42] NTNU University Library, Spesialsamlingene, privatarkiv nr. TEK1, Sigval Schmidt-Nielsen, box 30, P.M. angaaende anvendelsen av hærdede fettarter i margarinfabrikkerne [not dated, but identified as circulating on 20 November 1917 in letter to Margarinfabrikkernes Landssammenslutning, box 3, TEK1]. See also Lykknes and Gusland, *Akademi og industri*, 167.

[43] NTNU University Library, Spesialsamlingene, privatarkiv nr. TEK1, Sigval Schmidt-Nielsen, box 30, Telegram fra provianteringsdirektøren [Harald Pedersen] til S. Schmidt-Nielsen on 16 November 1917.

[44] NTNU University Library, Spesialsamlingene, privatarkiv nr. TEK1, Sigval Schmidt-Nielsen, box 20, "Naar Dr. Sopp dementerer," *Dagbladet* [ca. 1918]; Sigval Schmidt-Nielsen, "Aktuelle opgaver for vor fettindustri," *Tidsskrift for kemi* 10 (1918).

[45] Sigval Schmidt-Nielsen, *Vårt matforbruk i 1938 og litt om vår matberging i dag* (Trondheim: Trondhjems handelskammer, 1940), 79.

[46] "Schmidt-Nielsen, Sigval," in *Studentene fra 1907: Biografiske oplysninger samlet til 25-årsjubileet 1932* ed. Andreas Riis and Jon Lid (Oslo: Grøndahl & Søn, 1932), 360–62.

[47] NTNU University Library, Spesialsamlingene, privatarkiv nr. TEK1, Sigval Schmidt-Nielsen, box 32B, folder "Inspeksjonskontroller (Vera)."

[48] Lykknes and Gusland, *Akademi og industri*, 168–70.

considered to be poorer in quality. Denofa's production also turned out to be more expensive than Vera's.[49]

State control further meant that fat supplies from Denofa were expropriated. Not surprisingly, this was not to Denofa's liking, and it filed claims for economic compensation. Later Vera also requested compensation for its use of costly chemicals. Both claims ended in court.[50] As a representative of the state, therefore, Schmidt-Nielsen had to testify against both fats producers, one at a time. This must have been difficult for a professor at NTH who was supposed to have good relations and cooperate with industry. However, it seems that his role as a critical voice for the state did not prevent any future cooperation with industry. With a long history of being a state-appointed expert and the only professor in his field, Schmidt-Nielsen's role and integrity were probably understood and respected by the industrial partners – especially in the context of war and in light of the special position NTH had taken in the nation-building process. As Elvbakken and I have pointed out elsewhere, Schmidt-Nielsen's work in the two fats committees echoed his previous role as a state chemist, giving scientific legitimacy to state intervention in the fats industry.[51]

Schmidt-Nielsen's contract as a consultant for the state was not as generous as Farup's, although his years as the state's expert on fats would earn him around one-and-a-half times his regular annual salary of 4500 Norwegian kroner.[52] Extra costs arising from his time away in court were compensated as well, in the form of an assistant who probably took over some of his teaching, and a secretary. More important, however, were the benefits arising from his good relations with the fats industry. The fact that the Royal Norwegian Society of Sciences and Letters (DKNVS), for which Schmidt-Nielsen was Secretary General between 1926 and 1946, was granted money by Vera's former (until 1919) managing director, later a whale ship owner, testifies to this. Schmidt-Nielsen's contacts must have come in handy for his department as well; indeed, in the years following his work on the fats committees it initiated several projects on marine fats.[53]

In the 1920s Schmidt-Nielsen became a consultant for the margarine industry. Since its invention it had become clear that margarine in itself was not a full-fledged substitute for butter, because it lacked vitamins, a relatively newly discovered nutrient group. As a response to this problem, one of Schmidt-Nielsen's former chemistry students, Aage W. Owe, was hired by the margarine producer Mustand & Søn in

49 NTNU University Library, Spesialsamlingene, privatarkiv nr. TEK1, Sigval Schmidt-Nielsen, box 30, Statens Fettkomité til Det Kgl. Provianteringsdepartementet, 10 November 1917 (quote); box 33, folder "Denofa I," S. Schmidt-Nielsen to solicitor H. Christiansen [undated, probably from 1918].

50 NTNU University Library, Spesialsamlingene, privatarkiv nr. TEK1, Sigval Schmidt-Nielsen, box 30, Promemoria fra Schmidt-Nielsen ang. Skjønnet over De-No-Fas fett, 7 January 1918; box 32B, S. Schmidt-Nielsen to solicitor H. Christiansen on "verserende voldgiftsak mot Staten," May 1921; box 32B, L. Christensen to solicitor H. Christiansen, 20 May 1921.

51 Elvbakken and Lykknes, "Relationships Between Academia, State and Industry."

52 He was paid for each job separately, for example, as chair of the fats committee he received 900 Norwegian kroner. For more details, see Lykknes and Gusland, *Akademi og industri*, 189, n. 220.

53 Lykknes and Gusland, *Akademi og industri*, 172–73.

1921 to develop a vitamin-enriched margarine.[54] Schmidt-Nielsen was commissioned to test that this margarine was equal in nutritional value to butter. He set up a special research laboratory in his department at the Trondheim Institute, where he tested the effect of the margarine on rats by first giving them a vitamin-free diet, and then introducing the new vitamin-enriched margarine. The margarine had an immediate effect on the rats, and Schmidt-Nielsen was happy to announce, in a talk to his fellow chemists, that his former student had succeeded.[55] Subsequently, Schmidt-Nielsen's name was, literally, used to certify and guarantee the quality of the Mustad margarine: his name appeared on advertising posters which proclaimed that "[t]he vitamin content is controlled by prof. dr. S. Schmidt-Nielsen" (Figure 2).

In the 1920s and 1930s Schmidt-Nielsen and his wife Signe conducted a series of experiments on vitamins, thus combining consulting with "science for science's sake".[56] He continued to work as consultant for the rest of his career, for example advising on the food safety of using aluminium in food cans, on the use of potato flour in concentrated animal feed, and on the production of pasta-like food from fish meat during World War II.[57] He also continued to serve on state committees, especially in connection with food legislation. He retired from his post in 1945, but continued to publish – a food lexicon among other things – until he died in 1956. His collected works contain more than 300 titles.[58]

The professor as consultant

Some academic chemists served as consultants in the context of nineteenth- and early-twentieth-century industrialisation and urbanisation, which created a need for chemical experts to survey the quality of air, water, and food.[59] Sigval Schmidt-Nielsen was appointed as a state chemist affiliated with the university in Kristiania in order to satisfy this demand for chemical expertise, which was needed by the health authorities. A few years later, when he was appointed at NTH as the country's only professor of technical-organic chemistry, he also specialised in nutrients, and developed his authority further, to serve the state, academia, and industry.[60] In a similar way as expert advice from the state chemist had been important for the young nation in the field of medicine, consulting by an authority such as an NTH professor was closely related to the rise of the new nation state, for which new, prosperous industries were considered essential. Thus, when Farup and Schmidt-Nielsen served industry, they served the state, either directly by giving the state expert advice, like

54 O. Wicken, *Mustads Margarin gjennom 100 år* (Oslo: Mustad, 1990), 24–25.

55 Sigval Schmidt-Nielsen, "Om vitaminisering av margarin: Foredrag i den kemiske forening i Trondhjem," (Trondheim, 1924) [15 pp.], Samlede Verker.

56 Schmidt-Nielsen, "Kan reagensglass anvendes ved studiet av industrielle problemer?" For more on the joint work, see, for example, Signe Schmidt-Nielsen and Sigval Schmidt-Nielsen, "Nogen resultater fra vårt arbeide med vitamin A og D," *Tidsskrift for den norske lægeforening* 10 (1932), [20 pp.], Samlede Verker.

57 Lykknes and Gusland, *Akademi og industri*, 239–40.

58 Sigval Schmidt-Nielsen, Samlede Verker; Lykknes and Gusland, *Akademi og industri*, 147.

59 Mercelis, Galvez-Behar and Guagnini, "Commercializing Science."

60 Elvbakken and Lykknes, "Relationships Between Academia, State and Industry."

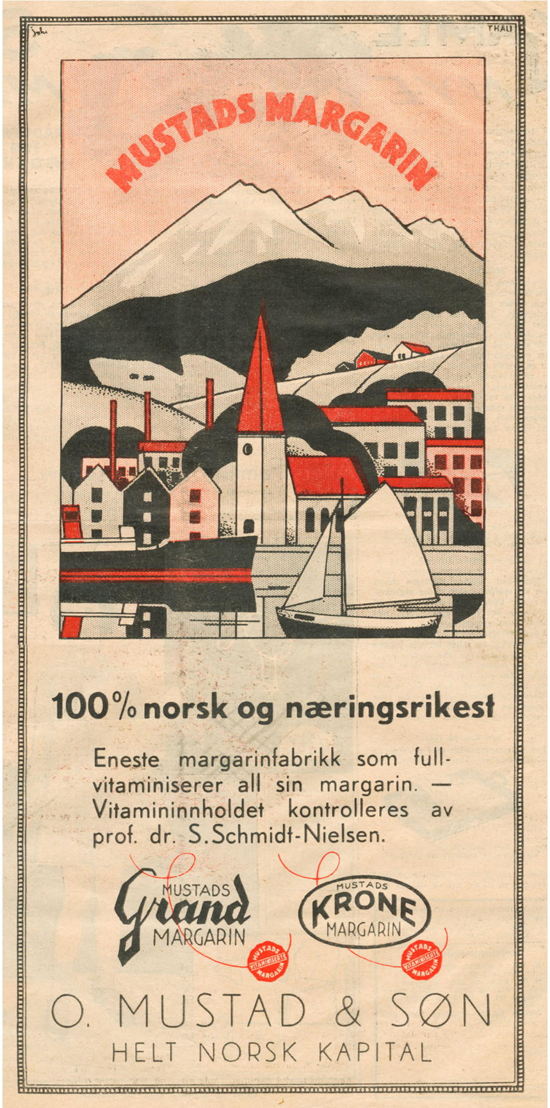

FIGURE 2 Advertisement announcing that Professor Dr. S. Schmidt-Nielsen's control of the vitamin content in Mustad margarine. Allers, 1933, historieboka.no. Reproduced by kind permission of Buskerud Fylkeskommune.

Schmidt-Nielsen did, or by contributing to innovations that could bring about industrial development, as was the case for Farup.

Indeed, NTH was not supposed to be a technical institute just in name, but also in the manner in which it encouraged economic prosperity via industrial development. Professors were expected to be the driving forces behind this development. At the same time, they were academicians who were supposed to publish articles in specialised journals, just like any other professor – a practice that had gradually become more important in the late nineteenth and early twentieth centuries.[61] But how were these professors to deal with the tension between academe and industry? Was it possible to succeed in both? Each of the four chemistry professors appointed between 1909 and 1913 solved this challenge in his own way. Two of them, including Schmidt-Nielsen, published extensively; three, including Farup (but not Schmidt-Nielsen), held patents; and all acted as consultants. One of them even started his own business, but without success.[62] It is also worth noting that the two professors who authored the greatest number of scientific papers were the ones who stayed the longest at the Institute. The two who did not, including Farup, left after only 5–10 years. This suggests that the latter two professors were more attracted to the opportunities (and money?) offered by industry, or were less happy with teaching and academic work – or perhaps both.

Anna Guagnini has discussed several motivations academic scientists might have to take up consultancy work in the nineteenth and early twentieth centuries: to supplement their income; to build or maintain close relationships with industry, and in this way, to keep their teaching up to date; to access facilities not otherwise available to them; and last but not least, for social and economic recognition.[63] For Farup, the collaboration with Elektrokemisk gave him the opportunity to conduct research and development in an area that engaged and motivated him. And since industrial projects were expected of professors at NTH, his temporary absence from teaching was probably accepted. This seems to be unlike practices in other countries.[64] But Farup's projects also benefitted students at the Institute. When Farup taught on electrochemical and metallurgical industrial processes he had first-hand, practical experience to share with his students. Some of them even became involved with Farup's investigations into ilmenite or briquetting. Andreas Ravnestad, who graduated in 1918, would work in the titanium industry for many years. Just one year after his exams, he became the head of the research and patent department at the Titan Co., the company which Elektrokemisk founded to develop titanium white industrially and commercially while Farup was its consultant. In the 1930s Ravnestad worked at the company's main office in Paris, and advised on the development of titanium factories in Germany and England. Schmidt-Nielsen's students too, like Thorleif Arentz, who graduated in the same year as Ravnestad and studied the reactions of cod liver oil in hydrogenation, worked on related investigations.[65] Arentz, in

[61] Alex Csiszar, *The Scientific Journal: Authorship and the Politics of Knowledge in the Nineteenth Century* (Chicago: University of Chicago Press, 2018), 241–43.

[62] The two other professors were Claus Nissen Riiber, professor of organic chemistry 1911–1936, and Birger Fjeld Halvorsen, professor of technical-inorganic chemistry 1912–1917. Halvorsen left NTH to become leader of Hydro's research and patent department. In 1917, Riiber established the company A/S Sodium for electrolysis of alkali chlorides, which was dissolved in 1932. See Lykknes and Gusland, "Akademi og industri", 152–53.

[63] Guagnini, "Ivory Towers."

[64] Thomas J. Misa, "The Changing Market for Chemical Knowledge: Applied Chemistry and Chemical Engineering in the Delware Valley, 1851–1929," *History and Technology* 2 (1985): 245–268.

[65] Information about students can be found in Georg Brochmann, ed., *Vi fra N.T.H. De første ti kull, 1910–1919* (Stavanger: Dreyers forlag, 1934), 164–65, and in Bjarne Bassøe, *Ingeniørmatrikkelen. Norske sivilingeniører 1901–1955 med tillegg* (Oslo: Teknisk Vekeblad, 1961), 137 and 412.

fact, was also appointed engineer at Vera, the fat producer. In this sense, consulting became mutually beneficial for the Institute and for the respective industries, and contributed to the legitimisation of the Institute as a relevant place for bringing forth new generations of industrial chemists in the service of the new nation state.

In some instances, industrial projects also supported NTH's research infrastructure. In Farup's case, Elektrokemisk paid for the chemistry department's first secretary, as well as assistants (to give him time to concentrate on his research), technical equipment for briquetting, and a shaking table for mineral separation.[66] In Schmidt-Nielsen's case the Institute most likely received support for establishing a research laboratory for experiments on rats, but the most important benefit to the Institute was the authority that Schmidt-Nielsen carried as the country's expert on nutrition, especially on fats and vitamins. As Elvbakken and I have argued elsewhere, with his roles Schmidt-Nielsen "put his stamp on nutrition issues, research, industry and state for a long period."[67] NTH's chemistry department became the place where such professional roles were developed, which added legitimacy to the ambition that NTH was meant to fulfil from the very beginning. Although Farup worked at the Institute for a much shorter period than Schmidt-Nielsen, as the central engineer behind the invention of titanium white, and as an active contributor to research and development at Elektrokemisk, he personified one side of the engineering role that was necessary to fulfil the ambitions of the Institute.

Despite their similar backgrounds, Schmidt-Nielsen, who trained in technical chemistry, identified to a larger extent as an academic scientist than did Farup, who had studied with distinguished scientists abroad. Indeed, Schmidt-Nielsen published extensively and was even a member of the Royal Norwegian Society for Sciences and Letters, which Farup was not. Despite his theoretical training in physical chemistry, Farup may best be viewed as a man oriented toward practice, first a pharmacist, later an industrial innovator, and then again a pharmacist. Along the way, electrometallurgy and pigments triggered his curiosity more than theoretical calculations and scientific investigations of minerals.

Kranaki's concept of "hybrid careers" comes in handy to nuance the picture of careers not easily characterised otherwise. It does not consider "science" and "technology" separate realms, but two parties in a dynamic relationship, their intersection "fluid and changing" – i.e. as a hybrid.[68] A scientist/engineer who, in this sense, has a hybrid career, does not consider himself more a scientist than a technologist/engineer, or vice versa, but has instead created a hybrid repertoire of practices, with traditions from science and technology merged into a new set of practices. Kranaki sees hybrid careers in distinction from "dual careers," where the individual alternates between being a scientist and an engineer in different contexts.[69] Indeed,

[66] Lykknes and Gusland, *Akademi og industri*, 162.
[67] Elvbakken and Lykknes, "Relationships Between Academia, State and Industry," 275.
[68] Kranakis, "Hybrid Careers," 178.
[69] For example, in his survey of physics lecturers from the German speaking world, Shaur Katzir found that some considered themselves first as scientists, and second as inventors. Shaur Katzir, "Technological Entrepreneurship from

hybrid repertoires of practice involve the creation of new elements of practice, rather than the addition of elements from one realm of knowledge to another. Kranakis emphasised that these new practices were also developed collectively, ensuring the social reproduction of hybrid careers. To what extent did Farup and Schmidt-Nielsen establish such hybrid careers and hybrid repertoires of practice and contribute to their institutionalisation? In this article, I have suggested that both of them succeeded to this end, each in their own way and their own field.

Farup brought together competencies in analytical chemistry, metallurgy and smelting at high temperatures, special knowledge about titanium ores and titanic acid and the processes involved in their transformations, but also knowledge about industry, entrepreneurship, and innovation processes, thus merging knowledge from his scientific training and know-how from his technological practice, to create new knowledge and know-how. And while it may be true that the "modern chemist", as Farup had been described, identified as an industrial chemist rather than an academic chemist,[70] in that he prioritised industrial research over more traditional scientific-academic work, he suited the kind of industrial-oriented research environment that NTH aspired to establish. And even if he did not publish widely, he did, in fact, author a series of reports about his experiments for Elektrokemisk. These are, however, as un-published reports, often overlooked.[71] By establishing his own area of expertise relevant to his professorship (which in fact was in inorganic chemistry, not technical-inorganic chemistry), he contributed to legitimising NTH as a *technical* institute, and to institutionalising industrial electrochemistry at NTH, in which process he involved his students. The fact that he was so successful in this respect, probably to the extent that he became one of the professors who "were roaming around on private enterprises – at the cost of the Institute and its students,"[72] as some students argued many years later, might have been excused because he helped achieve the goal of establishing a blended area of expertise, with hybrid repertoires of practice in chemistry at NTH.

Likewise, Schmidt-Nielsen succeeded in creating a new hybrid space in technical-organic chemistry by bringing together his technical expertise in fish industry and canned food, his knowledge in the new field of nutritional science and biochemistry, his broad experience in food analysis, public administration and regulatory work, development of production processes, and experiences in the controlling of food products, as expert witness in court, and in vitamin research. No other professor in the country could match his broad area of expertise, and given his long service

69 *Continued*
Patenting to Commercializing: A Survey of Late Nineteenth and Early Twentieth Century Physics Lecturers," *History and Technology* 33 (2017): 109–25.

70 Lykknes and Gusland, "Akademi og industri," 177.

71 See also Brigitte Van Tiggelen and Annette Lykknes, "Ida and Walter Noddack Through Better and Worse: An *Arbeitsgemeinschaft* in Chemistry," in *For Better or For Worse? Collaborative Couples in the Sciences*, ed. Annette Lykknes, Donald L. Opitz, and Brigitte Van Tiggelen (Basel: Birkhäuser/Springer Basel, 2012), 103–147, on 115–116, for another example of a chemist (Ida Noddack-Tacke) working for industry who authored reports which are normally not noticed when publications are counted.

72 Brochmann, *Vi fra N.T.H. De første ti kull*, 251.

at NTH he was to a larger extent than Farup able to *establish* this hybrid repertoire at an institutional level. With few professorships in Norway, it would be plausible to say that Schmidt-Nielsen *became* the field that his chair represented. His work on marine fats, which I have described in this article, exemplifies this: his ideal of providing safe food for all, his chemical expertise in analysing food, his industrial consulting for a margarine producer, and his research on vitamins in his laboratory can be seen as one side of the same activity – acting as the authority on the chemistry of nutrients for society, industry, science, his students – and the new nation state. But just as Farup and Schmidt-Nielsen differed in their approaches to consultancy, other chemistry professors had to find their own way of filling the role as a professor at an institute of technology. What united them was the need to build the new Norway as an independent, industrial nation.

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