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The Design Laboratory. A Review of Five Design Education Programmes

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Five steps in the development of design studio culture are analysed based on a review of the literature: (i) Nikolai Ladovsky´s "Psycho-Technical Research Laboratory", 1921 to 1927, (ii) Gilbert Rohde´s "Design Laboratory", 1935 to 1937, (iii) Frederick Kiesler´s "Laboratory for Design Correlation", 1937 to 1941, (iv) John C. Jones´ "Design Research Laboratory", approx. 1963 to 1974, and (v) Neil Gershenfeld´s "Fab Labs", since 2003. Attention is drawn to the different ways in which art, science and technology are included in the curricula of these educational programmes. Contents and goals of teaching refer to features of laboratories and methods of work. An attempt is made to show how the metaphor of the laboratory was used to establish these programmes. The experimental character of the programmes and the changes from "pseudo-laboratory conditions" to "real-studio conditions" are discussed. The selected programmes can be characterised thematically, methodologically and metaphorically. The issue is to discuss design education not only as a technical but also as a social phenomenon.

design history, design research, design education

1 Preliminary Notes

Modern laboratory work links observation and experimentation and enables an integration of craft and innovation into science (Klein 2008, p. 10). The notion that artistic studios are comparable to laboratories emerged in avantgarde thinking and influenced the development of architectural and design studios. The experiments of these laboratories were not limited to the studio, the museum or the workshop, but were intended to be made available for the general public. Osip Brik called for working in the studio to be carried on into "the laboratories of life" (Brik op. cit. Arvatov 1972, p. 125), and Vladimir Mayakovsky stated that "The streets are our brushes. The squares, our palettes." (Mayakovsky op. cit. Khan-Magomedov 1987, p. 14). Walter Gropius defined the Bauhaus workshops as "laboratories, in which products, suitable for mass production, should be established and improved by working on models" (Gropius 1964, p. 91).

In social constructivism, knowledge accumulated in a laboratory was not only validated by other laboratories, but the places where knowledge could be generated were made into laboratories themselves. Louis Pasteur set up a laboratory environment in which contagious ferment could be created and regulated (Latour 1993b, pp. 62f.). His laboratory construction for microbes not only guaranteed the quality of milk, but also influenced the construction of dairies designed as laboratories (Farías & Wilkie 2016, pp. 10f). In artistic work, the world appears to be an uncontrollable "outside" where cultural artefacts are evaluated (ibid.). Knorr-Cetina (1992, pp. 127–128) examines construction drawings of the Middle Ages, where the laboratory was a permanently existing room with a pool of materials and tools, and convertible materials or transitional objects were produced.

Comparing scientific with artistic work is questionable because scientists and artists differ from each other in the way they can be regarded as instruments working between the world investigated and the knowledge accumulated (Alpers 1998, 403f). For Rheinberger (2012, n. p.), compared to technical planning, art is similar to science in the way it handles uncertain events. Artistic and scientific research share the features (i) "locality" and (ii) "stability" (Gramelsberger 2013, p. 103): (i) Certain places serve as a basis for the production of art and science. In the future this work will more and more be determined by a kind of "placelessness" and the relocation of research into virtual space (Landbrecht & Straub 2016, p. 40). (ii) As a science art has the problem of stabilisation, e.g. evaluating a piece of art in a social context. Design processes follow the course from mental to material states, i.e. externalisation, and not vice versa (Eekels & Roozenburg, 1991, p. 198), and stabilisation must be located in the realm of materiality.

The question to start with is whether it is possible to define a common foundation for science and art. Stating differences also means searching for relationships and similarities (Rheinberger 2014, p. 50). The five educational programmes discussed here were reform efforts of design education and design research combining science with art (Hasenhütl 2017, p. 149). They have in common that they regarded themselves as "Laboratories". These approaches are chosen because they follow experimental models of natural science and adopt methods of empirical research. The way in which the importance of art, science and technology is emphasised differs from curriculum to curriculum.

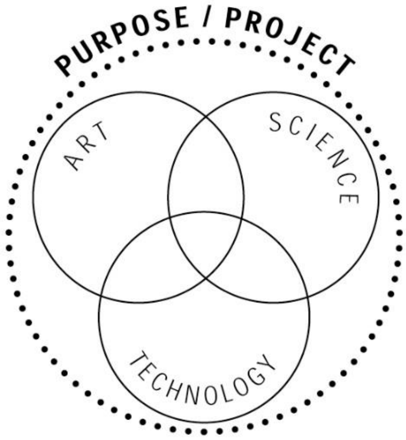

Figure 1 Archetype [Urmodell] of Design Curriculum. Source: (Findeli 2001, p. 8)

At the "Psycho-Technical Research Laboratory", 1927, art was replaced by the use of science and technology; at the "Design Laboratory", 1935, the focus was on art education based on scientific innovation; at the "Laboratory for Design Correlation", 1937, art was regarded as a tool of science and technology; at the "Design Research Laboratory", 1963, the focus was on science and technology including artistic research; and at the "Fab Lab", 2003, art was reintegrated into science and technology as a skill.

The programmes reviewed have in common that they attempted to reform design and research by relying on the metaphor of the laboratory. The question was raised whether art could be regarded as laboratory work. This paper examines the laboratories through a review of the literature. Looking into the programmes of Ladovsky and Jones is difficult because the documentary material is limited or not open to the public. Analysing the laboratories and studios is also affected by the fact that the original work of Ladovsky, Rhode, Kiesler, Jones and Gershenfeld has in the meantime been modified and translated. Knowledge of the original experimental processes is therefore rather hypothetical (Latour & Woolgar 1986, pp. 172–174). The creation of reference by permanently translating between matter and form is a possible method for assessing studio work (Latour 1999, p. 69f). Earlier steps are reconstructed within a reference chain.

2 "Psycho-Technical Research Laboratory", 1927

The "Psycho-Technical Research Laboratory", established by Nikolai Ladovsky, existed from 1927 to 1928 at the Higher Art and Technical Studios (Vkhutemas) in Moscow. The older "psychoanalytical method" (Ladovsky op. cit. Kreis 2009, p. 668) of space research was extended into this programme (Vöhringer 2007, p. 59). "Psychoanalysis" was used to describe spatial effects on the human mind. Mental states were regarded as a result of external influences (ibid., p. 50). It is unclear whether Ladovsky was influenced by Sigmund Freud´s notion of "Psychoanalysis" (ibid., p. 50). The method was used for the design proposal of the "International Red Stadion" in Moscow (Tschepkunowa 2014, p. 7). The laboratory was established in 1927 based on the lecture "A Psycho-Technical Research Laboratory for Architecture" held by Ladovsky in November 1926 (Khan-Magomedov 1987, p. 107; Pistorius 1992, pp. 31–32).

The programme consisted of different research groups, one for the analysis of architectural elements, one for research of psychological effects of colour, form, volume, etc., one for economic organisation, and one for design education. The last group was involved in the design of different experimental devices (Vöhringer 2013, p. 62; Kreis 2009, p. 670). Experiments on the ability to perceive lines, angles and volumes were conducted by "Glazometer" (ibid., p. 59). Devices for testing distances, spatial properties of surfaces, and angles of vision were "Liglazometer", "Ploglazometer" and "Uglazometer" (Khan-Magomedov 1987, p. 136; Vöhringer 2013, pp. 37 and 60–63).

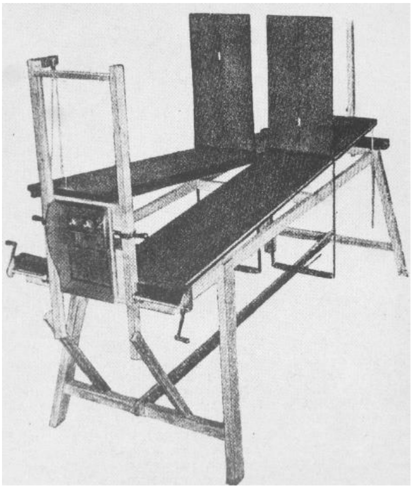

Figure 2 Prostometer. Source: (Khan-Magomedov 1987, p. 136)

The "Prostometer" (meter for space) was an apparatus for testing the ability of perceiving spatial depth. Test subjects were asked to look through two openings from a fixed point of view, while spatial effects were created by tilting two horizontal planes and moving vertically attached figures. By this experiment, also used by Le Corbusier, the ability of stereoscopic perception was tested (Vöhringer 2013, p. 35). In order to prevent test subjects from being distracted, the room in which this apparatus was installed was painted black (ibid., pp. 61f).

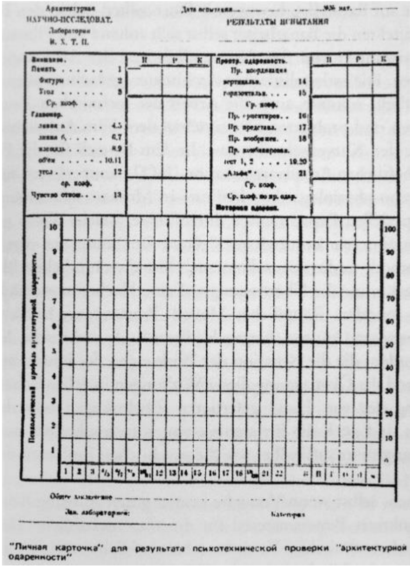

Figure 3 Personal chart. Source: (Vöhringer 2007, p. 65)

Subject´s estimations were recorded on special charts, assessing their technical suitability. The data included attentiveness, memory and spatial skills (ibid., p. 64). The data collected resulted in a personal “psychological profile”, applicable for further processes of learning (ibid.). Findings were used (i) for entrance examinations for students of architecture, (ii) for the training and improvement of perception skills and spatial imagination, and (iii) for supporting experiments during design processes (ibid., p. 59).

The curriculum included psychotechnique with the objective of reducing energy and mental effort during the perception of spatial and functional features of forms (Ladovsky 1992a, p. 45). A “rationalist aesthetics” attempted to reduce mental effort in architecture (Ladovsky 1992b, p. 40).

> *An architect have to familiarize with laws of perception. Psychotechnique is one important modern scientific influence, because it is building bridges between pure science and applied sciences. Laboratory work should enhance practical skills. (Ladovsky 1992a, p. 45)*

Design by drawing was given up and replaced by design in space (Ladovsky op. cit. Khan-Magomedov 1987, p. 544). Spatial models were used enhancing spatial cognition and enabling the development of construction plans instead of traditional art teaching starting with drawing (Vöhringer 2013, p. 51). The spatial model or modelling in space was the tool of the “psychoanalytic architect” (ibid., p. 50).

3 “Design Laboratory”, 1935

The “Design Laboratory”, led by Gilbert Rohde from 1935 to 1937, was a free art school located in New York and financed by the Works Progress Administration. Frances M. Pollak developed the original concept (Bearor 1996, p. 15). The idea of an “American Bauhaus” influenced this programme. Its predecessors were the Bauhaus in Weimar, 1919, and the Carnegie Institute of Technology in Pittsburgh, 1935 (Keyes 1936, p. 5). The curriculum of the Bauhaus in Dessau was also influential due to its focus on machine-oriented design principles (Bearor 1996, p. 19; Clark 2009, p. 47).

Figure 4 Display design students study abstract composition in three dimensions in all materials. This student is working in wood. Source: (Dunne 1937, p. 40)

In contrast to existing schools of art, the programme of this "free art school for underprivileged students" (Keyes 1935, p. 19) intended to coordinate training in aesthetics, machine fabrication and merchandising (Rohde op cit. Keyes 1935, p. 19). For Rohde (1936) the purpose of the laboratory was to develop "various necessary skills" (p. 640) based on the integration of art, handicraft and industrial design. The objective of the programme was to promote this integration.

> *The point is to understand by usage what the machine can and can not do. The work in the design room is coordinated with work in the shop; and the two with study of materials, emphasizing commercially available forms and factory processes, aided by collections of materials at the school and visits to the factories. (Rohde 1936, pp. 642f)*

Postgraduate training emphasised "learning-to-be-practical" (Dunne 1937, p. 41) by practical training, lectures, drawing exercises and field trips. Students were encouraged to work from the outset with equipment, methods and techniques of their core area. The focus was on the field of industrial design, besides drawing, painting, sculpture, visual display and fine arts. This approach stood in opposition to a design driven economy. It appears to be ironic that Gilbert Rohde, with a past in commercial design for business, represented this school (Clark 2009, p. 43).

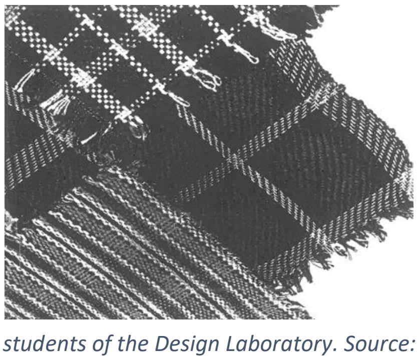

Figure 5 Textiles designed and woven by students of the Design Laboratory. Source: (Rohde 1936, p. 640)

Students all took part in the same practical training, lectures, drawing exercises and field trips. Teaching focused on experimenting with different materials and techniques (Clark 2009, p. 47). "Knowledge of good design was presumed to be the result of direct physical and sensory experience disciplined by an intelligent and sensitive mind." (Bearor 1996, p. 20). Teaching methods were based on "progressive education" (Clark 2009, p. 40) and the method of "learning by doing" (Keyes 1936, p. 5). "For the instructors nearly as much as the students, the daily activities at the Laboratory were a pragmatist exercise in `learning by doing´" (Clark 2009, p. 41).

[...] the curriculum is based on the experimental procedure of a research laboratory. [...] Free experimental production in interior architecture, furniture, industrial products and appliances, wood, metal, ceramics, glass, plastics and textiles will figure prominently in shop work. (Rohde, op. cit. Anonymous 1936, p. 117)

The programme addressed students interested in handicraft, economy and art (Rohde 1936, p. 638). Most of the participants were art students aged between 16 and 60 (Keyes 1936, p. 5). Design was implemented "industrial-design minded" rather than "craft minded" (Rohde 1936, p. 643). In an age of financial repression, industrial design was appreciated for serving American industry. Students educated as prosumers, i.e. people who both produce and consume, could easily be integrated into a modern industrial society as "new-artists" and "artist-technicians" (Rohde, op. cit. Bearor 1996 p. 29).

4 "Laboratory for Design Correlation", 1937

The "Laboratory for Design Correlation", founded in 1937 by Frederick Kiesler, was a graduate programme at the Columbia University in New York. After proposing a "Laboratory for Social Architecture" (Kiesler 1934, n.p.) in the 1930s, Kiesler was involved in establishing a design school influenced by craft schools, e.g. the "Cranbrook Academy of Art" (Benson 1934, p. 308). Kiesler together with E.M. Benson had proposed an "independent research laboratory that would be to art and industrial design what the Rockefeller Institute was to medical research." (Bearor 1996, p. 15). Although it is not clear to what extent Kiesler taught at the school, there is evidence of his participation in the Design Laboratory being established, and of his role as an architect in the advisory board (Keyes 1935, p. 19; Bearor 1996, p. 16 n. 10).

Kiesler (1939, pp. 60–79) was interested in art and science and in biological and physical theories. He can be regarded as a visionary personality metaphorically transferring theories of empirical science into artistic work (Hasenhütl 2014, p. 102f.). Kiesler (1939) established a specific design method by the neologism "Correalism" (p. 77), drawing on the notions "Co-Reality", "Correlation" and "Co-realism", i.e. a reference to Surrealism (ibid., p. 60f; Pessler 2003, p. 3). Kiesler (1939, p. 77) introduced "Correalism" as basic research and "Biotechnique" as applied research. The main objective of the programme was to promote human physical health by the use of design objects (ibid., p. 65).

The general objectives of the laboratory are to define an approach to progressive industrial design; to correlate design to the physical and psychological needs of man (control of fatigue and generation)... Kiesler (1937, n.p.)

Figure 6 File Card: Photostat No. 11. Source: (Austrian Frederick and Lillian Kiesler Private Foundation TXT_5089_0_LDC 1)

The working group consisted of students of architecture and sociology. One of the few proposals realised was the project of a mobile home library, a design process almost entirely documented. The result of the "research into design" (Frayling 1993, p. 5), which was conducted for a period of one year, was a card index box referring to different issues, e.g. ventilation technology, fatigue measurement, energy balance, morphology of architecture (Austrian Frederick and Lillian Kiesler Private Foundation TXT 5176/0). The illustration above shows the front side of the file card "Fatigue Measurement - Bioelectric Methods". On the file cards were text fragments and illustrations taken from scientific literature. In this example, an experiment on muscle contraction and relaxation conducted by the University of Chicago in 1928 is shown. These file cards were part of a referential system by which the group deduced the design of the mobile home library step by step. These cards were also used for teaching.

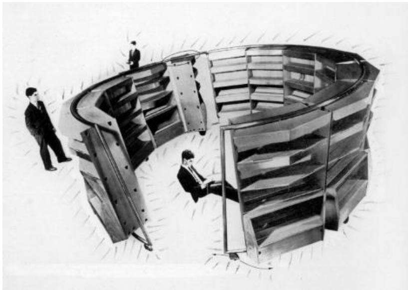

Figure 7 Biotechnique. Source: (Kiesler 1939, p. 72f)

Kiesler (2001, p. 95) developed this design of an ergonomical home library as a result of an experimental procedure. The designed prototype itself was intended to correlate with the problem being tackled, e.g. the book as a media, reading as a cultural technique. The manufactured prototype was the result of a comprehensive literature review of market analysis and of several motion studies, all in the spirit of scientific management. Storage and action space were optimised with regard to functions, dimensions and materials.

The curriculum was dominated by strict scientific methods (Reports on the Laboratory of Design Correlation, Austrian Frederick and Lillian Kiesler Private Foundation TXT 5233/0 Folder 4). Ergonomics, theories of evolution, field theory, strategic corporate planning, nuclear physics, industrial engineering, and the special theory of relativity, delivered source material for theory construction. The work of Frederick Taylor, Frank Bunker Gilbreth and Christine Frederick is very similar to this design method.

5 "Design Research Laboratory", 1963

The "Design Research Laboratory", founded in 1963 by Christopher Jones, was a post graduate programme at the University of Manchester, Institute of Science and Technology. Jones (1970a, p. 353) attempted to include applied research in the educational programmes of architects and engineers by integrating computer sciences, ergonomics, operational research and systems engineering. The objective of this programme was to offer technical training enabling students to become "design technologists", working cross-disciplinary on complex problems (ibid., p. 355).

> *The main objectives of the practical parts of this program in Design Technology are to provide experience of working in groups on preliminary studies of novel design problems and in carrying out design research projects. (ibid., pp. 355f)*

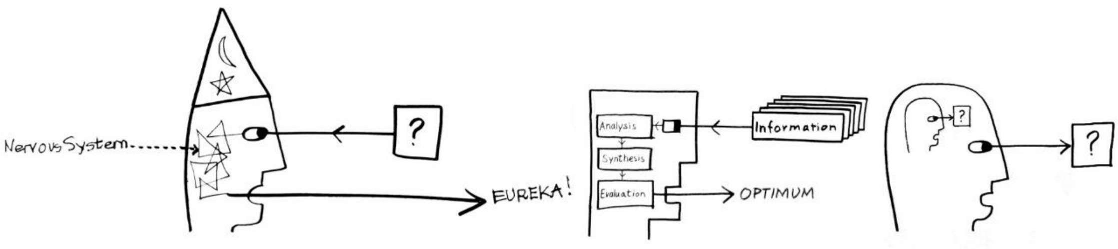

Figure 8 Designer as magician. Designer as computer. Designer as self-organizing system. Source: (Jones 1970b, p. 2)

The illustration shows how the transformation processes of design work were metaphorically interpreted. Jones (1970b, p. 2) wanted to abandon the concept of the designer as a magician without rejecting art. Automation, information technology and human-machine interaction had a massive influence on his work. In the late 1950s, he prophetically described automation as a kind of networked production where three-dimensional goods could be ordered at “automatic factories” via input and output devices, and design changes could be managed nearly instantly (Jones 2000, pp. 84f).

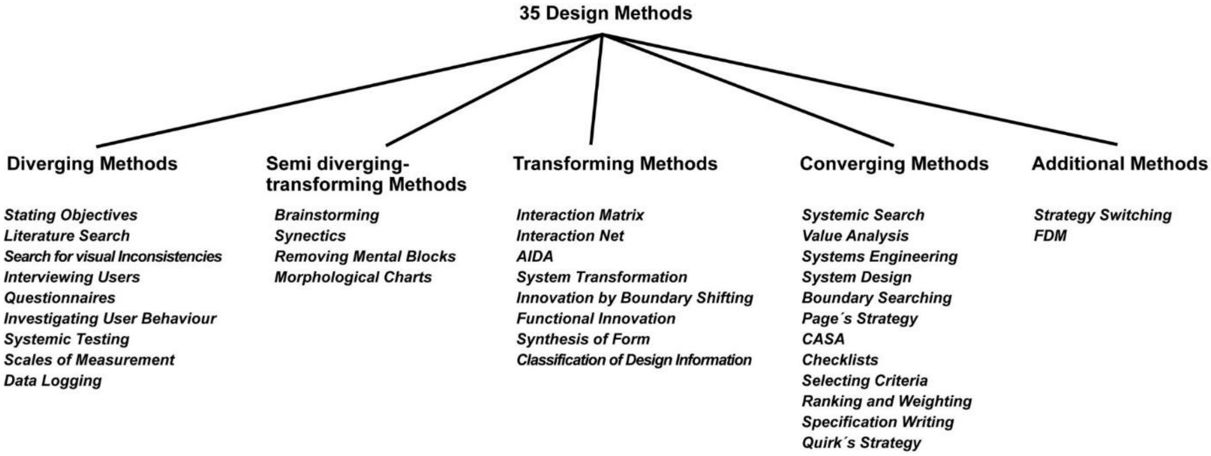

Figure 9 Catalogue of methods. Source: (Author following Jones 1970c, pp. 94–396)

Summed up in the illustration above is the curriculum, published in a seminal book on design methods (Jones 1970, pp. 94–396), which included methods of creativity techniques, of empirical social research and of technical product development. The tasks in teacher-centred instruction and project work dealt with design methods rather than with real-world problems (Jones 1970a, p. 354). Research oriented teaching resulted in an emphasis on theorising and writing. Early studies conducted, e.g. “The Effects of Designing”, “Optimisation using a Computer”, “Car Seating”, “Visual Choice Reaction Times”, and “A Report on the Modular Jointing System of Steel Frame Housing”, were associated with general sections, e.g. “Technological Change”, “Design Methods”, “User Requirements”, “Human Performance”, and “Building Systems” (Jones, Talbot and Goodwin 1967, n. p.). Nigel Cross wrote his M.Sc. Dissertation research project in 1967 on the topic “Simulation of Computer Aided Design” (Cross 2001, p. 44). The aim was to find out what CAD might be like and what the design requirements for CAD systems might be (ibid.). Designers interacted with a simulated CAD-system via television images by following orders which were drawn on little paper charts (Cross 1977, p. 108). As in Wizard-of-Oz-tests, the test subjects were not aware of the simulation of the CAD-system by a group of planners.

The programme began with teaching theory and continued with practical project work. “The course consisted of two semesters: the first (October – April) consisted of lectures and laboratory work, followed by examinations; the second was a 5-month individual dissertation, supervised primarily by Christopher Jones, assisted by the other lecturers. [...] Christopher Jones gave lectures on design methods and technological change, and provided visionary leadership around ideas of the future of society and technology.” (Personal correspondence of the author with Nigel Cross, 24 August 2016). Jones (1970a) regarded his programme as based on experiments. “The purpose of this experiment in design education is to find ways of removing the barriers between arts and sciences and between the many professions that are increasingly relevant to design problems.” (p. 353) He gave up teaching a few years later unhappy with institutional conditions. “In 1970 Christopher Jones was offered the post of Professor of Design at the new UK Open University. I also joined him there as lecturer. The Design Technology course continued at UMIST, with Reg Talbot, for a few years more. Christopher Jones resigned from the Open University in 1974, disillusioned because it did not fit his vision of a more experimental and technologically advanced university.” (Personal correspondence of the author with Nigel Cross, 24 August 2016).

6 “Fab Lab”, 2003

The “Fabulous Laboratory”, “Lab for Fabrication” or “Fab Lab” (Gershenfeld 2005, pp. 11f; Gershenfeld 2012, p. 47) was part of a university programme “How to Make (almost) Anything” established by Neil Gershenfeld and his students at the MIT Media Lab, Cambridge, Massachusetts. Starting in 1998, the objective was to produce a so-called “personal fabricator” within the laboratory setting of MIT´s “Center for Bits and Atoms” (ibid.). It was centred around designing, developing and constructing technical innovations by consumers and first of all by the students.

> *This thought led to the launch of a project to create field `fab labs´ for exploring the implications and applications of personal fabrication in those parts of the planet that don´t get to MIT. As you wish, `fab lab´ can mean a lab for fabrication, or simply a fabulous laboratory. Just as a minicomputer combined components–the processor, the tape drive, the keypunch, and so forth–that were originally housed in separate cabinets, a fab lab is a collection of commercially available machines and parts linked by software and processes we developed for making things. (Gershenfeld 2005. p. 11f)*

Regionalising production facilities and expanding digital fabrication by personal fabrication was an important objective. Consumers were given the opportunity to produce goods not available in department stores (Gershenfeld op. cit. Anderson 2012, p. 77). Students were interested in producing goods different to those on sale. Since the Renaissance, manual skills were excluded from the educational canon. Education focused on the abilities of reading and writing (Gershenfeld 2005, p. 7). Producing goods as “illiberal arts” was no konger included (ibid., p. 34). Illiberal arts, e.g. artistry and skills, were neglected for economic reasons. “We´re still living with the historical division of the liberal from the illiberal arts, with the belief that the only reasons to study fabrication are for pure art or profane commerce, rather than as a fundamental aspect of personal liberation.” (ibid., p. 42)

Figure 10 Fab Lab. Source: (Gershenfeld 2005, p. 25)

Fab Labs consisted of a laser cutter, sign cutter, milling machine and tools for programming tiny micro computers (ibid., pp. 11–12). “This is not a static configuration; the intention over time is to replace parts of the fab lab with parts made in the fab lab, until eventually the labs themselves are self-reproducing.” (ibid.)

The teaching programme was characterised by “peer learning” and “design-based learning” (Koh, Chai, Wong, & Hong 2015, pp. 8 and 59). If students acquired certain skills, e.g. programming or production techniques, they shared their knowledge with other members of the group. This exchange of ideas, skills and experiences developed a momentum boosting the student’s problem solving capacity (Gershenfeld 2005, p. 24). Paradoxically, the majority of the students in the class were reading arts, architecture and engineering, not computational sciences as expected. Curriculum, tutorial material and teaching staff were unable to cover the requirements of such heterogeneous groups (ibid., pp. 6f). The learning process was determined by a demand for and not by a supply of topics of teaching (ibid., p. 7).

> *This process can be thought of as a `just-in-time´ educational model, teaching on demand, rather than the more traditional `just-in-case´ model that covers a curriculum fixed in advance in the hopes that will include something that will later be useful. (ibid., p. 7)*

7 Discussion

The “Psycho-Technical Research Laboratory” attempted to establish industrial psychology as a key technology of social engineering. Psycho-technical architecture was a governmental tool for planning and controlling (Vöhringer 2013, p. 35). The state-funded “Design Laboratory” was institutionalised by the Federal Art Project (FAP) as a means for democratisation of American culture (Clark 2009, p. 41). A letter written by FAP-Director Holger Cahill shows that the purpose of the programme was the recruitment of teachers to carry forward the laboratory´s methods and ideas to young people. Cahill suggested a “program for re-training New England craftsmen” (Clark 2009, p. 42). The “Laboratory for Design Correlation” had a strong influence on transferring Russian and European avantgarde approaches into a design driven economy. “Gesamtkunstwerk”, “Constructivism” and “Psychoanalysis” were commingled with ergonomics and scientific management. European industrial science which “probed a reorganisation of industrial production experimentally” (Felsch 2005, p. 34) had an enormous impact on the reform activities of American industrial design developed by Kiesler. “Psycho-technology” and “mental engineering” as part of the emerging social sciences were tools of “democratic social control” (Lemov 2005, pp. 55–57). The “Design Research Laboratory” intended to integrate applied sciences into the training programmes of professional designers and planers. The objective was to dismantle barriers between different disciplines (Jones 1970a, p. 353). The “Fab Lab” methodology facilitated a massive transfer of knowledge between different disciplines. Anderson (2012) discussed fabbing as part of the maker culture and claimed that “Fab Labs are a special kind of makerspace” (p. 46). Expert knowledge could be disseminated in makerspaces dependent on the technical and social conditions. Rohde and Gershenfeld emphasised the importance of manual skills. Mechanical and digital fabrication brought forward a “technological momentum” (Hughes 1994, pp. 108f) and resulted in reform. The “Design Laboratory” upgraded the value of handicraft and practical work, as opposed to industrialisation downgrading the value of manual abilities. Fab Labs had opened these borders.

Experiments at the “Psycho-Technical Research Laboratory” were about psychological research on spatial effects. The programme was influenced by experimental culture in Russia in the 1920s. Economy, education and art were reorganised with expectations of a great future (Vöhringer 2007, p. 20). Experiments at the “Design Laboratory” were about testing different materials and techniques. John Dewey´s “Laboratory School” (Bearor 1993, pp. 72f) helped to develop the point of view that interests and personal initiatives could serve as a starting point for experiments. Formal teaching was thought to be an enrichment for personal knowledge. Experiments at the “Laboratory for Design Correlation” were about transferring methods from ergonomics and scientific management to designed prototypes. Both Ladovsky and Kiesler were interested in examining psychological processes. But Kiesler didn´t use experimental setups. He regarded the prototype itself as a quasi-experimental setup for corroborating theoretical assumptions. Experiments at the “Laboratory for Design Research” were about testing different methods. Problems were tackled by the use of logical and intuitive methods. Team work and interdisciplinary research were key elements of design education that Jones had established in the spirit of the design-methods movement. Experiments at the “Fab Lab” were about manufacturing, connecting, programming and communicating. Design processes were transferred into technical innovation. The key issue of this type of post-digital literacy was to reintegrate manual skills into the liberal arts model.

The construction of theory in these programmes was influenced by three different types of “scientific references” (Picon 2008, pp. 51–63.): content-related, methodological, and metaphorical. Ladovsky (1992a, p. 45) used methodological references by transferring applied psychology to design research. Referring to Hugo Münsterbergs “Grundzüge der Psychotechnik”, 1914, he proposed an objective foundation of spatial effects. Rohde realised methodological references by focussing on experiences in design education (Clark 2009, p. 43). Kiesler (1939, p. 77) put content-related and metaphorical references into effect by taking up scientific concepts, e.g. biotechniques, nuclear concepts, management, etc. It can be assumed that most of his references were based on poetical estrangements (Phillips 2017, p. 256). Jones realised content-related and methodological references by adopting qualitative research as a basis for design research. Gershenfeld used methodological references by interlinking different fabrication units. The claim that “studio education is education in making things” (Schon 1985, p. 94) seems to have been achieved in the Fab Lab.

Purification and translation could be aspects of assessing the quality of research processes (Latour 1993a, p. 10f). They both could be involved in the emergence of “quasi-objects” (Serres 1982, p. 233). Artistic work is assumed to consist of experiments where the production of “quasi-objects” (Latour 1993a, p. 89) could occur. Design could be “a kind of experimentation” (Schon 1985, p. 83) where “on-the-spot experiments” (ibid., p. 85) could happen. Bruno Latour´s notes on the Archimedian pulley (Latour 1993a, pp. 109–111) show connection points in the construction of quasi-objects in architecture and design (Hasenhütl 2014, p. 13–27; Van Toorn 2008, p. 76; Randerson 2011, pp. 237–239). Purification can be regarded as separating science from politics. Translation can be regarded as an expansion of political power into a technical mechanism (Latour 1993a, p. 110). Purification in design could be conceived as a discourse on architectural research in “research for design” (Frayling 1993, p. 5; Gethmann 2009, p. 47). e.g. Ladovsky´s and Kiesler´s “scientific” languages. Translation in design could be conceived as the adoption of functionalism and ergonomics in the private household, as a mixture of different techniques through new design tools, and as man-machine interfaces (Gethmann 2009, p. 47), e.g. Ladovsky´s and Kiesler´s use of psychotechniques and Taylorism.

Early laboratories imitated methods of basic research in natural sciences, but did not involve research from other disciplines. Experiments in these programmes were instruments of verification, but not instruments for creating new knowledge. Knowledge was coupled with perceptual patterns or a certain habitus. It can be assumed that in Kiesler´s file card system references to different issues were regarded as given facts and were not constructed in each translation step. Because the origin of the concepts of space-time, continuity, correlation, etc., was not documented, the chain of references was interrupted and could not be backtracked. All programmes referred to technical progress by implementing new methods or technological innovations. Focussing on perceptual patterns, research into design, technical skills, problem solving capacities and prototyping, all programmes were about “design ethics” (Findeli 2001, p. 13) in the broadest sense. The replacement of “design ethics” by “design thinking” (Leifer & Meinel 2016, p. 3) was crucial to the work of the “Design Research Laboratory” and of the “Fab Lab”.

By using advanced simulation techniques and more effective design methods, “`laboratory´ design processes” change into “`real world´ conditions” (Lawson 2004, p. 47). The “studio-laboratory” can serve as a place where such a shift can take place (Century 2013, p. 3 and pp. 6–9). Artistic and technical production are combined by bringing artists, scientists and technicians together. “Studio-laboratories” provide new opportunities in design education, regarding “design problems as intricate systems [...] that might be defined through both rationality and creativity” (Wang 2010, p. 181). Jones (1970a, pp. 355f) assumes that the best way of training people in tackling wicked problems “is to expose them to the principles and methods of both sciences and arts” (Jones 1970a, pp. 355f). Scientific and artistic research is combined in these “studio-laboratories” by “heterogeneous engineering” (Law 1987, p. 113) or “hybrid manoeuvres” (Nickelsen & Binder 2009, p. 174 f. 13). Designers can be described as “system builders” (Law 1987, p. 112) who manage several design constraints and relate different processes with each other to establish an integral entity. They mix principles, contributions, people and things together (Nickelsen & Binder 2009, p. 168). Objects and issues are produced and exchanged by a large amount of participants (Hirsch & Müller 2005, p. 536). Real world conditions also mean mobilising and developing social instruments (Yaneva 2009, p. 276). The borders and barriers between designers and non-designers, i.e. between experts and laypersons, gradually disappear. If the world itself is transformed into a laboratory by prosuming and co-designing, the paradigm of the design laboratory needs to be put in perspective.

8 References

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