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Vitaglass: A Modern Boundary Technology between Laboratory Research, Architecture, Public Health, and Environmentality in the 1920s and 1930s
Kijan Espahangizi

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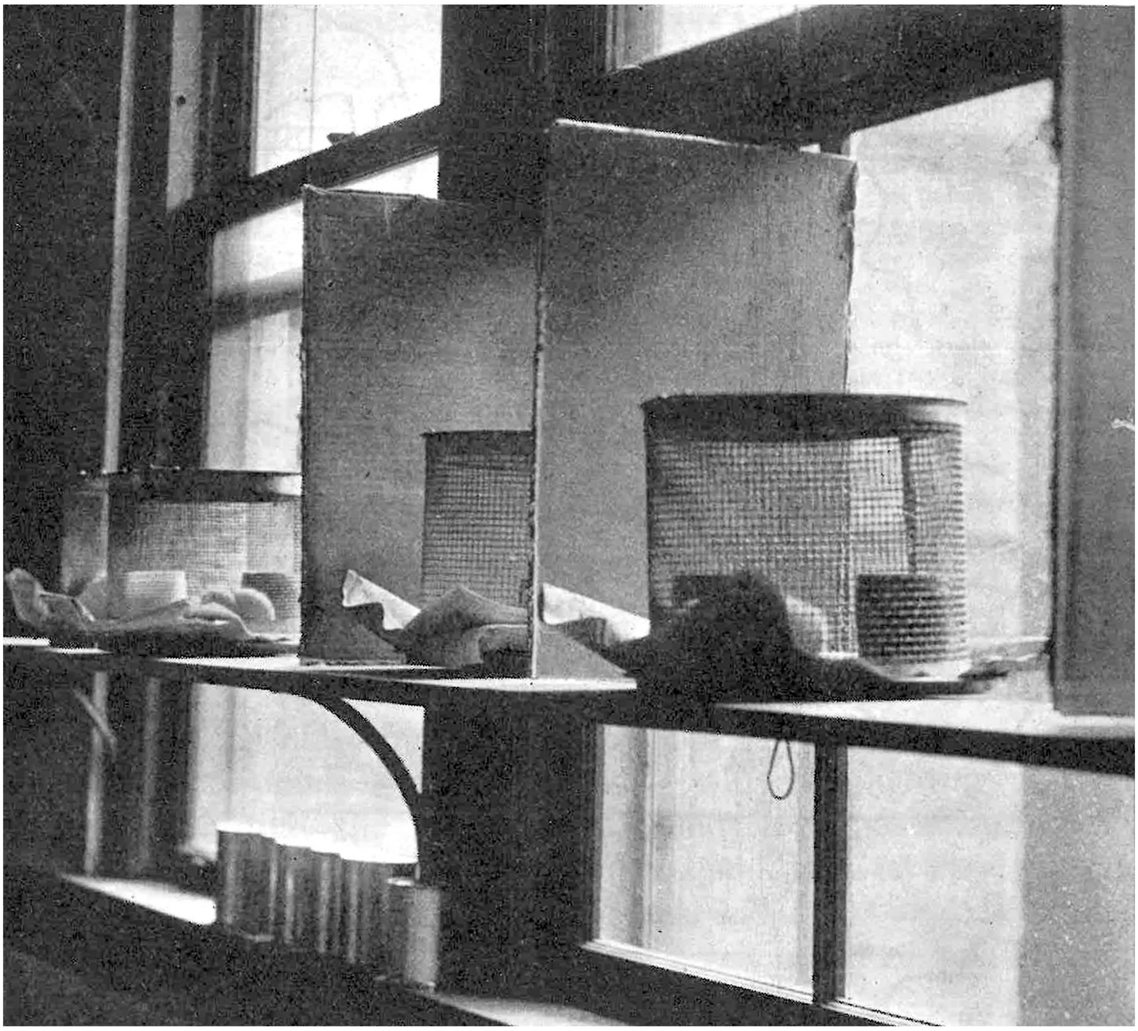


f.1 Rachitic rats behind Vitaglass, 1928.

"A laboratory in the university, used by my department, has three windows facing south. The sashes of two of these windows were removed and replaced by two Vitaglass panes each. By building a shelf in front of these three sashes on which to place rat cages, and by using screens to cut out cross rays, it was possible to measure the preventive action of transmitted rays through each of four panes of Vitaglass and through window glass as recorded by the rat occupants of these cages on a basal diet of rickets-producing power (Sherman-Pappenheimer No. 84). Three 30-day tests were run." 1/f.1

This experimental setting was part of a research project at the Laboratory of Physiological Chemistry at Columbia University in New York in 1928. The goal was to determine the "antirachitic value" of a new kind of window glass, which had been given considerable public attention since the mid-1920s. This so-called Vitaglass—which even made it into *Time* 2 —was transmissible to the "healthiest" part of sunlight, ultraviolet rays. Long before

1 Walter Eddy, "The Use of Ultra-Violet Light Transmitting Windows," *American Journal for the Public Health and the Nation's Health*, 18, no. 12 (1928), pp. 1470–9; here p. 1474.

2 "New Glass," *Time*, November 1, 1926, and "Sun & Glass," *Time*, May 23, 1927.

the discovery of the carcinogenic effect that dominates our view of these rays today, they seemed to promise unambiguous vitality and health, as a cure for the disease of rickets, for example.

When Vitaglass hit the market, it provoked a public and scientific debate on ultraviolet rays and windows that lasted until the mid-1930s. [3] The product itself never met the initially high expectations. [4] Yet from an analytical point of view, this historical episode offers valuable insight into the interactions of architecture, laboratory research, and biopolitics in the early twentieth century, and also sheds light on the role of glass boundaries as a material medium of modern environmentality. I use the term environmentality to refer not to a certain political attitude towards ecological issues, but rather to a specific mode of reasoning and imagination based on careful appraisal of the conditions surrounding epistemic objects. [5]

The experimental setting at Columbia University, which was accompanied by parallel tests in a village schoolroom in the vicinity of New York City, illustrates the convergence in the 1920s of architectural, health-enhancing, and experimental environments, whose respective boundaries coincided in the glass pane. In order to determine whether exposure to a certain quantity of ultraviolet rays would make the test animals less susceptible to rickets, sunlight was filtered through two types of glass boundary: on the one hand ordinary window glass, which was opaque to the so-called Dorno rays between 300 and 313 µm; on the other Vitaglass, which was transparent to these UVB rays, as we would call them today.

The historical juxtaposition of "ordinary" window glass and Vitaglass challenges the narrow, analytical focus on light transparency that still dominates glass studies in cultural history today. [6] "Modernity has been haunted, as we know very well, by a myth of transparency." [7] And this modern myth has literally materialized in glass—in architecture as well as in the sciences. The interwar history of Vitaglass, staged between the window and the test tube, so to speak, subverts the fetish of glass transparency. In straddling the histories of two disciplines,

3 This discursive bump can be visualized by the Google Ngram viewer: https://books.google.com/ngrams/graph?content=Vitaglass&year_start=1900&year_end=1960&corpus=15&smoothing=3&share= (accessed December 23, 2015).

4 John Sadar, "The Healthful Ambience of Vitaglass: Glass, Light, and the Curative Environment," *Architectural Research Quarterly*, 12, no. 3–4 (2008), pp. 269–81. Cf. Daniel Freund, *American Sunshine: Diseases of Darkness and the Quest for Natural Light* (Chicago, IL: University of Chicago Press, 2012), p. 61.

5 Cf. my paper "Environmentality—Revisiting the Milieu of Jakob von Uexküll's *Umweltlehre*," presented at the Annual Conference of the German Studies Association in Denver in October 2013. Cf. Thomas Brandstetter, Karin Harrasser, and Günther Friesinger (eds.), *Ambiente: Das Leben und seine Räume* (Vienna: Turia & Kant, 2010).

6 Kijan Espahangizi, "From Topos to Oikos: The Standardization of Glass Containers as Epistemic Boundaries in Modern Laboratory Research (1850–1900)," *Science in Context*, 28, no. 3 (2015), pp. 397–425. For a differentiated account on glass transparency in the history of modern architecture, see Laurent Stalder, "Glas 1930–1970," in Susanne Hauser and Julia Weber (eds.), *Architektur in transdisziplinärer Perspektive: Von Philosophie bis Tanz—Aktuelle Zugänge und Positionen* (Bielefeld: transcript, 2015), pp. 19–41.

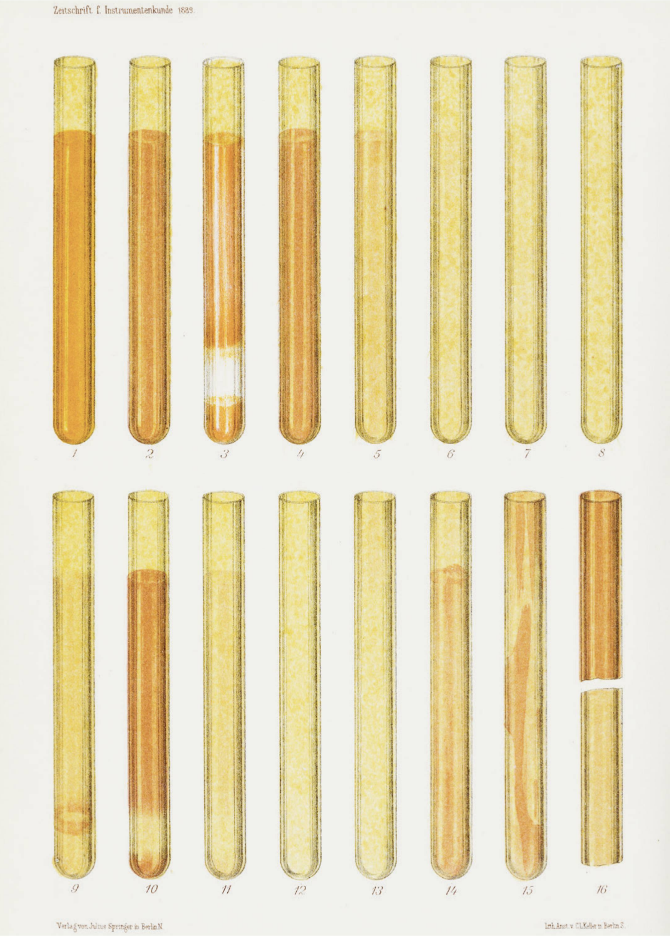
7 Anthony Vidler, "Transparency," in Vidler, *The Architectural Uncanny: Essays in the Modern Unhomely* (Cambridge, MA: MIT Press, 1992), pp. 217–25; here p. 217.

architecture and the experimental sciences, it allows us to gain a deeper understanding of a material boundary technology that has permeated modern society. 8

8 This study therefore meets the methodological requirement to reconstruct a "definite and demonstrable connection, susceptible to theoretical analysis" between the two "cultural environments" of architecture and science—as requested in "Introduction," in Antoine Picon and Alessandra Ponte (eds.), *Architecture and the Sciences: Exchanging Metaphors* (Princeton, NJ: Princeton Architectural Press, 2003), pp. 13–25. Cf. also Peter Galison and Emily Thompson (eds.), *The Architecture of Science* (Cambridge, MA: MIT Press, 1999).

From transparency to the boundary function of glass

The history of modern laboratory research shows that the glittering iconography of the transparent and quasi-immaterial container has obscured from view the rich material historicity and functionality of glass boundary technologies within and beyond the walls of modern laboratories. With the emergence of scientific precision measurement in the nineteenth century and advances in glass science and technology, especially since the 1880s, glass containers turned from handcrafted objects of a usually unknown physico-chemical constitution into scrutinized and standardized boundary devices. 9 They were designed to enclose and stabilize artificial environments for specific techno-scientific objects. Chemistry glassware, for example, had to be neutral in regard to the chemical processes contained within it, in order to prevent measurement errors. f.2/f.3 This new physico-chemical knowledge of glass surfaces and boundaries was relevant also to receptacles used in the distribution and circulation of techno-scientific objects in society, such as pharmaceutical ampoules and food containers. 10



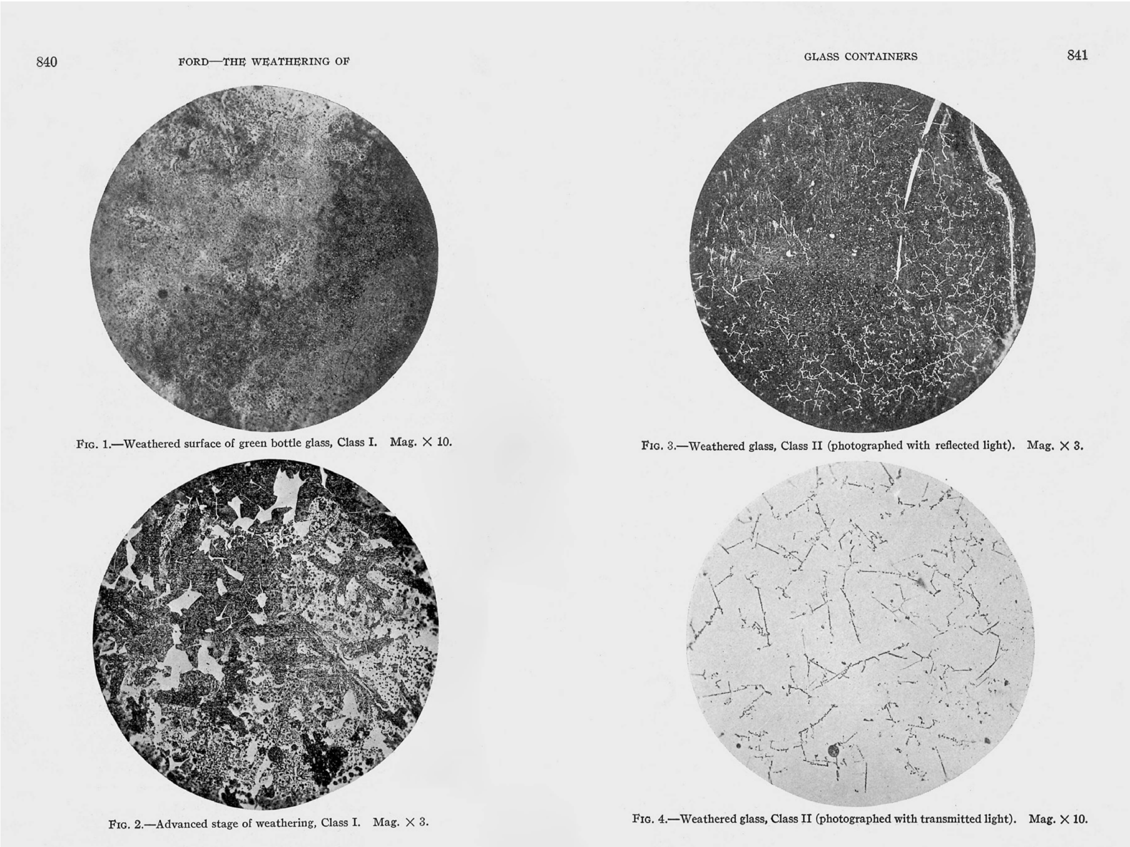
f.2 The chemical resistance of test tubes. A colorimetric test by Franz Mylius, 1889.

9 Cf. Kijan Espahangizi, "From Topos to Oikos" (see note 6), and Espahangizi, "The Twofold History of Laboratory Glassware," in Mathias Grote and Max Stadler (eds.), *Membranes, Surfaces and Boundaries: Interstices in the History of Science, Technology and Culture* (Berlin: Max Planck Institut für Wissenschaftsgeschichte, 2011), pp. 27–44.

The leading glass scientist of the American Glass Container Association was well aware of the broad variety of applications developed over the previous decades for new special types of glass. In 1930, he wrote:

"Glass in any form is just glass to many of its users. ... But in reality there exists a wide variety of glasses ... . Adjustments of its chemical composition can change physical properties. Such changes are made to adapt glass for specific uses in industry. ... We can now even obtain special window glass which transmits the

10 Kijan Espahangizi, "Immutable Mobiles im Glas: Grenzbetrachtungen zur Zirkulationsgeschichte nicht-inskribierter Objekte," *Nach Feierabend: Zürcher Jahrbuch für Wissensgeschichte*, 7 (2011), pp. 105–28. On new approaches in the historical ontology and epistemology of materials cf. Kijan Espahangizi and Barbara Orland (eds.), *Stoffe in Bewegung: Beiträge zu einer Wissensgeschichte der materiellen Welt* (Zürich/Berlin: diaphanes, 2014).



f.3 Micrographs of weathered glass surfaces, Glass Container Association 1922.

ultra-violet rays of sunlight. Each of these, while of the glass family, shows different properties and widely varying applications. … Chemical glassware must withstand corrosive action and sudden temperature shock … . A food container is likewise a special glass. In this article are combined durability, resistance to temperature shock, optical characteristics, color, and strength. … This glass is the result of extensive studies in the art of glass manufacturing. … Composition no longer is a matter of tradition but of exact, technically established batch proportions composed of materials selected to give special physical properties. … Food products can now be held in storage for years in glass without evidence of any effects in the ingredients." [11]

The use of glass containers ranged from scientific research to the packaging of industrially manufactured goods. In the interwar period, this new knowledge of glass entered the architectural field, as in the case of Vitaglass. The types of glass used in these different contexts had in common not only their material substance but also their function. [12] Windows, flasks, test tubes, petri dishes, ampoules, food containers, and milk bottles all had to perform a specific boundary function: to regulate the material, organic, and energetic exchange between an enclosed environment and its surroundings. The new technological boundary function of glass involved the phenomenal as well as the epistemic dimension, which is to say, that in order to know *what* happened within a glass-enclosed environment one had to

11 Karl Ford, "The Rise of the Glass Container," *The Glass Container*, 9, no. 1 (1930), compiled from pp. 5–7.

12 Cf. the chapters "Material" and "Funktion" in Laurent Stalder, "Glas 1930–1970" (see note 6), pp. 25–32; Stalder, "Prä_Liminarien," in Laurent Stalder et al. (eds.), *Schwellenatlas*, *ARCH+*, 191/192 (2009), pp. 24–5.

know *how* its glass boundary worked, and vice versa. This new phenomenological-epistemological reciprocity of scientific glassware, nascent since the 1880s, can be observed also in the Vitaglass experiments of 1928 at Columbia University. In order to produce meaningful quantitative results on the healthy environment behind glass it was necessary to measure the transmissibility of the glass panes at different wavelengths. A MIT physicist was hired to carry out this task. [13]

13 Eddy, "Ultra-Violet Light Transmitting Windows" (see note 1), p. 1474.

This example shows that the respective boundary function of different glass containers—be it chemical resistance, radiation transmissibility, or whatever—depended on various other bodies of techno-scientific knowledge, in addition to actual glass science. The use of Vitaglass relied on spectrographic measurements, theories of radiation, and physiological knowledge that had emerged since the late nineteenth century.

The Science of Light and the Healing Power of UV Rays

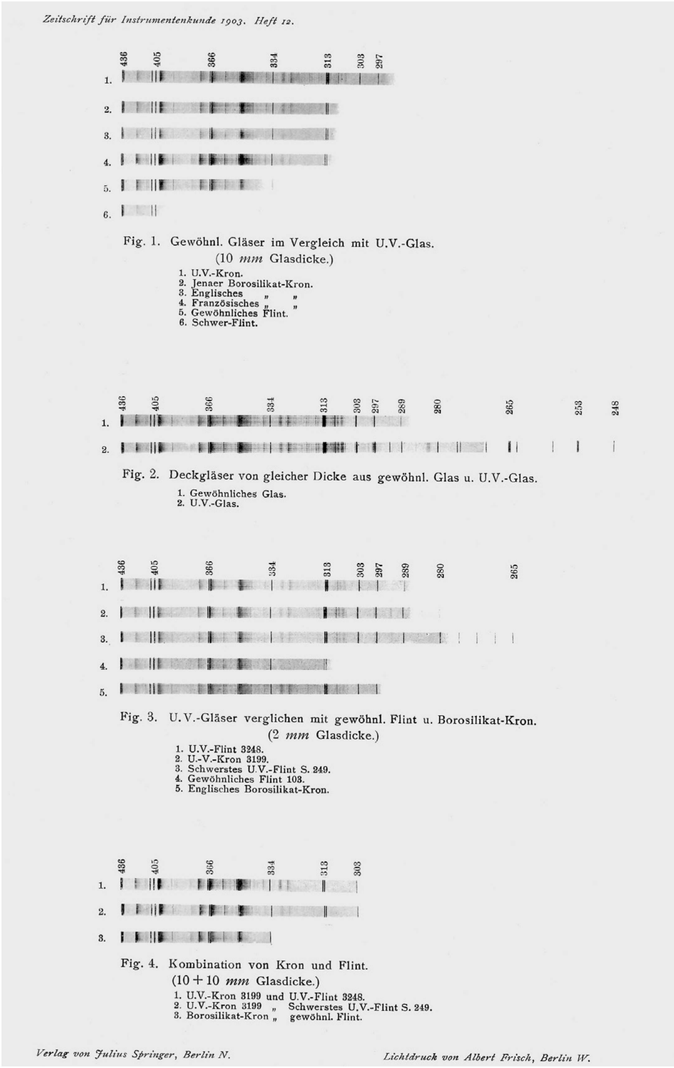
In the course of the nineteenth century, visible light was found to constitute only a small part of a broader and mostly invisible continuous spectrum of electromagnetic wavelengths. Glass devices such as prisms, lenses, and glass screens played a crucial role in this development. As early as the 1820s, scientists were aware that glass, while transparent to visible light, was hardly transmissible to invisible heat and ultraviolet rays—or, as the latter were commonly known at the time, chemical or actinic rays. [14] Glass screens were used as selectively transmissible filters in order to study the effects of different parts of the spectrum, for example in bacteriology.

14 Cf. Klaus Hentschel, "Macedonio Melloni über strahlende Wärme," *NTM*, 13 (2005), pp. 216–37.

In 1877, two British scientists placed test tubes with bacteria solutions "on the window-ledge" of their laboratory and observed that this exposure to sunlight destroyed the microbes. [15] They used colored glass filters in order to find out which part of the spectrum of sunlight was responsible for this effect. It took until the end of the nineteenth century to show that the germicidal effect was due to ultraviolet radiation. Other "healthy" effects of sunlight and especially of ultraviolet radiation were discovered too, at that time, such as enhanced tissue growth, and the healing of eczema, lupus, and other diseases. [16] The invention of a lamp for artificial UV rays facilitated research into their effects in chemistry, physics, biology, and medicine, most importantly in dermatology and heliotherapy. One drawback to these lamps was that they were based on the electrical discharge of mercury vapor in an ordinary soda-lime glass envelope that absorbed a great deal of the UV rays. In 1904, Otto Schott, who was the most influential glass scientist at the time, and owner of the

15 Philipp Hockberger, "The Discovery of the Damaging Effect of Sunlight on Bacteria," *Photochemistry and Photobiology*, *B*, 58 (2000), pp. 185–91; Hockberger, "A History of Ultraviolet Photobiology for Humans, Animals and Microorganisms," *Photochemistry and Photobiology*, 76, no. 6 (2002), pp. 561–79.

16 For the detailed history of light and UV therapy, see Niklaus Ingold, *Lichtduschen: Geschichte einer Gesundheitstechnik 1890–1975* (Zurich: Chronos, 2015).



f.4 Comparison of ordinary glass and UV glass by Eberhard Zschimmer, 1903.

world's leading company for scientific glassware, presented a new glass composition that would allow the healthy rays to leave the lamp. Schott was able to draw on the broad expertise in glass technology and scientific glassware garnered by his company since the 1870s. This "Uviolglas," as it was known, had been developed in 1903 by one of Schott's most proficient glass scientists, Eberhard Zschimmer, mainly for optical uses. [17] Studies since the mid-nineteenth century had shown that optical lenses absorbed the invisible UV rays in the light spectrum. This posed a serious problem for all experimental sciences using spectrographic methods, such as chemistry and astronomy. [18] In other words, progress in the science of light depended on optical media that were transmissible both to visible and invisible rays. f.4 Zschimmer's new glass, in the form of container glass and windows, was also used for physiology and light therapy. So, evidently, when Vitaglass arrived on the scene in the mid-1920s, it wasn't the first glass product transmissible to UV rays. How, then, did it come to be a major public issue in the interwar period?

Public health, glass architecture, and Vitaglass

After the Great War, a broad public health and urban sanitation movement developed on both sides of the Atlantic Ocean. The main preoccupation of the advocates of this so-called "social hygiene" was the "influence of natural and artificially produced climatic conditions," i.e. of air, water, temperature, and especially sunlight, on the population. [19] The new avant-garde of glass architecture that had gathered shortly before the First World War shared (and fueled) this excessive contemporary passion for sunlight. [20]

17 Eberhard Zschimmer, "Über neue Glasarten von gesteigerter Ultraviolett-Durchlässigkeit," *Zeitschrift für Instrumentenkunde*, 23, no. 12 (1903), pp. 360–3.

18 Cf. Otto Schott, "Über eine neue Ultraviolett-Quecksilberlampe (Uviollampe)," *Zeitschrift für angewandte Chemie*, 18, no. 16 (1905), pp. 615–22. Uviol was a commercial product, so Schott did not reveal the composition of the glass.

19 A[dolf] Gottstein, A[rthur] Schlossmann, and L[udwig] Teleky (eds.), *Handbuch der sozialen Hygiene und Gesundheitsfürsorge*, vol. 5: *Soziale Physiologie und Pathologie* (Berlin: Springer, 1927), pp. 146, 125.

20 Cf. Paul Scheerbart, *Glasarchitektur* (Berlin: Der Sturm, 1914), chap. 1, and again Sadar, "Healthful Ambience of Vitaglass" (see note 4), pp. 269–72.

In the interwar years, glass became the "material of choice" for those architects who sought to create a new society in the face of the dark, polluted, and disease-ridden living conditions of modern urban spaces. [21] Nonetheless, at the same time the biopolitical value of glass architecture was contested by more pessimistic accounts. In 1919, a US-American eugenicist identified the glass window as a veritable threat to the human race:

"[T]he great change in home life and the change in industrial life and in the industries themselves could not begin until an abundance of cheap glass filled all homes with a flood of daylight, and all shops and offices and factories as well, keeping in the artificial heat at the same time. From that time the outdoor life rapidly lost its people while the world of indoors gained devotees, willing or unwilling, by thousands of thousands."

Further: *"With window glass the habits of life and livelihood are completely changed. ... The whole environment is changed for the species, including temperature, humidity, material environment, composition of air breathed, visual and mental horizons, and a change in the relative adjustments of human beings to disease germs. Such radical changes both within and without the human organism are bound to produce physiological changes in the individuals. They also set in motion new factors in the evolution of the race."* [22]

In 1918, however, the German pediatrician Kurt Huldschinsky discovered that the exposure of children to ultraviolet rays—of the natural (sunlight) and artificial (mercury arc lamp) variety—could cure rickets. Especially given the deprivations of the First World War, this disease, which turned out to be a Vitamin D deficiency [23] that caused severe bone deformities, stunted growth, and infant mortality, had become pandemic among children, especially in cities. Huldschinsky's groundbreaking discovery of the antirachitic power of UV rays, however, seemed to deliver a strong argument against such an alarming interpretation of glass architecture. One can only imagine the shock when the public realized that the utopia of new glass architecture had a major flaw: since ordinary window glass was virtually opaque to ultraviolet rays, the most vital part of the sunlight spectrum never reached the living room. No wonder *Time* magazine was appalled: "Children and animals that live in glassed houses are cheated of that ultraviolet part of the sun's light which helps the bones ossify. The glass blocks the ultraviolet rays; the children and animals become rickety." [24] A German newspaper warned its readers: "Our windows are harmful to health!" [25] As mentioned above, scientists had known since the first half of the nineteenth century that ordinary soda-lime glass was opaque to UV rays, but

21 Sadar, ibid, p. 270; Stalder, "Glas 1930–1970" (see note 6).

22 R. E. Danforth, "Window Glass as a Factor in Human Evolution," *The Scientific Monthly*, 8, no. 6 (1919), pp. 537–557; here pp. 537, 540.

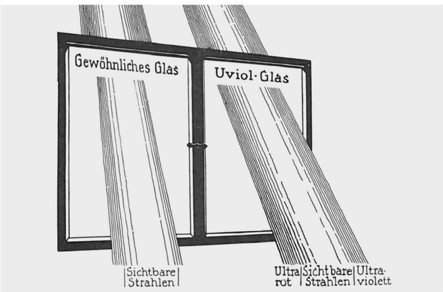
23 Kurt Huldschinsky, "Heilung von Rachitis durch künstliche Höhensonne," *Deutsche Medizinische Wochenschrift*, 45 (1919), pp. 712–3. Hockberger, "History of Ultraviolet Photobiology" (see note 15), p. 565.

24 "Sun & Glass" (see note 2).

25 "Unsere Fensterscheiben sind gesundheitsschädlich, denn sie lassen die segensreichen Ultraviolettstrahlen nicht durch! Die Wissenschaft auf der Suche nach einem gesundheitsförderlichen Fensterglas," *Abendblatt der National-Zeitung*, December 15, 1927.

it was only now that their expert knowledge pervaded the public debate on account of its biopolitical relevance. In no time at all, a range of new remedial glass products “appeared for sale,” most prominently Vitaglass. [26]

Vitaglass was invented by Francis Everard Lamplough, a glass technologist from England, and registered as a trademark in 1925. The low level of iron oxide in the Vitaglass composition increased its UV transmissibility. [27] At the initiative of physiologist Leonard Hill of London University, an expert for the effects of climate on health, Vitaglass was first tested at the monkey house of the city zoo. Several glass companies in the UK and the US immediately embarked on the mass production of Vitaglass, as a joint venture. To promote international sales, they set up a Vita Glass Marketing Board and developed a “dedicated” propaganda strategy. [28] It was their advertising campaign that had initiated the public debate on the UV transmissibility of window glass and public health in 1926 in the first place. But the media focus on Vitaglass unintentionally prompted the launch of rival products on this new market, among them Helioglas, Sanalux, Ultravit, and Corex, and many others. [29] When the German glassworks in Jena found out about the new Anglo-American Vitaglass fad its response was immediate: it developed three new Uviolglas products, started mass production, lowered its prices, and initiated a marketing campaign of its own. Uviol advertisements appeared in no less than twenty-five professional journals for medicine, architecture, gardening, horticulture, or animal farming, as well as in several German-language newspapers. [30] Not surprisingly, the ads emphasized that Uviolglas had been invented “25 years ago” and used occasionally in sanatoriums and gardening prior to the First World War. On the one hand, Schott berated the “blatant advertising abroad” for ignoring the German invention of 1903; on the other, his company recognized the benefits of the “immoderate” Anglo-American media hype: it put UV glass back in the public eye. [31]



Publicity for an appealing and commercially successful UV glass was one thing, but manufacturing it was another. The various products competed in regard to their transmission rate (and its consistence over time), and to their price; and they also had to meet architectural requirements, such as mechanical stability, suitability for mass production, resistance to weathering, and so forth. In spite of these practical challenges, the idea behind the new products fell on fertile soil both among the general public and the scientific community. f.5

26 “Sun & Glass” (see note 2).

27 Between 1908 and 1914, William Crookes had found out that glasses containing a high level of iron oxide blocked UV rays: “The Preparation of Eye-Preserving Glass for Spectacles,” *Philosophical Transactions of the Royal Society of London*, A 214 (1914), pp. 1–25.

28 On the history of Vitaglass Corporation and their marketing strategy, cf. Sadar, “Healthful Ambience of Vitaglass” (see note 4), pp. 272–81.

f.5 Uviol advertisement, Schott 1928.

29 “UV-Berichte IV,” Schott Archive Jena 7/62 (Laborberichte 35, 1917–1944), p. 7. Cf. H[arrison] P. Hood, “A New Ultra-Violet Transmitting Glass,” *Science*, 64 (New Series), no. 1655 (1926), pp. 281–2.

30 “Das Ultraviolettglas,” *Der Tag*, February 9, 1928; “Fensterglas und Sonne,” *Münchener Neueste Nachrichten*, February 13, 1928; “Glas als Arzt: Therapeutisches Fensterglas,” *Deutsche Allgemeine Zeitung*, May 20, 1928; “Das Jenaer Uviolglas,” *Wiener Handelsblatt*, September 4, 1928.

31 “Das ultraviolettdurchlässige Fensterglas ist eine 25 Jahre alte deutsche Erfindung,” “Jenaer Uviol-Glas 4262,” “Über Sonnenstrahlen und Ultraviolett-Durchlässiges Glas—Mitteilung 4270,” Schott Archive Jena 18/12 (Das Jenaer Uviolglas 1908–1930).

The scientific value of UV glass

The ambitious commercial advertising induced research that aimed to thoroughly evaluate the possible benefits of UV glass products. Scientists such as Walter H. Eddy, who conducted the Vitaglass experiments at Columbia University, were conscious of this motivation:

"A NEW industry and a new line of selling talk have sprung into being within the past few years. ... The selling talks of salesmen endeavoring to convince prospective customers demand critical evaluation and constructive suggestion to eliminate claims made without basis in fact.

The industry to which I refer is that concerned in producing window material which, correcting a defect of ordinary window glass, will transmit in addition to the illuminating rays those shorter sun rays that are now known to be curative and preventive of the faulty lime utilization designated under the term 'rickets'." [32]

From the mid-1920s to the mid-1930s, dozens of scientific studies on the effects of UV glass were carried out on both sides of the Atlantic, in clinical studies, bacteriology, zoology, agriculture, and so forth. They included tests with rachitic rats behind Vitaglass, studies on the height, weight, hemoglobin level, and bone growth of the children in vita-glazed schoolrooms, [33] studies on crops grown in vita-glazed greenhouses, [34] studies that measured the concentration of bacteria in the air of vita-glazed rooms, [35] and many more. [36] In the same period, studies were made of how light and UV radiation might modify foodstuffs, beverages, and pharmaceutical substances enclosed in glass containers, thereby referencing the general functionality of glass as a boundary material for all kinds of techno-scientific objects, from chemical substances to the modern living room. [37]

Even before these scientific studies were able to produce well-founded knowledge, clinics, zoos, greenhouses, schools, and sanatoriums on both sides of the Atlantic started replacing their windows. [38] Evidently, public faith in the benefits of UV glass windows was widespread and strong. Schott's glassworks even used its customer base to gather

32 Eddy, "Ultra-Violet Light Transmitting Windows" (see note 1), p. 1470.

33 Ian Sutherland, "Growth under Vita Glass," *Journal of Hygiene*, 32, no. 2 (1932), pp. 211–18.

34 W. Dix, "Vegetationsversuche mit ultraviolette Strahlen durchlässigem Glas," *Gartenbauwissenschaft*, 2 (1929), pp. 365–8; J. Reinhold and M. Schmidt, "Versuche mit verschiedenen Glassorten im Frühgemüsebau," *Gartenbauwissenschaft*, 3 (1930), pp. 301–30. See the research overview in H. W. Popp and Florence Brown, "A Review of Recent Work on the Effect of Ultraviolet Radiation Upon Seed Plants," *Bulletin of the Torrey Botanical Club*, 60, no. 3 (1933), pp. 161–210.

35 Jean Broadhurst and Theodore W. Hausmann, "Bacterial Destruction Through Glass," *The American Journal of Nursing*, 30, no. 11 (1930), pp. 1391–4.

36 Cf. "Literatur über biologische Wirkung von UV-Strahlen usw.," Schott Archive Jena 18/12 (Das Jenaer Uviolglas 1908–1930).

37 In 1926, a Glass Container Committee was appointed by the American Pharmaceutical Association in order to investigate the "deterioration of certain chemicals by light rays," especially ultraviolet rays. Cf. also Gustav Keppeler, "Untersuchungen an Flaschengläsern," *Glastechnische Berichte*, 8, no. 2 (1930), pp. 65–77; Deichmüller, "Die schädlichen Wirkungen ultravioletter Strahlen und die Lichtdurchlässigkeit, insbesondere bei transparenten Folien," *Die Verpackung*, 7, no. 18 (1932), pp. 283–4.

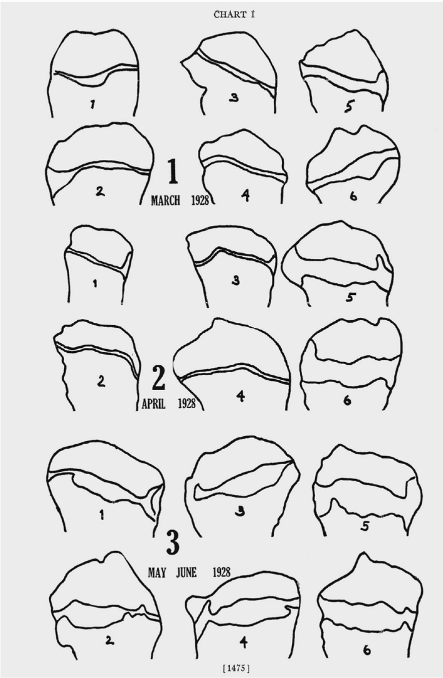
38 Cf. Sadar, "Healthful Ambience of Vitaglass" (see note 4), and Kijan Espahangizi, *Wissenschaft im Glas: Eine historische Ökologie moderner Laborforschung* (diss. ETH Zurich, 2010), p. 305, fn. 768.

more information, requesting nurseries, schools, agricultural businesses, and factories from all over the country to report on their experience of UV glass. [39] But the feedback was ambiguous, as in most scientific studies on UV glass. This was also the case with the tests on rachitic rats at Columbia University, even though there were in fact noticeable effects: the bones of the test animals behind Vitaglass differed from those behind ordinary glass. "Camera lucida drawings of the split ends of 'rat knee bones" illustrated this effect. [40/f.6]

39 Cf. Schott Archive Jena 18/12 (Das Jenaer Uviolglas 1908–1930).

40 Walter Eddy, "Ultra-Violet Light Transmitting Windows" (see note 1), p. 1474: "The narrowness of the 'line' between the end of the bone and the shaft indicates degree of protection. The narrower the line the higher the protection. … The numbers 1, 2, 3, 4 indicate animals that were in front of Vitaglass. The numbers 5 and 6 indicate animals that were in front of ordinary window glass."

The general problem with most UV glass studies and the reason for their ambivalence in regard to possible benefits was that experimental results were attained in a highly controlled environment and could therefore not simply be transferred to real-life situations, where the relevant parameters—such as the percentage of skin surface covered by clothes, the distance to the window, the paths of rays, the ratio of reflected rays, etc.—were far more complex and variable. [41] All these aspects affected the assessment of the cost-benefit-ratio rather negatively. The main argument against the actual installation of UV glass windows especially in urban areas, however, was that, before the sunlight reached the windows, a substantial number of the UVB rays would be filtered out by the atmosphere, climatic conditions, or smog, [42] to say nothing of the dirt that usually clouded the mundane reality of glass architecture, as Lewis Mumford observed in the late 1930s. [43]



f.6 The knees of rachitic rats behind Vitaglass, 1928.

41 Ibid., p. 1472.

42 Janet H. Clark, "The Probable Amount of Ultra-Violet Radiation Obtained Indoors Through Ultra-Violet Transmitting Glass," *Science*, 68 (New Series), no. 1755 (1928), pp. 165–6; Konrad Büttner and Erika Sutter, "Der Einfluss des Großstadtdunstes auf das Strahlungsklima, insbesondere im Ultraviolett', *Die Naturwissenschaften*, 17, no. 33 (1929), p. 652.

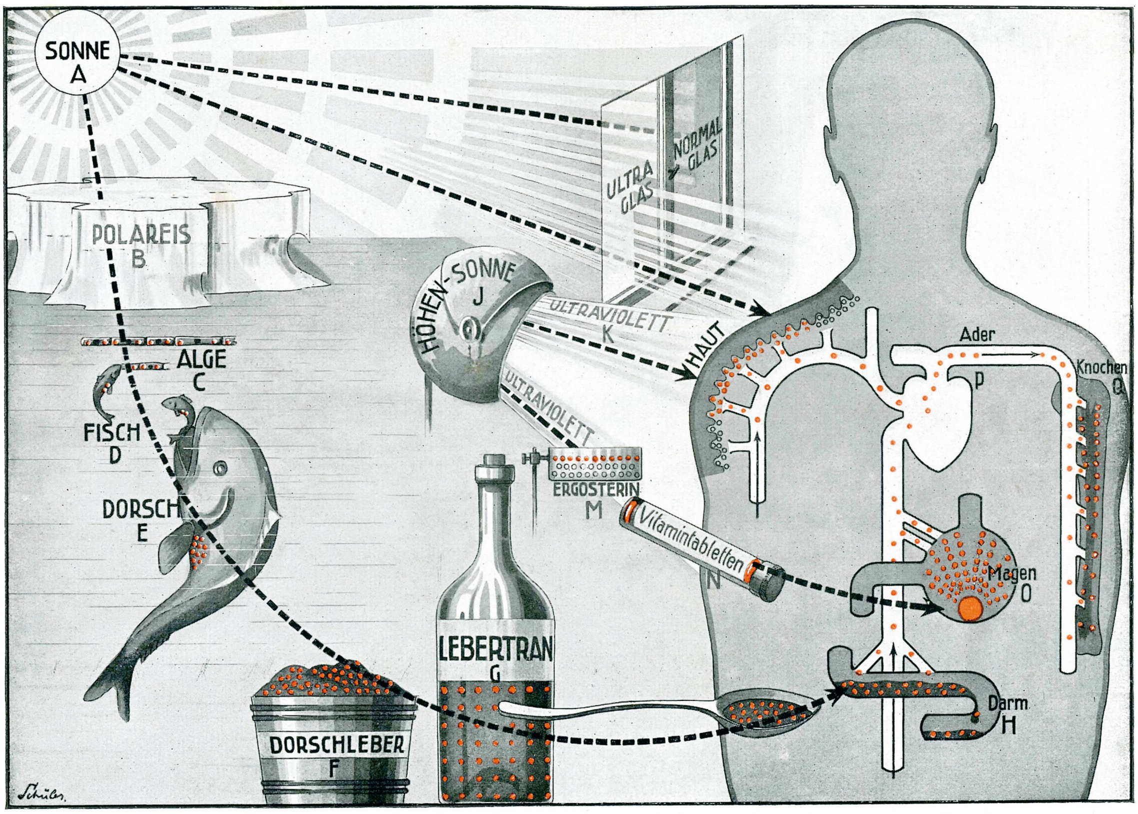
43 Lewis Mumford, *The Culture of Cities* (New York: Twayne, 1998 [1938]), pp. 207–8. For an early indication see "Ultra-Violet Light Transmitting Glass and City Smoke," *Glass Review*, 3, no. 2 (1927), p. 23.

Vitaglass and environmentality

Despite its suggestive power and the general buzz it created, Vitaglass was a commercial failure. Yet, if considered from a broader historical and epistemological perspective, the interwar debate on the UV transmissibility of glass windows was astonishingly productive. It served to interrelate and restructure current knowledge of different environmental boundaries: the natural ones such as the atmosphere and the technical ones made of glass.

The histories of glass manufacture and of the atmospheric sciences have been deeply intertwined since the early nineteenth century. The idea that the earth's atmosphere functions like a giant glasshouse that is transparent to visible light but opaque to heat rays was first hypothesized by Jean Baptiste Fourier in the

f.7 Fritz Kahn, "The Biological Effects of Ultraviolet Light," 1926.



Die biologischen Wirkungen des ultravioletten Lichtes.
Erklärung im Text S. 254/255.

1820s then popularized by Svante Arrhenius around 1900. 44 In the 1920s and 1930s, the close association of atmospheres and glass envelopes became a part of the popular imagination, be it on the covers of American pulp magazines or in the writings of glass architects:

"Our enclosed spaces are separated from the source of all light on earth, the sun, by two intermediate substances, the atmosphere and the glass layer of our window, both of which are not passed without loss. Both absorb a part of the rays which originate from the sun or the sky, or they reflect them." 45

It is safe to say that glass is an important historical medium in which concepts of environmental boundaries both fictitious and real have taken form since the nineteenth century—literally materialized in glass. 46 In this sense, the UV glass debate of the interwar period may be read as a productive episode in the material genealogy of modern environmentality.

First of all, it involved different actors and issues—the experimental sciences, architecture, public health, biopolitics, industrial production, and so on—in establishing a new socio-ecological infrastructure. 47 Secondly, it changed the very functionality of the environmental glass boundary. Fourier's glasshouse had been a naturally given semipermeable filter. One could use it, but not change the parameters. The interwar debate on UV radiation—inspired by earlier developments in experimental

44 Espahangizi, "The Twofold History of Laboratory Glassware" (see note 9), p. 37; Svante Arrhenius and H. Borns, *Worlds in the Making: The Evolution of the Universe* (New York: Harper, 1908), p. 52.

45 Otto Völkers, *Glas und Fenster: Ihr Wesen, ihre Geschichte und ihre Bedeutung in der Gegenwart* (Berlin: Bauwelt Verlag, 1939), p. 76. See, for example, the urban glass dome on the cover of *Wonderstories* (Gernsback: New York, 1935).

46 Cf. the general argument in Espahangizi, "Twofold History of Laboratory Glassware" (see note 9). In this sense, the object of glass supports the argument that the spaces in which scientific practice takes place not only shape the conception of the sciences but also interact with the practice of architecture, developed in Galison and Thompson (eds.), *Architecture of Science* (see note 8).

47 Cf. Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in Thomas J. Misa, Philip Brey, and Andrew Feeberg (eds.), *Modernity and Technology* (Cambridge, MA: MIT Press, 2004), pp. 185–225; here p. 188–9.

research since the 1880s—fostered the perception of glass as an adjustable boundary device.

Therefore, the Vitaglass debate must be understood as an important episode in the prehistory of the environmental turn in twentieth-century architecture described by Reyner Banham. Revealingly, it took place at some remove from the avant-garde discourse of modern glass architects. 48 UV glass windows performed the "operative transparency" of today's hi-tech glass façades *avant la lettre*—which is to say, they regulated system-environment relations rather than giving the building a "face." 49

A third productive outcome of the UV glass debate of the 1920s was its contribution to the broader undercurrent of modern environmentality beyond the architectural field. This consisted in its integration of various epistemic, technical, and metaphorical notions of environmental boundaries in one holistic image: the atmosphere, the human skin, containers for objects, or architecture. Fritz Kahn's epic work of the mid-1920s on the modern human body offers a very telling example of this new socio-ecological imagination in the early twentieth century. f.7 In the upper part of the illustration we see the UV glass iconography. Both the windowpane and the glass container are incorporated as boundary devices in the metabolic pathways of the health-enhancing Vitamin D. In this picture we can grasp the emerging notion of an overarching, multi-layered environmental "living machine" that is structured by natural as well as man-made technological boundaries and in which modern human existence is embedded. 50 This liminality—epitomized by the glass boundary between organicist and mechanistic interpretations, between an environmental "diode" and a "second skin"—runs like a thread through the architectural debates of the twentieth century. 51 Against this backdrop, the UV glass debate of the interwar period reveals itself to be a productive historical conjuncture in the material, epistemic, and imaginative genealogy of modern environmentality.

Post scriptum: The Biosphere 2 project—designed as a simulation of the real biosphere and built in the desert in Arizona in 1991—"rediscovered" the poor UV transmissibility of ordinary glass. The lack of UV radiation negatively affected the vegetation in the artificial ecosystem. 52

48 Reyner Banham, *The Architecture of the Well-Tempered Environment* (London: Architectural Press, 1984 [1969]), p. 18.

49 Nikolaus Kuhnert and Angelika Schnell, "Transparencies Yet to Come," *ARCH+*, 144/145 (1998), pp. 18–19; here p. 19. Cf. Völkers, *Glas und Fenster* (see note 45), pp. 73–80.

50 Cf. Völkers, *Glas und Fenster* (see note 45), p. 78; Ted Krueger, "Like a Second Skin: Living Machines," in *Architectural Design*, 66, no. 9/10 (1996), pp. 29–32.

51 Krueger, ibid, p. 29; Mike Davies, "A Wall for all Seasons," *Royal Institute of British Architects*, 88, no. 2 (1981), pp. 55–7.

52 Charles Cockell, Adrian Southern, and Aleshs Herrera, "Lack of UV Radiation in Biosphere 2: Practical and Theoretical Effects on Plants," *Ecological Engineering*, 16 (2000), pp. 293–9.