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Translations of Material to Technology in Bauhaus Architecture

The story of the German Bauhaus, its beginnings and demise, is well known in architectural history. Frequently hailed as the beginning of contemporary architectural education, the Bauhaus' plea for thinking afresh about problems of building design in terms of new materials and tools continues to resonate in architectural discourse today. Originally conceived by Walter Gropius as an alternative to a normative Beaux Arts study of exemplars in antiquity, the Bauhaus promoted an education of artists and architects in a common *Vorkurs* (preliminary course). Because of its novelty, but also because of its important role in preparing students for training in the different workshops, the *Vorkurs* became one of the Bauhaus' most defining pedagogical features — an approach towards technical and artistic education predicated on an assumption that new technological solutions could be fostered through an early study of different material effects and affects. Shortly after his departure from the Bauhaus in 1927, the former director of the *Vorkurs*, László Moholy–Nagy published two books, *Von Material zur Architektur* in 1929 (*The New Vision* in 1932) and *Vision in Motion* in 1947 to promote the Bauhaus approach in practice. Although copiously illustrated with examples of student and professional work, one is hard–pressed to find concrete examples in these publications for the translation of *Vorkurs* material studies to the imagination of "*technische Form*" (technical form) in its presumed goal of architecture.

Founded during the years immediately following the end of the First World War, the pedagogy developed at the Bauhaus was as much a response to Germany's changing political landscape as it was to new industrial practices. Criticized for the "technical backwardness, aesthetic inferiority, and economic worthlessness" of its industrial production before the war, German manufacturers, designers and architects formed the *Deutscher Werkbund* (German Arts and Crafts Association) and argued that the quality of German goods would improve if artists familiar with industrial processes designed them.[1] Gropius took inspiration from many of these ideas and incorporated them into his new school that he proposed would embody a reconsideration of crafts–based training, calling for the unity of the creative arts under the primacy of architecture. [2]

1 Wilhelm Waetzoldt, "Die Entwicklung des kunstgewerblichen Unterrichswesens in Preussen," *Deutsche Rundschau* 176 (1918): 228–45; 365–80 after John V. Maciuika, *Before the Bauhaus* (Cambridge: Cambridge University Press 2005), 21, n. 60.

2 Frank Whitford, *The Bauhaus: Masters & Students by Themselves* (London: Conran Octopus Ltd., 1992), 38–41.

Taught continuously from the fall of 1920 throughout the school's existence, the beginnings for the *Vorkurs* emerged less from a need to re–educate students with an existing training in the creative and applied arts than out of a necessity to raise the general level of talent of those enrolled in the first year.[3] As Gropius explained, the aim of the *Vorkurs* became a means to liberate the pupil "from the dead weight of conventions" so that they could approach the practical application of different materials and form in designing a new architecture that emerged from a process of manufacture.[4] After completing a half-yearlong obligatory Vorkurs to unleash a student's imagination through exercises that introduced them to the visual and haptic qualities of materials, graduates were then permitted to enroll in one of the different workshops with only the best individuals admitted to the study of architecture in their fourth year.

3 Franciscono, *Walter Gropius and the Creation of the Bauhaus in Weimar*, 162, n. 32.

4 Walter Gropius, *The New Architecture and the Bauhaus*, trans. P. Morton Shand (London: Faber and Faber Limited, 1935), 47.

Fig. 1 View of the International Architecture Exhibition at the 1923 Bauhaus Exhibition.

However, when after four years of incubation, the Bauhaus opened the 1923 *Bauhaus Ausstellung* (Bauhaus Exhibition) to showcase its new industrial prototypes to the public, the architecture on display was not created by the students but included a carefully selected array of international contemporary architecture (fig. 1).[5] Compared to the other advanced courses in design, Gropius had yet to found a workshop for architecture in which students could develop their own designs.[6] Students often complained that Gropius refused to teach architecture, which he argued was because students must "have first four years of training before [they are] able to go into conceiving architecture."[7]

5 Walter Passerge, "The Bauhaus Exhibition in Weimar," *Das Kunstblatt* 7 (1923): 309 ff trans. Wolfgang Jabs and Basil Gilbert in Hans M. Wingler, *The Bauhaus* (Cambridge, Mass.; London, England: The MIT Press, 1969), 67–8.

6 Wallis Miller, "Architecture, Building, and the Bauhaus," ch. 4, 64–9 in: Kathleen James–Chakraborty ed, *Bauhaus Culture: From Weimar to the Cold War* (Minneapolis, London: University of Minnesota Press, 2006).

7 George Baird, "Bauhaus Conflicts Seen Now," (BBC radio broadcast, transcript: October 18, 1968); transmission: October 25, 1968, 21:25–22:25), 12 after James–Chakraborty ed, *Bauhaus Culture*, 69, n. 20.

On the occasion of the Bauhaus' fourth year of operation, Gropius did not announce the beginning of a new architecture workshop, but the addition of a third programmatic goal "Kunst und Technik—eine neue Einheit" (art and technology—a new unity) suggesting that "technology does not need art, but art does need technology." Presented in a lecture for the 1923 *Bauhaus Ausstellung's* (Bauhaus Exhibition) opening reception, Gropius' change to the Bauhaus program was the resolution of a conflict between two radically different interpretations of the Bauhaus' pedagogical aims – those of Gropius and his at that time *Vorkurs* director, Johannes Itten. Itten's promotion of individual expression contrasted with Gropius' goal of an integrated architectonic vision, which he argued demanded that the Bauhaus start taking commercial commissions. [8]

8 Walter Gropius "The Necessity of Commissioned Work for the Bauhaus (December 9, 1921)," trans. Wolfgang Jabs and Basil Gilbert in Wingler, *The Bauhaus*, 51.

Gropius' intention in founding the Bauhaus was always to find a new socially constructive place for the artist who had lost his roots in nineteenth century industrial production. Yet, because of mounting political and financial pressures, Gropius saw the Bauhaus' production of prototypical products for industry as a way to free the Bauhaus from state subsides. For Gropius, the ultimate goal for the Bauhaus program remained in the conception of architecture, which he now characterized as walking "hand in hand with technology" since contemporary architecture had "the same traits characteristic of the modern engineered products of the machine."[9]

9 Walter Gropius, *Internationale Architektur* (Munich: Albert Langen Verlag, 1925), 71.

With the appointment of the Hungarian Constructivist artist, László Moholy–Nagy as director of the *Vorkurs* in October 1923, Gropius sought to reinforce the Bauhaus' new pedagogical unity with technology. What Itten had conceived as a metaphysical speculation of form and color during the Bauhaus' first three years were reoriented towards an objective assessment of material effects and affects. Inspired by the Hungarian born botanist and nature philosopher Raoul Francé's concept of 'bio–technique,' Moholy–Nagy intended that students would translate these "typical" or representative possibilities of different material effects or affects to the creative imagination of "technical forms" for art, industry and – as the original German title: *Von Material zu Architektur* of his book *The New Vision*, suggests – architecture.[10]

10 Lázló Moholy–Nagy, *The New Vision: Fundamentals of Bauhaus Design, Painting, Sculpture, and Architecture* (Mineola, NY: Dover Publications, 2012), 21 and 60. The first publication retained the a closer translation of the German title as László Moholy–Nagy, *The New Vision: From Material to Architecture* (New York: Breuer, Warren, Putman Inc., 1932).

Yet, when Gropius finally established a building department in 1927, his replacement, Hannes Meyer broke with the original idea of a unified art school and sought to establish the architecture department as an autonomous entity. Under these circumstances, Moholy–Nagy left the Bauhaus with Gropius and moved to Berlin as a freelance designer and photographer until 1937, when he was invited to Chicago by the Association of Arts and Industries to head a new design school based on the Bauhaus model.[11] It is only in Chicago that Moholy–Nagy is able to provide examples of student architectural designs. Yet in these instances, Moholy–Nagy still relies upon examples of built work or that produced by students in the other arts to demonstrate the application of Francé's design theory in practice. Without any formal training in the technical or creative arts (including architecture), much of Moholy–Nagy's approach towards the education of architects must be attributed to his quick synthesis of a divers range of new trends in art and architecture including Russian Constructivism and Francé's concept of 'bio–technique.' Compared to Gropius's claim that "technology does not need art" Moholy–Nagy embraced the work of Constructivist artists as a model for the material studies in the *Vorkurs*. For Moholy–Nagy, the value of the impressions a student amassed in these exercises depended upon their ability to make translations of their effects or affects to prototypes for industry and inevitably architecture.

11 Krisztina Passuth, *Moholy Nagy* (London: Thames Hudson, 1985), 61–5.

Moholy–Nagy, the Development of a Pedagogical Approach

Born in Hungary during the turn of the twentieth century, Moholy–Nagy's self–education as a teacher and artist had a decisive influence on his aesthetic approach to materials. Originally trained in law, Moholy–Nagy's earliest creative experiments were in portraiture and landscape painting.[12] Here, Moholy–Nagy began to experiment with an abstract emphasis on the lines of his paintings "where ordinarily no lines are used."[13] When he left Hungary a few months after the short–lived Communist Republic of Bela Kun collapsed in August 1919 Moholy–Nagy at first immigrated to Vienna for six weeks.[14] Moholy–Nagy moved to Berlin in March 1920 because as

12 Passuth, *Moholy Nagy*, 13–14.

13 Lázló Moholy–Nagy, "Abstract of an Artist," in Moholy–Nagy, *The New Vision*, 212.

14 Moholy–Nagy, *The New Vision*, 16.

he recalled later, "I was less intrigued with the baroque pompousness of the Austrian capital than with the highly developed technology of industrial Germany."[15] This new interest coincided with a sudden change in Moholy–Nagy's work whereby the "network of lines" gained more prominence in *Perpe* from 1919 as wheels, machine belts and trusses – images of industrial Germany. These objects were prominently figured in the works produced by two Berlin artists during the same year: Francis Picabia's *Réveil matin I* (Alarm Clock I) on the May 1919 cover of DADA magazine and the Merz artist, Kurt Schwitters' drawing, *Konstruktion* (Construction) in the July 10, 1919 issue of the popular Berlin avant–garde journal *Der Sturm*. It is hard to imagine that Moholy–Nagy was not already familiar with the work of Schwitters whose exhibition he visited at the Sturm gallery within a month after arriving in Berlin during March of 1920.

15 Moholy–Nagy, "Abstract of an Artist," Moholy–Nagy, *The New Vision*, 216.

Despite an initially critical reaction to the painted and assembled materials in Schwitters' Merz art, Moholy–Nagy's own exploration of assemblage became essential to his appreciation of the 'typical possibilities' of materials at the Bauhaus. After visiting Schwitters' Sturm exhibition, Moholy–Nagy complained in a letter to his Hungarian colleague, Iván Hevesy that "a man called Kurt Schwitters makes pictures from newspaper articles, luggage labels, hairs and hoops. What's the point?"[16] Nevertheless, Moholy–Nagy quickly exchanged paint for assemblage, gluing and nailing screws, bolts, sections of T–squares, and machine pieces to wooden boards covered with paint or drawings. Schwitters Merz–use of found objects to create art and architecture introduced Moholy–Nagy to a method for going beyond normative practices of creating art and architecture by finding inspiration in the constructive potential of materials. As Schwitters explained in the first issue of his magazine *Merz*, the use of found objects to create art was the result of a unique approach towards his artistic materials: "These things are inserted into the picture either as they are or else modified in accordance with what the picture requires. They lost their individual character, their own poison, by being evaluated against one another, by being *entmaterialisiert* (dematerialized) they become material for the picture."[17] For Schwitters, the process by which a found object's culturally attributed identity was 'dematerialized' in its imaginative transformation as an element of art or architecture was likened to a mill. Schwitters relentlessly depicted wheels and mills in his drawings and sculptures during this time to describe his new artistic method. In 1920, Schwitters extended his artistic method to architecture creating a small cathedral model with gears in its nave entitled *Haus Merz* (House Merz) as alternative to Gropius' use of the crystal metaphor for the *Zukunftskathedrale*.[18] Moholy–Nagy, who had no formal training in art, shared a studio with Schwitters in Berlin from 1921–23. The sudden exploration of assemblage in his own artwork throughout 1921 illustrates the strong influence that Schwitters had on him (fig. 2).[19] Free from any academic fixations that might have hindered innovation, Moholy–Nagy was able to go beyond artistic boundaries and traditional concepts of art and design.[20]

16 Moholy–Nagy, letter to writer Iván Hevesy, Berlin, April 1920, collection of the Documentation Center of the Art History Research Group of the Hungarian Academy of Sciences, Budapest, reproduced in Passuth, 338.

17 With my inclusion of *entmaterialisiert* from the original German text, this English translation by Werner Schmalenbach, *Kurt Schwitters* (Köln, M. DuMont Schauberg, 1967), 94.

18 Matthew Mindrup, "The Merz Mill and the Cathedral of the Future," *Interstices* 14 (November 2013): 52–5.

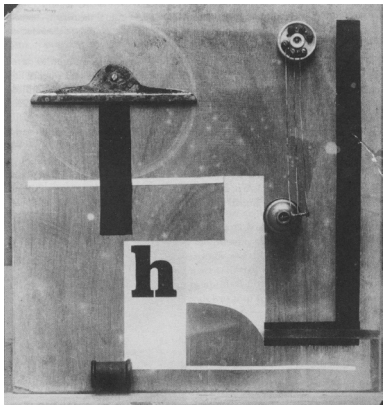

Fig. 2 Lászlo Moholy–Nagy, *h Construction,* 1921.

19 Lázló Moholy–Nagy, "Abstract of an Artist," 216.

20 Irene–Charlotte Lusk, *Montagen ins Blaue: Lázsló Moholy–Nagy, Fotomontagen und –collagem 1922–1943* (Giessen: Anabas, 1980), 68–9 and Elizabeth Otto, "A 'Schooling of the Senses': Post–Dada Visual Experiments in the Bauhaus Photomontages of Lázsló Moholy–Nagy and Marianne Brandt," *New German Critique* 107 (Summer 2009) after Elizabeth Otto, "Designing Men," in: *Bauhaus Construct*, 188, n. 24.

From 1922 on, Moholy–Nagy began to synthesize Schwitters' influence with Constructivism – its glorification of the machine, technology and industry – not only in formal terms but also by experimenting with new techniques and materials. It was at this time that Moholy-Nagy co-authored the *Buch neuer Künstler* (Book of New Artists) in which he included Schwitters' *House Merz*, continued his celebration of the machine and participated in the 1922 Dada–Constructivist Congress in Weimar.[21] From Schwitters, Moholy–Nagy was introduced to a method for exploiting the objective principles of everyday materials in art while in Constructivism he embraced the machine as a model for the purity of art and its emphasis upon creating art through the composition of elements that were void of representational references arguing with Raoul Hausmann, Hans Arp and Ivan Puni that "[t]o be an artist is to surrender to the elements that give form."[22] Inspired by these approaches, Moholy–Nagy increasingly concentrated throughout the twenties on an exploration of direct light in photographs, photograms and three–dimensional compositions of wood, glass, and mirror–polished metals[23] "in which the movement of the viewer reveals the first state of free play of light in space that is produced by the mirror–like, reflecting material."[24]

A New Vision for Technical and Artistic Education

In early 1923, Gropius invited Moholy–Nagy to replace Itten at the Bauhaus and in the spring of the same year he took over the *Vorkurs* from the Bauhaus master Joseph Albers. By that time, Gropius had become convinced that creative work at the Bauhaus had to be connected with industrial design if the school was to enact reform. Although Moholy–Nagy exhibited at the Expressionist Sturm Gallery in 1922 and was convinced that the creation of new forms could assist with the development of an improved world order, the twenty–seven–year–old Hungarian émigré was thought to represent the new direction of Russian Constructivism.[25] Where Expressionism tried to develop "with the boundlessness of individual moments of feeling and visions," Constructivism was imbued "with the will to the most outward objectivity, economy, and conscious precision" that could be merged with industrial production.[26] The contrast to Itten's metaphysical and individualistic tendencies could not be stronger than in Moholy–Nagy's embrace of the machine, new technologies and Constructivism's objective purity. For Moholy–Nagy though, the creation of this new unity between art and technology was not dependent upon students engaging in systematic work towards "standardized production."[27] Rather, Moholy–Nagy sought to provide students with opportunities during their first years of study for "amassing of impressions" that could establish a solid foundation for the "handling of materials in technical and artistic work."[28]

Upon his appointment at the Bauhaus, Moholy–Nagy made subtle changes to the *Vorkurs* in order to align it with Gropius' new aim for a unity

21 Ludwig Kassak and László Moholy–Nagy, *Buch neuer Künstler* (1922), reprint ed. (Baden: Verlag Lars Müller, 1991).

22 Raoul Hausmann, Hans Arp, Ivan Puni, László Moholy–Nagy, "Aufruf zur Elementaren Kunst," *De Stijl*, no. 10 (1921): 156. Translated as "*Manifesto of Elemental Art*." In: *Moholy–Nagy*, ed. Krisztina Passuth (New York: Thames and Hudson, 1985), 286.

23 Laszlo Moholy–Nagy created around sixty photomontages from circa 1922 while sharing a studio with Kurt Schwitters.

24 Hannah Weitemeier, "László Moholy–Nagy: Leben und Werk," in László Moholy–Nagy, exhibition catalogue (Stuttgart: Hatje, 1974), 71 after Rainer K. Wick, *Teaching at the Bauhaus* (Hatje Cantz Publishers, 2001), 137 n. 36.

25 Rose–Carol Washton–Long explores the selection and impact Moholy–Nagy had upon the Bauhaus in Rose–Carol Washton–Long, "From Metaphysics to Material Culture," in James–Chakraborty ed, *Bauhaus Culture*, 49–58.

26 Emö Kallai, "Konstruktivismus," *Jahrbuch der Jungen Kunst* (1924), in *Wechselwirkungen*, ed. Gassner, 163–67 after: Victor Margolin, *Struggle for Utopia* (Chicago and London: The University of Chicago Press, 1997), 77, n. 104

27 Moholy–Nagy, *The New Vision*, 23–24.

28 Moholy–Nagy, *The New Vision*, 23–24.

between art and technology. In the same spirit as Itten, Moholy–Nagy viewed the *Vorkurs* as a pedagogical necessity for undoing the errors of academic education and to liberate the creative potential of the students. Moholy–Nagy saw their principle task as sharpening their students' perceptiveness – to become more 'aware' – be it to the qualities of a particular material or the pressing questions of their time. In this, Moholy–Nagy became essentially concerned with the training of the sense of touch, "a grasp of materials through actual experience [...] such as is never attained through book knowledge in the usual school exercises and the traditional courses of instruction."[29] Thus, he continued Itten's practice of introducing students to a variety of mediums and materials through exercises that sought to train their tactile and optical senses. Yet, whereas the tactile exercises created under Itten are marked by a farcical charm and humorous witticism, those under Moholy–Nagy were directed at the systematic study of the materials through chart–like *Tasttafeln* (touch panels) (fig. 3). For Moholy–Nagy, these data–gathering tools were intended to record the psychological reactions of individuals to different textures by means of "tactile diagrams" to objectify what was subjectively felt to make them accessible to inter–subjective reconstructions, i.e. translations to new industrial products and architecture.[30]

29 Moholy–Nagy, *The New Vision*, 18–19.

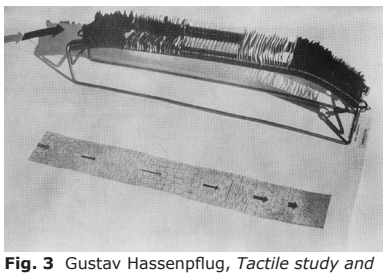

Fig. 3 Gustav Hassenpflug, *Tactile study and diagram for Moholy–Nagy's Vorkus. 1927.*

30 Wick, *Teaching at the Bauhaus*, 149–54.

Albers had already established a curriculum that combined the exploration of material properties with simple construction methods. From 1923 until the end of the Weimar Bauhaus in 1925, Albers was responsible for the so–called work–studies that formed part of the *Vorkurs*, then still just one semester that was officially led by Moholy–Nagy. In 1925 Moholy–Nagy expanded this course into a second semester where the basic knowledge of matter and method, acquired earlier, was applied to the inventive creation of form. Experiment, the free play of intuition and material knowledge, was valued higher than the finished result. "Education by process" became the motto of the *Vorkurs*.[31]

31 Sibyl Moholy–Nagy, *Moholy–Nagy: Experiment in Totality* (Cambridge, Mass.: MIT Press, 1969, 2nd edition), 39.

It is difficult to find differences between the pedagogical aims of Moholy–Nagy and Albers that emerge only in nuances between their terminology and use of *Vorkurs*' material studies. Moholy-Nagy and Albers both adapted a Constructivist emphasis towards the truth to materials. For Moholy-Nagy, this meant the establishment of unambiguous descriptions for terms like "structure," "texture" and what the Constructivists called faktura (facture). Moholy–Nagy defined the 'structure' of a thing as the "unalterable manner in which the material is built up, while 'texture' is the "organically resulting outward surface." Texture though, should not be confused with the "surface aspect" or facture that Moholy–Nagy defined as "the manner and the appearance of the surface, the sensorially perceptible result (the effect) of the working process."[32] Borrowing Moholy–Nagy's terminological distinction, Albers built up his instruction upon two pillars: on the exercises with *matière* or surface appearance and materials or structural properties. Unlike the *matière* exercises, which aimed to help de-

32 Moholy–Nagy, *The New Vision*, 30–7.

velop sensory recognition of the surface of materials, the material exercises were concerned with exploring immanent features of the material, such as stability, load–bearing capacity, strength, and so on, that is, to examine their "inner energies."[33] In the latter, one might find a first sign toward the "technical form" that will be discussed later. The emphasis that Albers and Moholy–Nagy sought was, in terms of art, "[a]n art that presents rather than represents."[34]

33 Moholy–Nagy, *The New Vision*, 179–80, n. 56

34 Albers quoted in Herzogenrath, "Joseph Albers und der 'Vorkurs' am Bauhaus, 1919–1933," *Wallraf–Richartz–Jahrbuch: Westdeutsches Jahrbuch für Kunstgeschichte* 41 (1979–80): 252 after Wick, Teaching at the Bauhaus, 179. n. 53.

The aim of refining the haptic and optical senses of students enrolled in the *Vorkurs* was to act as a source of inspiration for practical applications in design. Throughout *The New Vision*, Moholy–Nagy speculated upon the applications that the *Vorkurs* exercises could have for art and technology. However, without concrete examples from the Bauhaus students, Moholy–Nagy resorted to descriptive illustrations of the work's potential. In reference to paper, Moholy–Nagy argued how studies with the surface treatment of paper could be used to create attractive patterns for manufacturers of chocolate or cookie wrappers. Similarly, the examples produced by Albers' paper folding exercises were proposed as a source for inventions of building constructions, household appliances, packaging, or book–binding; while the study of virtual volumes by rotating pieces of wire could anticipate the movement of parts in appliances and machines.[35] As Moholy–Nagy explained "[t]he problem will be, of course, as everywhere else, to find the right ways of application" – their translation from material to the creative and applied arts including architecture.[36]

35 Moholy–Nagy, *The New Vision*, 129.

36 Moholy–Nagy, *The New Vision*, 54.

An example of this creative transfer of information garnered from material studies is found in Moholy–Nagy's own 1934 Dutch Rayon Industry exhibition design for the Commercial Fair in Utrecht and the World's Fair in Brussels. As Moholy–Nagy's wife Sybile recalls, Moholy–Nagy hung tables from the wall and employed the very materials that were being displayed to create the architecture. Similar to the touch panels of Bauhaus students, Moholy–Nagy took inspiration from a study of the natural gradations of sound for the composition of a harp of colorful rayon spools for a screen wall (fig. 4).[37]

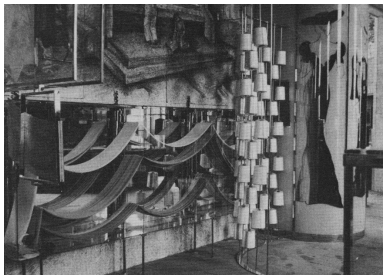

Fig. 4 Moholy–Nagy, *Dutch Rayon Manufacturers,* Utretch, 1934.

37 Sibyl Moholy–Nagy, *Moholy–Nagy: Experiment in Totality*, 111–12.

Translations From Material to Architecture

Moholy–Nagy argued at length in both *The New Vision* and *Vision in Motion* that the 'Bauhaus idea' was to delve into a given medium in order to extract the key properties of its structure and translate them as productive principles for finding technological solutions to practical problems. Moholy–Nagy identified the intellectual underpinnings for this approach in Raoul Heinrich Francé's (1874–1943) concept of 'bio–technique' as "the possibilities of using nature as a constructional model in creative technique."[38] Two months after the publication of a chapter of Francé's book, *Die Pflanze als Erfinder* (Plants as Inventors) in the Berlin art journal *Das*

38 Moholy–Nagy, *The New Vision*, 60.

Kunstblatt, Moholy–Nagy was hired at the Bauhaus.[39] In *The New Vision*, Moholy–Nagy reiterated Francé's premise for the application of natural processes to technical artifacts or simply, technology in an understanding of "form follows function" such that: "[e]very process has its necessary form, which always results in functional forms. They follow the law of shortest distance between two points; cooling occurs only on surfaces exposed to cooling; pressure only on points of pressure; tension on lines of tension; motion creates for itself forms of movement – for each energy there is a form of energy."[40] In reference to the laws of economy and least resistance, Moholy–Nagy reasons that "[a]ll technical forms can be deduced from forms in nature" since "similar activities shall always lead to similar forms."[41] Referencing Francé, Moholy–Nagy noted how all processes in the world develop according to seven fundamental technical forms including the crystal, sphere, cone, plate, strip, rod, and spiral (screw). With particular attention towards the spiral (screw), Moholy–Nagy illustrated how these are the basic technical elements in diverse forms of aesthetic and industrial manufacture including an elevator shaft, a circus training structure and art.[42] Using a sculpture created by Korona Krause in 1924, Moholy–Nagy demonstrated how Francé's technical forms also had diverse applications by which the spiral of a screw could be employed as a spring carrying an entire structure.[43] At Moholy–Nagy's New Bauhaus school in Chicago the translation of a spring's lever–like function led to the design of one of its the most celebrated projects a wood spring mattress.

The wood spring mattress created at the Chicago Bauhaus provides a clear illustration of Moholy–Nagy's pedagogical approach towards the creative translation of experiences garnered in the *Vorkurs* exercises to technological solutions. Already in Germany, Moholy–Nagy observed how the manipulation of flat sheets of paper into three–dimensional structures could be adaptable to the work with any flat sheet or slab, such as cardboard, plywood, metal, wire mesh, and plastics[44] (figs. 5 and 6). When working in wood (blocks, dowels, slabs) Moholy–Nagy remarked how cuttings and sawing's made by hand and machine, made a rigid board "rubber–like."[45] Perhaps he already had in mind an application for these woodcuttings when he suggested in *The New Vision* how "the same principle can be applied to every other material and every other tool" including metal.[46] A few years later in *Vision in Motion* Moholy–Nagy was able to demonstrate how Jack Waldheim and Kalman Toman extended the *Vorkurs* study of cutting and sawing wood to arrive at the technological solution for a wooden spring which could be easily produced and provide the comfortable elasticity of a metal box spring. Curiously, one notices that neither the spiral nor any of Francé's seven technical forms are present in the resulting spring design, a 'z' shaped "accordion type," of spring demonstrating Moholy–Nagy's axiom for the translation of forms as an "understanding that certain shapes arrived at and valid in one material cannot be satisfactorily imitated in another despite the identity of function."[47]

39 Francé, Raoul. "Die sieben technischen Grundformen der Natur." *Das Kunstblatt* 8, no. 1 (January 1923): 5–11.

40 Raoul Francé, *Die Pflanzen als Erfinder* (Stuttgart: Kosmos, 1920), 82 translated as *Plants as Inventors* (New York: A. and C. Boni, 1923), 12–3.

41 Moholy–Nagy, *The New Vision*, 60.

42 Moholy–Nagy, *The New Vision*, 122.

43 The work is produced by Korona Krause in 1924. In *The New Vision* Moholy–Nagy describes it as "An attempt at constructive application of the spiral, which carries the whole structure." Moholy–Nagy, *The New Vision*, Fig. 132, 125.

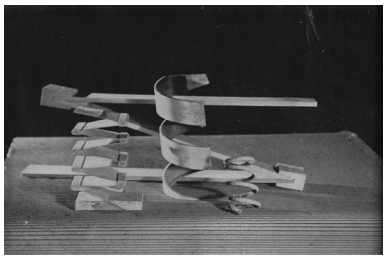

Fig. 5 Charlies Niedringhaus and Jack Waldheim, *Four Types of Wood Springs,* c. 1941–42.

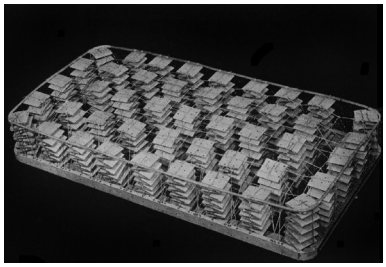

Fig. 6 Charles Niedringhaus and Jack Waldheim, *Woodspring Mattress,* 1942.

44 László Moholy–Nagy, *Vision in Motion* (Chicago: P. Theobald, 1961), 81.

45 Moholy–Nagy, *The New Vision*, 54.

46 Moholy–Nagy, *The New Vision*, 57–8, Fig. 48.

47 Moholy–Nagy, *Vision in Motion*, 35.

In *Vision in Motion*, Moholy–Nagy continued to promote bio–technique as a universal approach towards design but made less effort to illustrate the application of Francé's seven technical forms in practice. Referencing Francé, Moholy–Nagy argued that for those designers who seek to build up a work solely from the elements that are required for its function will find that no technical form exists which cannot be traced to the forms of nature.[48] By comparing the grip of a hand with a pair of pliers, the strength of an eggshell with a Horton Spheroid oil tank and a scallop shell with metal corrugation as examples, Moholy–Nagy reasoned that in all fields of creation, designers are using suggestions of nature to find functional solutions of a technical biological kind. In these examples Moholy–Nagy departed from a universal application of Francé's seven constructional elements to a "wide comprehensive knowledge of characteristics and elements" with the artist (or designer) having the right to "select and reject" them.[49] This reinforces Francé's own approach to art, technology and architecture in his 1927 published *Die Waage des Lebens* (The Balance of Life) where nature is not to be used as a template to be copied but in the same spirit as a century earlier Quatremère de Quincy noted in his *Essai sur la nature, le but et les moyens de l'imitation dans les beaux–arts* (Essay on the Nature, the End and the Means of Imitation in the Fine Arts): "One therefore imitates nature by doing not what she does but as she does."[50]

48 Moholy–Nagy, *Vision in Motion*, 44.

49 Moholy–Nagy, *Vision in Motion*, 241.

50 In a conversation with Haeckel, Francé argues that one does not create new art by copying the forms of nature like a template but "you should look at the problem solved by the form … use the same method as the organism used in solving it by producing its own specific form." Raoul Francé, *Die Waage des Lebens* (1921) after Detlef Mertens, "Where Architecture Meets Biology" in Joke Brouwer and Arjen Mulder eds., *Interact or Die* (NAi Publishers, 2007), p. 122; Quatremere de Quincy, "On Imitation," in: AD, v. 28, no. 9–10 (1988): 7.

Following a similar approach towards the imitation of an existing model, at the New Bauhaus, architectural exercises were developed to extend the critical evaluation of material and spatial compositions in the *Vorkurs* to the discovery of technological solutions for architecture. One of the first design exercises in the education of an architect at the New Bauhaus was to design a "primitive house" not by copying a historical prototype but by re–enacting the inventive mechanics of age–old architectures (fig. 7).[51] Confronted by a specific climatic and geographical condition with specific building materials and living/working conditions the student was encouraged to rediscover the functional principles of regional architectures. Yet, by living in the industrial age, the student is challenged to "improve the traditional handling of material and techniques under the impact of the new technology."[52] For Moholy–Nagy, this was an exchange by which a study of pre–industrial wooden peg joints could inspire new ways of driving nails in industrial production. Conversely, studies with constructing chair legs could inform the student how to understand the brace in lumber construction.[53]

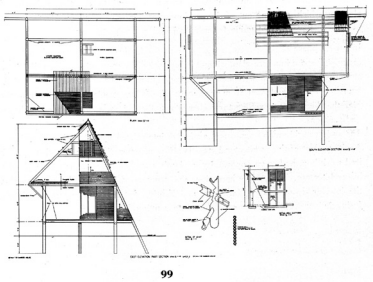

Fig. 7 Henry Khan, Bamboo house for a tropical environment, 1940.

51 Moholy–Nagy, *Vision in Motion*, 98.

52 Moholy–Nagy, *Vision in Motion*, 98.

53 Moholy–Nagy, *Vision in Motion*, 99.

The ability for a designer to use the constructive principles of natural or man–made objects in one location to solve technical problems of design in another is clearly the interconnectivity of solutions that Moholy–Nagy aimed. The last step of Bauhaus pedagogy is the practice of making "correlations" by an emphasis on "integration through a conscious search for relationships – artistic, scientific, technical as well as social."[54] Although he provided no concrete examples from the work of Bauhaus students,

54 Moholy–Nagy, *Vision in Motion*, 68.

Moholy–Nagy reasoned that solutions to architectural tasks are founded upon this same correlation of findings from "the previous exercises on a smaller scale."[55] Similar to the etymological origins of the word 'metaphor' in the Greek term '*metapherein*' as a *translatio* (transportation) of sensory information from one modality to another, the efficacy of the constructive technique a student experiences in one location would thus depend upon how well it solves that of a designed object in another. This is the act of genius for Moholy–Nagy. It is "the flashlike act of connecting elements not obviously belonging together. Their productive relationships, unnoticed before, produce a new result."[56]

55 Moholy–Nagy, *Vision in Motion*, 100.

56 Moholy–Nagy, *Vision in Motion*, 68.

The Italian writer and literary philosopher, Umberto Eco places a great amount of importance upon the creative function of these 'translations' within and between semiotic systems. Eco's exploration of the Russian–American linguist, Roman Jakobson's definition of intra– and intersystemic translations provides valuable insight into the creative transfer of technical solution Moholy–Nagy intended at the Bauhaus. As Eco explains, intrasystemic translations include the "interpretation of verbal signs by means of signs of some other language" while intersystemic translations occur when there is "an interpretation of verbal signs by means of signs of non–verbal sign systems."[57] For Eco, one can consider how the 'intrasystemic' translation of a map for the Crown Prince Islands on the west coast of Greenland remains within the same semiotic system when one reproduces it at a larger scale while the translation of the same map to three–dimensions by an Eskimo hunter using sealskin and driftwood is 'intersystemic.'[58] Compared to the intrasystemic variations of Waldheim and Toman's New Bauhaus wooden springs, there is a decided step from purport to purport in Moholy–Nagy's intersystemetic translation of the sound to color in his screen design for the Dutch Rayon Industry's exhibition, whereby the one "is always creatively enriching the first item."[59]

57 Umberto Eco, *Experiences in Translation*, trans. Alastrair McEwen (Toronto, et al.: University of Toronto Press, 2001), 67.

58 Umberto Eco, *Experiences in Translation*, 103 and 118.

59 Umberto Eco, "The influence of Roman Jakobson in the Development of Semiotics," in *Roman Jakobson: Echoes of His Scholarship* (Lisse, The Netherlands: Peter de Ridder Press, 1977), 53.

Moholy–Nagy's pedagogical approach towards the intra– and intersystemic translations of *Vorkurs* materials studies was dependent upon the ability of a designer to find appropriate applications for them. The knowledge a student garnered about the principles of structure, texture, and surface treatment created by working with various materials in the *Vorkurs* were to be used for finding technological solutions to design problems that Moholy–Nagy viewed as the organization of space, form, material and processes in the most productive, economic way for solving a certain function.[60] The designer's choices were not based upon interchangeable considerations of single elements but as Moholy–Nagy's Rayon exhibition and wood spring mattress project at the New Bauhaus illustrate, how to use inter– and intrasystemic translations of material studies to art and architecture.

60 Moholy–Nagy, *The New Vision*, 156–7.

Conclusion

Throughout his career, Moholy–Nagy sought to justify his approach to the education of architects in learning the creative translation of sensory experience to solving problems of technical form. Already at the beginning of his book *The New Vision*, Moholy–Nagy asserted a universality of experience claiming that "[e]veryone is equipped by nature to receive and assimilate sensory experiences.[61] Everyone is sensitive to tones and colors, has sure touch and space reactions, etc. This means that by nature everyone is able to participate in all the pleasures of sensory experience." One of the Bauhaus' most defining pedagogical features, the *Vorkurs*, had its goal in training a student's ability to make translations between material, art, technological solutions and architecture. With the material exercises in the *Vorkurs* directed toward sensory experiences, the enrichment of emotional values, and the development of thought, a student at the Bauhaus was intended to amass impressions that may appear unimportant at first. It was not intended as an introduction to the practice of industrial design but to train a new generation of designers to grasp the relationship between form and function as a kind of wholeness. For his Chicago Bauhaus curriculum, Moholy–Nagy drew heavily on the pedagogy he established in Germany, starting off with a one–year *Vorkurs* followed by three years of specialized workshop training.

61 Moholy–Nagy, *The New Vision*, 15.

Moholy–Nagy's approach towards the *Vorkurs* exercises at the German and later Chicago Bauhaus' was clearly influenced by both Schwitters and Constructivism's approach towards the creation of art void of representational elements in which compositions relied on an exploitation of the objective effects or affects of everyday materials. One observes in *The New Vision* that origin for many of these exercises was in the creation of art. When Moholy-Nagy speculated on the practical applications for the surface treatment of paper in chocolate wrappers or the rotation of wire to study the movement of machine parts, he also included Schwitters' 1922 Rubbish Picture and Naum Gabo's 1922 Kinetic Construction in Space as examples for each. These inclusions challenged Gropius' 1923 proposal that "technology does not need art, but art does need technology" proposing instead an approach to Bauhaus design education founded on a Constructivist method for creating art that does not need technology. For Moholy–Nagy, the development of new technological solutions for industry and architecture needs an artist (or architect) who has "amassed impressions" about materials and their effects/affects. There impressions were to be garnered not by a textural study of historical precedents but by "looking again" at material and constructive properties so that the student could be endowed with a knowledge of materials and the sapience for making intuitive translations of their principles to the technical solution of practical problems of design and architecture in particular.

Author

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Figure 1. View of the International Architecture Exhibition at the 1923 Bauhaus Exhibition. Used with permission from the Hochschule für Architektur und Bauwesen Weimar. *(Excerpted from Winkler, Die Architektur am Bauhaus in Weimar, p. 141)*
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Figure 4. László Moholy-Nagy, Dutch Rayon Manufacturers Exhibition, Utrecht, 1934. © Laszlo Moholy-Nagy/Bild-Kunst. Licensed by Viscopy, 2014. *(Excerpted from Sibyl Moholy-Nagy, Experiment in Totality, Figure 40, p. 112)*
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Figure 7. Henry Kann, Bamboo house for a tropical environment, 1940. © Laszlo Moholy-Nagy/Bild-Kunst. Licensed by Viscopy, 2014. *(Excerpted from László Moholy-Nagy, Vision in Motion, Figure 121, p. 99)*

Recommended Citation

Mindrup, Matthew: Translations of Material to Technology in Bauhaus Architecture. In: Wolkenkuckucksheim, Internationale Zeitschrift zur Theorie der Architektur. Vol. 19, Issue 33, 2014, [pages], cloud-cuckoo.net/fileadmin/issues_en/issue_33/article_mindrup.pdf [inquiry date].