

Article

The Matrix Design ^[1]

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*Dedicated to Hans Ulrich Kölsch
in deep appreciation of his grand merits in all fields of plastics history.*

Abstract: The term 'Matrix Design' is explained by developments in design and architecture from the middle of the 1920s to the end of the 1930s, leading to an international design movement. This 'Matrix Design' typically exhibits as characteristic design elements among others round corner forms and/or often ribbed but sometimes also fluted ornaments.

Apparently because of the strong economic depression in the Weimar Republic, this process accelerated in Germany from 1929/30 onward in plastics design, realised by its long time forgotten pioneers.

In the USA and Britain, plastics design proceeded later on since 1933 by numerous, well-known designers.

The term 'Matrix Design' is carefully delimited and traded off against other terms found in literature, like 'Form around 1930', 'Technodesign', 'minor, non-functional streamline', 'Machine Style' or 'Bakelite Style'.

Keywords: Architecture history, Bakelite Style, compression moulding, design history, Form around 1930, Machine Style, Mastaba Style, Matrix Design, Moderne, Modernism, ornament, plastics, Plastics Age, plastics history, pressed glass, ribbon, round corner, Streamline, style, synthetic resin, Technodesign, Zigzag Style.

1. Introduction

In 1993, the architect and pioneering plastics collector Hans-Ulrich Kölsch coined the term '*matrix style*' in the attempt to describe "a new style" in the 1920s and 30s, which (translated) "evolved from the construction of moulds for moulding material". The inherent "constructive necessities" of this technique would lead to a specific form of moulded plastic objects, "following the law of matrix", which

became an "aesthetic overall concept" ... "in the oeuvre of progressive avant-garde artists and architects".^[2]

Until now, the term '*matrix style*' has not really been adopted by design history, though it was used in 1997 by Gerda Breuer, Professor of Art and Design History at Wuppertal University, referring to Kölsch, describing the plastics design of that time.^[3] In 2002, it was used again by Breuer.^[4] Furthermore, the exhibition "vergleichsweise einfach – kunststoffe

technik architektur" ("Comparably simple – plastics, technology, architecture") picked out as a central theme the (translated) "early plastics design and architecture", the "matrix style", and "Bauhaus without plastics" etc.. This exhibition was organised by the Faculty of Art and Design at the Bauhaus-University in the "Haus am Horn" in Weimar.^[5]

Later on, we will point to possible reasons for that hidden history of the term 'matrix style' (cf. chapter 7).

After a careful, interdisciplinary consideration, we will try to specify its significant role in general and will attempt to establish a new, related term, i.e. 'Matrix Design'.

2. Art, design and architectural movements in the first third of the 20th century.

The different periods of the Industrial Revolution, originating from Great Britain in the 19th century, comprised important technological developments with great consequences for further artistic, architectural and social life.

However, an early counter reaction arose in the UK, which believed that industrialisation and machine production were debasing the quality of life in general and the effectuation and aesthetics of objects in particular. Developed since around 1870, the late romantic Arts and Crafts movement, emphasized the craftsmanship, inspired by the ideas of John Ruskin and the designer, artist and writer William Morris.^[6]

Hugely influenced by Arts and Crafts, Art Nouveau, as the major artistic and architectural movement in Europe at the beginning of the 20th century, often took over natural, mostly vegetal decorations and strongly curved ornaments. Historically and as an aesthetic-visual expression, it represents a link to Modernism, which in art, decorative arts and architecture comprises in fact a lot of different artistic 'isms', i.e. Impressionism,

Expressionism, Constructivism, Cubism, Dadaism, Futurism, Suprematism Surrealism, Symbolism, Vorticism etc., existing either parallel or subsequently.^[7,8]

Another movement in architecture and design is known as the 'New Objectivity' ('Neue Sachlichkeit') with Verism, Magic Realism and Functionalism (French Esprit Nouveau and Purism, Dutch de Stijl, German Bauhaus, Soviet Vkhutemas School, International Style and others).^[9,10]

In contrast to the austere Functionalism, a new movement later on called Art Déco, developed more or less simultaneously in arts and architecture from around 1925 onward. Starting in France, this lavish, luxurious kind of decoration spread out through Europe and the USA. Additionally to its refined, elegant or even gorgeous versions, Art Déco comprises also geometrically expressive variations like the 'Zigzag Style' (Zigzag Moderne),^[5] the 'Stepped' or 'Mastaba Style' (Egyptian influence because of the discovery of Tutankhamun's tomb in 1922) or the 'Pueblo Style' or 'Mayan Déco' (Native American revival).^[9,11]

During the German 'Weimar Republic', the period between the end of WW I and the Nazi seizure of power, according to design historian Gert Selle a 'transition style' appeared intermediately between all the movements mentioned above and the developments in the later on Third Reich.^[12] Selle called this type the (translated) "Form around 1930" or "Techno-Design". This "technoid form" in the "quinquennium of turn between 1927 and 1932"^[13] was characterised by a "slender-elegant type of form, with reduced surfaces and emblematically condensed functional skeletons".^[12] Its essential task was on the one hand (translated) "to link technology with form and environment", on the other hand "to develop products for large, often millions of production units, which are capable to serve the needs and requirements of different end users".^[13] Furthermore, this

'Techno-Design' was qualified as "efficient", "fascinating", "absolutely pure" and "cold-erotic", but at the same time as "untransparent", "alarming" and "pre-fascist", because its aesthetic properties were easily adopted by the subsequent Nazi rulership after 1933.^[12]

However, this development, watched here through typical German post-war glasses, occurred not only in Germany, but much more widespread with respect to protagonists, chronology and internationality. During a much longer time, i.e. from the middle of the 1920s until ca. 1940, such a design and architectural movement with its technological origin belonging to the 'First Machine Age',^[14] could be found at protagonists without any suspicion of being *prefascist* (cf. chapter 3), as well as in countries without fascism, e.g. the USA and the UK (cf. chapters 7, 8). Hence, these 'technoid forms' with their typical round corners and often ripped decoration elements appeared much longer and more widespread in many architectural and artistic fields. This will be shown below.

In the USA of the late 1930s, a period that wanted "to link technology with form and environment", two forms of the so-called 'Streamline' were developed. An early one and as we will see wrongly labelled (cf. chapter 7) "minor or nonfunctional streamlining" and a later one, called "functional streamlining", which were summarised and analysed theoretically in 1940 by Harold Van Doren.^[15]

For all these phenomena (in Germany: the 'Form around 1930' or *Techno-Design*, in the USA: the "minor or nonfunctional streamlining"), we propose an overall term, which gives a revised temporal and locational framework and which especially, not exclusively explains the lines of development from general, new technical necessities and their implications on design and architecture of that time, i. e. the 'Matrix Design'.

This will be equally shown below.

3. Mendelsohn and the architectural Expressionism in the first part of the 20th century.

Let us first consider in detail one early direction in architectural Modernism, i.e. the 'organic' variation of Expressionism. Herein, the 'Einstein Tower' ('Einstein-turm') in Potsdam, Germany, plays a special, a unique role (cf. Figure 1).



Figure 1 Erich Mendelsohn,^[a] 1919 - 1921: Einstein Tower, Potsdam.^[16]

Built 1919-21 by Erich Mendelsohn,^[a] its round, soft forms, at first glance simply organic, biomorphically inspired, can however also be regarded as if they were plastically moulded. And indeed, the Einstein Tower was originally "conceived as a monolith produced by casting fluid material into a mould",^[17] i.e. to be realised "as a plastic and fluid vision" in the new industrial composite material, namely steel "reinforced concrete".^[18] The mould means here a 'matrix' as formgiving device (cf. chapter 6).

Just after the emergence of Albert Einstein's theories of relativity, Mendelsohn, who personally knew him, was apparently fascinated by the dualism between science/technology and nature: Ever since it was realized (translated) "that matter and energy...are merely different

[a] Erich Mendelsohn, 1887-1953. German born, highly influencing architect. Since 1933 in the UK, Palestine and the USA.

states of the same primary element,...the engineer has abandoned the mechanical theory of dead matter and has reaffirmed his allegiance to nature...The machine...has become the constructive element of a new, living organism“.^[19]

After the expressionistic Einstein Tower, Mendelsohn partially rebuilt from 1921-23 the Berliner Tagblatt-Building, ('Mosse-Haus'), originally with a historicist corner tower. In 1924-1933, Mendelsohn developed his architectural language as a "tridimensional vision of space" by extracting "new forms" from "fluidified material".^[20] So, "this...period is characterised by the poetics of the corner",^[21] with later on less expressive and free floating but more concentrated, typical semicircular round corners. Mendelsohn established "a careful...relationship between curves and rectangles that would be widely copied or at least emulated".^[22] An example is the Power Station of the Red Banner Textile Factory, from 1925/26 in Leningrad/St. Petersburg, cf. Figure 2.^[23]



Figure 2 Erich Mendelsohn,^[a] 1925/26: Power Station of the Red Banner Textile Factory, Leningrad/St. Petersburg.^[24]

A further of many other examples with 'round corner' elements was the Schocken Department Store in Stuttgart, built 1926-28, cf. Figure 3.^[25]

Ernst May,^[b] another contemporary architect, was the director of the so-called



Figure 3 Erich Mendelsohn,^[a] 1926-28: Schocken Department Store, Stuttgart.^[26]

'New Frankfurt' project ('Neues Frankfurt'), a municipal housing development programme of the City of Frankfurt am Main. Since 1925/26, Ernst May planned and then realised a new, suburban residential area, the so-called 'Römerstadt'. The long, curved residential block and the curved balcony constructions shown in Figure 4 have a similar architectural language as many isochronic Mendelsohn buildings.

In general: "Round corners express continuity of surface, compactness of volume and softness of form".^[27]

If there was also another influence by the so-called 'Steamboat Style' ('Dampferstil'), should not be further discussed here.^[28,29]



Figure 4 Ernst May,^[b] 1926/27: Curved residential block and balcony constructions, 'Römerstadt', Frankfurt am Main, Germany.^[30]

[b] Ernst May, 1886-1970. German architect. 1925-1930: Influential city planner in

Frankfurt am Main, leader of the architectural project "Neues Frankfurt".

4. The early pioneers of plastics design

After the chapter with an architecture, characterised by ‘*casting fluid material* (steel reinforced concrete) *into a mould*’ i.e. a matrix, let us consider the simultaneous development of industrial and plastics design as an important period of ongoing Industrial Revolution in the first decades of the 20th century.

New challenges had emerged: the increase in population called for simple, more radical solutions to social problems. Mass production, faster transportation of goods and new materials had been available at that time or had to be developed.

Since Leo Hendrik Baekeland’s [c] patents on processing the phenolic resin ‘*Bakelite*’ in 1907 and its industrial production 1909/10 first in Germany and then in the USA, the new synthetic material found its way to the consumers. In the third decade of the 20th century, in addition to the phenolics, the urea resins with their unlimited chromaticity strongly extended the possible uses and the acceptance and hence the mass distribution in the societies of different countries in Europe and the USA.

During the same period, industrial design began to play its important role, after having had early precursors, among them e.g. Christopher Dresser and Peter Behrens.^[31] And just at the end of the 1920s, both mass production with machine forming processes and the still developing industrial product design influenced each other due to economical reasons. In the winter of 1929/30, Germany had been dragged much more strongly than many other countries into the whirlpool of the world economic crisis, originated by the big Wall Street Crash. Thus, the young German plastics industry had been forced

to look for new ways of presenting and marketing its products, using on a large scale the effectiveness of design in selling manyfold articles, or in terms of today: using product design as a component of marketing.^[32] In consequence, from 1929/30 onward, the largest companies of the German plastics industry engaged different artists such as Christian Dell [d], Ludwig König [e], Friedrich Adler [f], Walter Maria Kersting [g] and others.^[10,33]

In 1933, most of them were removed by the Nazis from their positions at that time. And their products were only manu-

[c] Leo Hendrik Baekeland, 1863-1944. Belgian born US chemist, “Father of the Plastics Industry”. Invented the production procedures of phenolic resin *Bakelite*.

[d] Christian Dell, 1893-1974. German silversmith and designer. 1922-25: Technical leader (Werkmeister) of the Bauhaus metal workshop in Weimar. 1926-33: Director of the metal workshop at Academy of Arts in Frankfurt am Main (Städelschule). Since 1929: Designer for the plastics assortment of the H. Römmler AG, Spremberg, the second largest synthetic resins (*Resopal*) producing and processing company in Germany.^[33] Since 1945: Freelance jeweller.

[e] Ludwig König, 1891-1974. German Ceramist and designer. 1922-29: director of the ceramics workshop of the State Majolica Manufacture, Karlsruhe. 1930-33: Professor for design at Cologne Academy of Fine Arts (Kölner Werkschulen). Since 1930: Designer for the plastics assortment of the Dynamit-Nobel AG, Troisdorf, the largest synthetic resins (*Pollopas*) producing and processing company in Germany. 1941-45: Professor at Bunzlau School of Ceramics. 1945-1953: Director of Landshut School of Ceramics.

[f] Friedrich Adler, 1878-1942. German Art Nouveau and Art Déco designer in many areas, 1907-1933: Professor at the School of Applied Art, Hamburg. Since 1930: Designer for the plastics assortment of the Bebrit Werk, Bebra, Germany. Murdered in Auschwitz 1942.

[g] Walter Maria Kersting, 1892-1970. German architect, graphic and technical designer. 1930-33: Professor for technical design at Cologne Academy of Fine Arts (Kölner Werkschulen). Since 1930: Designer for the plastics assortment of the AEG moulding factory, Henningsdorf, Germany. 1933-1942: Professor for graphic design at Düsseldorf Academy of Arts. Since 1945: Freelance designer.

factured at the latest until 1939, the end of civil production. After World War II, these pioneers of plastic design and hence of modern industrial design have been more or less forgotten until our days.

So, in Germany at least as early as 1929 to 1933 the basics of plastics design had to be established in close cooperation with engineers, to construct the complex moulds for the compression moulding process.

According to Jeffrey Meikle,^[34] in the USA similar activities began four years later in 1933. Then, the Bakelite Company engaged prominent American designers, such as Donald Deskey, Norman Bel Geddes, Henry Dreyfuss, John Vassos, Joseph Claudel Sinel and others to work with the new synthetic resins and to introduce modern styling. Later on Raymond Loewy and Walter Dorwin Teague became involved. Other plastic companies followed, e.g. Harold Van Doren (Toledo Synthetic Products), Gilbert Rhode (Röhms and Haas) and others.

5. The early compression moulding technique for glass

Before describing how the constructive problems of forming the new thermosetting resins were tackled, we will shed light on the pressing process of a much older 'thermoplastic', i.e. glass, an inorganic polymeric material.

Among the possible, different forming techniques, glass pressing was found to be first performed in China (ca. 5th - 3rd century B.C.) to produce e.g. glass beads.^[35] First pressed cups (double handled) date from the Western Han dynasty between 180 – 157 B.C.^[36] In modern Europe, first simple techniques of glass pressing were developed in northern Bohemia and Ireland no earlier than at the end of the 18th century.^[37] In the USA, gaffers began to experiment with hand presses for glass from 1825.^[37] Until the beginning of the 20th century, those

apparatus were complex, multi-part devices, due to the e.g. historicising forms and ornaments with their manifold under-cuttings, as shown in Figure 1 for a bowl on foot.

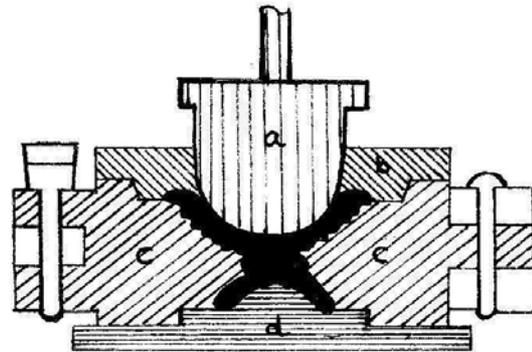


Figure 5 Cross section of a multi-part glass pressing device consisting of a punch *a*, a cover ring *b*, two side forms *c* and a basic plate *d*.^[38,39]

The multi-part mould consists of a cover ring *b*, two side forms *c* and a basic plate *d*. With the punch *a*, the already hot, highly viscous glass mass is pressed into the cavity of the whole apparatus. After pulling out the punch, the four locked parts of the mould had to be loosened and the glass bowl dismantled. Those complex moulding devices with their permanent dis- and reassembly were suitable only for a relative slow semi-handicraft manufacturing process and not yet for fast and low-cost industrial mass production.

In general, until the 1920s the glass pressing technology did not influence the design of its products in a specific way, forms and ornaments being mostly reflective of the glass grinding techniques of their periods, as shown in Figure 6.

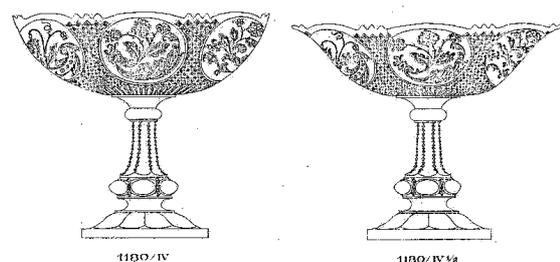


Figure 6 Ca. 1910: Pressed glass bowls on foot, Frankenstein, Lower Silesia.^[40]

The same orientation on tradition can still be observed for moulding compressed artefacts of the plastics predecessors papier mâché (carton bouillie) ^[41] and early (bio)polymeric materials such as hard rubber, shellac ^[42] and Bois Durci.^[43,44] With simple, only two-part devices, mostly flat artefacts have been produced. No specific press-in die was used, cf. Figure 7 for a shellac hand mirror from ca. 1870.^[45]

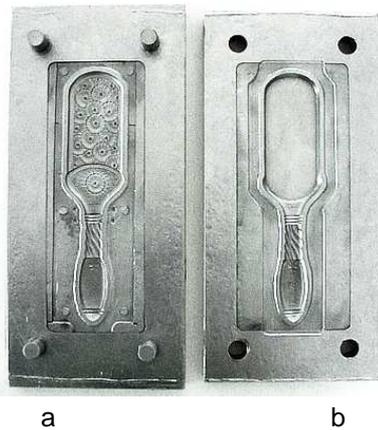


Figure 7 Ca. 1870: Two-part device for moulding of flat shellac hand mirrors. a) Rear side, b) Front (mirror) side.^[45]

6. The compression moulding technique for plastics

However, since 1910 the new, fully synthetic thermosetting phenolic resins totally changed the situation. From the beginning, they were produced on a large scale for the rapidly growing electrical industry, but of course also for decorative objects. The start of mass production of the new thermosetting resins required compression moulding processes with hydraulic machine presses.

For this purpose and to be as fast and cheap as possible, mostly two-part versions were used. Furthermore, the hardened and highly polished, stainless steel compression moulds had to be heatable (cf. Figure 8). The lower part of the mould is the 'matrix' (blank mould, bottom punch), into which the cold press powder was filled in and heated. Then, the heated 'patrix' (top punch) distributed the

liquefied material into all parts of the matrix by high pressure. After the pressing time required for reacting the plastics into its final state (curing, hardening, thermo-setting), the final object is expelled out of the matrix by an ejector.

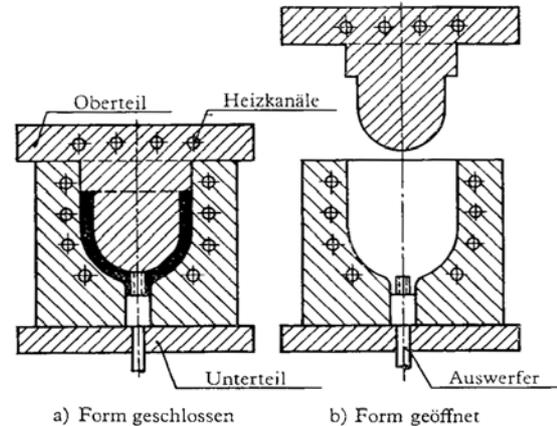


Figure 8 Cross-section of a two-part compression moulding, with bottom punch or 'matrix' ("Unterteil"), top punch or 'patrix' ("Oberteil"), and heating channels ("Heizkanäle") and ejector ("Auswerfer"). a) Closed. b) Open.^[46]

Contrary to still other pressing techniques for e.g. cold metal sheets, the characteristics of the fluid, thermosetting, polymeric material is very important for the features of the mould construction and in consequence for product design. With respect to this, a number of criteria had to be carefully followed. They were not yet fully known to the mentioned pioneers of plastics design between 1929 and 1933.



Figure 9 Christian Dell,^[d] 1929: parts of his first coffee and dinner set made of pressed urea resin *Resopal*, H. Römmler AG, Spremberg, Germany.^[47]

So, in 1929 Christian Dell designed his first coffee and dinner service still in the typical design vocabulary of the Bauhaus (cf. Figure 9).^[32,33,48]

Especially the most complicated object, a coffeepot prototype exhibits considerable material inhomogeneities, which could be due to too cold or non-uniformly heated moulds. This would be responsible for the visible flow lines, causing internal material stress which leads to existing hairline cracks along them.^[49]

Sharp, not rounded edges at the bottom as well as at the top side give the objects of the service a certain delicacy which is reminiscent of the well known silverware of Christian Dell, but at the same time increase the risk of cracking because of stress concentration, as we will see soon. In general, the first *Resopal* service of Christian Dell seems to be a very early historic evidence with respect to the struggling for criteria for the interdependence of processing technology and design.^[49]

Apparently in 1929/30, those basic rules had not yet been fully established effectually and finally compiled. In 1935 however, they were already formulated in "Electrotechnical products made of synthetic resin pressed material and their construction",^[50] expressed more precisely in 1938^[15] and published as recommended rules in January 1939 by the Association of German Engineers (VDI).^[51] Intermediately, it was a path of trial and tribulation. Even in 1940, a treatise criticised inappropriate and defective pressing techniques.^[52]

Some of the most important rules for the design of the moulds of pressed material and in consequence of the generated product, are as follows:^[18,19,53,54]

Rule 1) All surfaces in the pressing direction should be inclined (cf. Figure 10b). Hence, the objects could easily be ejected out of the matrix.

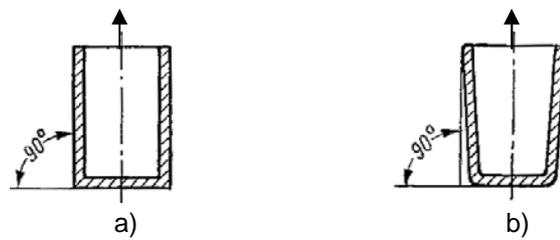


Figure 10 Design appropriate for compression moulding material. a) "Wrong": No surface inclination. b) "Right": Outer and inner surface inclined in pressing direction.^[51]

Rule 2) Surfaces may be slightly curved, either concave or convex (cf. Figure 11b,c)

Thus, a greater strength is obtained and a sinking in by shrinkage of the moulded material before the end of cooling down is optically reduced. Through continued hardening, many materials may slowly continue to shrink for a considerable period after moulding.^[53]

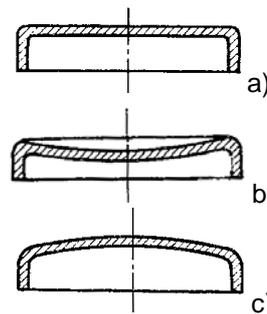


Figure 11 Design appropriate for compression moulding material. a) "Wrong": Flat surface, risk to sink in. b) "Right": Concave surface, c) "Right": convex surface.^[51]

Rule 3) Undercuttings are to be avoided as much as possible.

Undercuttings (cf. Figure 12a) would require multi-part, highly complicated and expensive moulds, as shown earlier in chapter 5. However, simple forms without undercuttings, surface inclinations and round edges and corners (cf. Figure 12b) facilitate the ejection out of the mould.

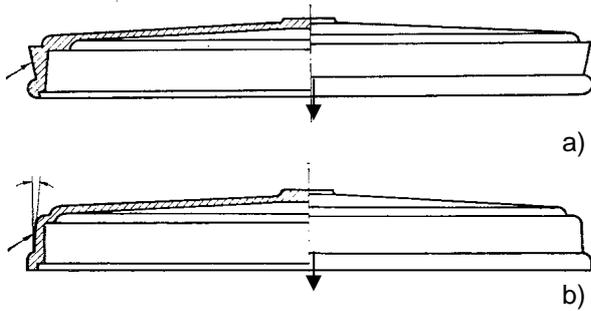


Figure 12 Design appropriate for compression moulding material. a) "Wrong": Lid with undercuts in pressing direction. b) "Right": Simple form, no undercuts, surface inclinations, round edges and corners.^[51]

Rule 4) The object should have equal wall thicknesses.

This is not the case with sharp edges and corners (cf. Figure 13a, 14a,c), where mass accumulation leads to internal flow inhomogeneities and thus material stress. However, equal wall thickness can be achieved by several possibilities. Especially, round edges and corners (cf. Figure 13b,c and 14b,d) are quite appropriate to facilitate the flow of the moulding mass during compression and to obtain proper surfaces.^[54,55]

Furthermore, the 'round corner principle' reduces the inner material stresses and hence the risk of cracking because of stress concentration.

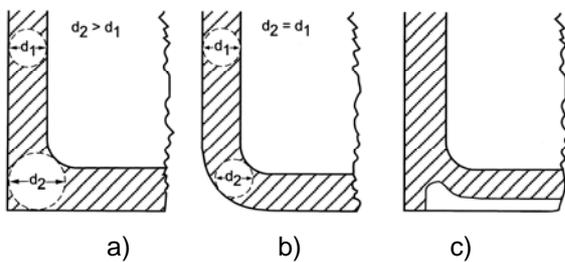


Figure 13 Design appropriate for compression moulding material. a) "Wrong": Mass accumulation in sharp corner areas. b) "Right": Avoided mass accumulation by round corners. c) "Right": Lower mass accumulation.^[54]

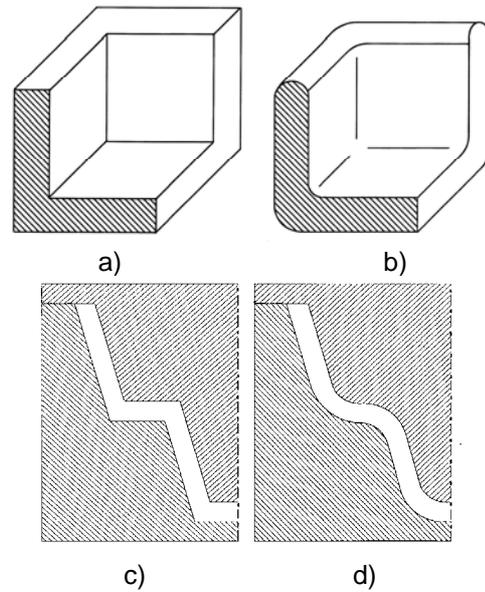


Figure 14 Design appropriate for compression moulding material. a,c) "Wrong": Sharp corners. b,d) "Right": Round corners.^[55]

Rule 5) Another method to mask the sinking in by material shrinkage or to stiffen larger surfaces, is to introduce convex ribs, (rods, reeds) or concave flutes and notches.

This can be done in principle inside and outside (cf. Figure 15).^[54]

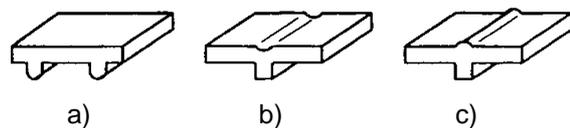


Figure 15 Design appropriate for compression moulding material. a) Ribs inside. b) Rib inside, flute outside. c) Ribs inside and outside.^[54]

Ribs outside used also in a decorative way allows the designer furthermore to eliminate or divide large plane surfaces, since it is difficult and costly to obtain a uniformly good finish which is free from flow lines over a large area (cf. Figure 16).^[53]

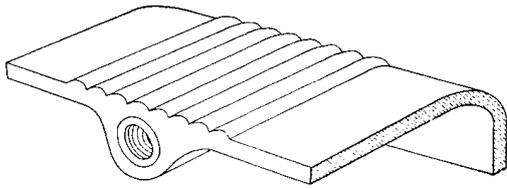


Figure 16 Design appropriate for compression moulding material. Use of decorative surface ribs (rods, reeds).^[53]

7. The 'Matrix Design' in form

From rules 1-4 result design characteristics with round corners and edges and curved surfaces.

However the 'round corner principle' in design is of course not as new as it was applied for synthetic resin material.

Bending wooden rods around forms led to one-dimensional bending of the fabulous bentwood chairs and furniture of Thonet since 1850. An in principle similar process with steel tubes enabled Marcel Breuer 1925 to develop his 'Wassily Chair'. But one-dimensional, mechanical bending of metal was already possible earlier. Since the time it was possible to produce rods and flat metal sheets of iron, bending should have been performed. Already around 1500, Leonardo da Vinci described rolling (metal working) machines for both kinds of products. Shortly afterwards, larger rolling machines have been described for e.g. tin and lead to produce sheets for organ pipes.^[56]

Two-dimensional metal sheet forming ("deep drawing") needs a press with an upper and a lower punch.

Just with the 'fabrication' of sheet metal, Harold Van Doren ^[h] - and not Walter Dorwin Teague, as Hans-Ulrich Kölsch inadvertently stated,^[1,2] - compiled in 1940 in his book "Industrial Design" principles of forms, among others round

corner treatments and streamline.^[57] Perhaps this uncertainty of origin and in consequence the unknown background was among other things responsible that Kölsch's term '*matrix style*' did not become assimilated into the design historical community.

Apparently Van Doren was already somewhat familiar with synthetic resins ("*the plastics were something brand new for the mass production designer*"),^[58] but knew not yet very much about the details of rules 1-4 for plastics processing, described above. So, he stated only very generally, not from the engineer's, but from the designer's point of view of course that "*the substitution of radii and fillets for sharp angles and corners has become such a factor in modern design, it will be necessary to discuss ways and means of accomplishing these effects*".^[59]

However, he did not give an answer as to why the round corners are "*such a factor in modern design*". Probably, one reason was the strongly increasing plastics production (worldwide 200,000 - 220,000 t in 1935, with the USA and Germany in the first positions),^[60] and the related consumption of products.

Theoretically summarising and analysing the principles of more than a decade of relevant design development, Van Doren began with a few simple corner treatments, describing ^[59] a block case with sharp edges (cf. Figure 17a), as it would have been typical for e.g. the Bauhaus "New Objectivity": "*There is nothing wrong aesthetically with a corner like this, as a form, but in fabricated metal it has a tendency to make the entire case look tinny and cheap*".

[h] Harold Van Doren, 1895-1957. One of the first generation industrial and theoretical designers in USA, beginning in 1930s. 1940: Cofounder of the Society of Industrial Designers (SID). 1948: President SID.

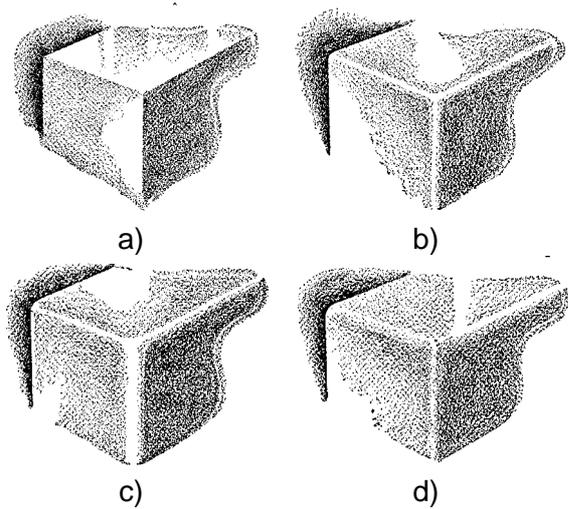


Figure 17 Harold Van Doren,^[h] 1940: Simple corner treatments. a) Sharp edges. b) Small radius on all edges. c) Larger vertical radius. d) Larger horizontal radius.^[59]

The equal rounding of all three edges (cf. Figure 17b) seems to Van Doren “*not particularly interesting....there is no variety of form*”.^[59] Enlarging the radius either vertically or horizontally (cf. Figure 17c,d) would look “*somewhat peculiar*” and “*not particular pleasant*”.^[59]

So for metal work, he proposed a combination of a sharp and a round side or front edge with a greatly increased radius, according to Figures 18a,b.

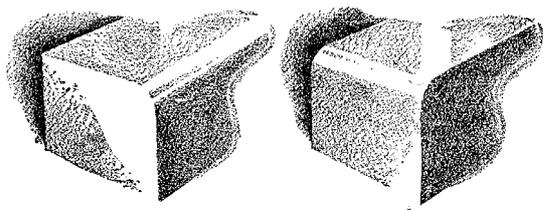


Figure 18 Harold Van Doren,^[h] 1940: Sharp and round side or front edge with greatly increased radius.^[59]

Furthermore he combined round corner forms in different axes (cf. Figure 19a,b,d) and increased the radius to big edges (cf. Figure 19c).

Van Doren called this substitution of angles and corners versus radii and fillets “*streamlining in its minor or nonfunctional sense*”.

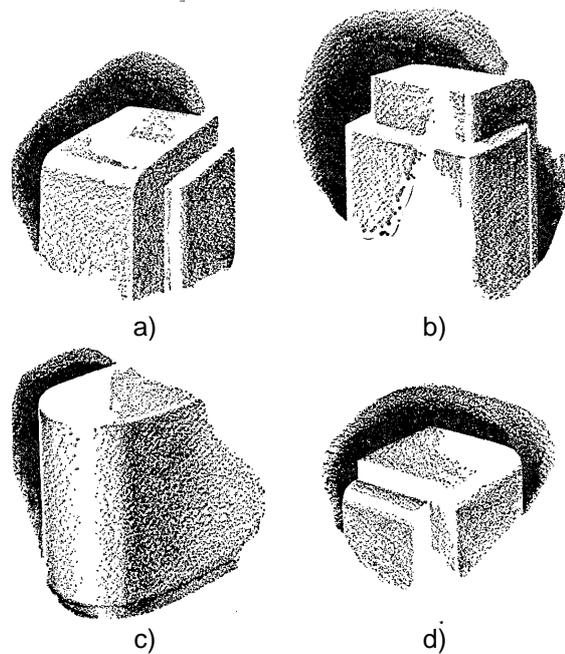


Figure 19 Harold Van Doren,^[h] 1940: ‘*Minor or nonfunctional streamlining*’. a,b,d) Combinations of sharp and round edges along different axes. c) Big radius edge.^[59]

On the other hand, he defined the “*true*”, “*functional streamlining*” as forms, developed to favour dynamics in fluids and gases. Typical examples are the allways ellipsoid and hyperbolic forms or sections of it (cf. Figure 20).^[59]

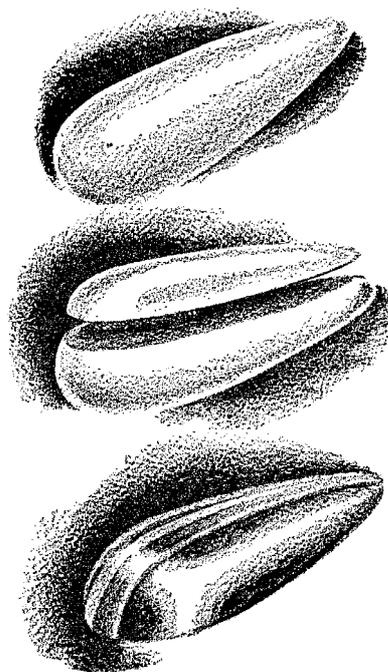


Figure 20 Harold Van Doren,^[h] 1940: ‘*True*’, ‘*functional streamlining*’ in ellipsoid and hyperbolic form or sections of it.^[59]

The denomination “*minor or nonfunctional streamlining*” seems not to be appropriate. It should be changed and not be included into the term ‘streamlining’, because

1) Contrary to the “*functional*” and hence ‘*true streamlining*’, the allways circular, “*minor or nonfunctional streamlining*” which contains no ellipsoid elements, has physically nothing to do with the dynamics of streaming.

2) Van Doren’s denomination “*non-functional streamlining*” is contradictory, because its design principle is in contrast quite functional, being linked with his description of compression moulding techniques.

Apparently, Jeffrey Meikle just pointed that out, when he spoke of a Sears Roebuck & Co. Radio, Silvertone 4500 ‘Election’ (cf. Figure 21): “*A bakelite radio – its smooth one-piece cabinet molded of Bakelite, black or dark brown, round-edged but hardly streamlined, too plain to be celebrated as “machine-age...”!*”^[61]

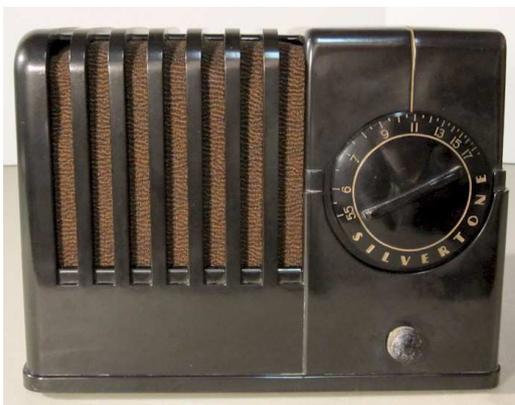


Figure 21 1936: Radio, Silvertone 4500 ‘Election’, phenolic resin radio cabinet, Sears Roebuck & Co., USA.^[61]

What Van Doren summarised under “*non-functional streamlining*” fits exactly (also with respect to metal sheet deep drawing) to what Hans-Ulrich Kölsch has proposed as ‘*matrix style*’.^[2] Therefore, we should not confuse and mix it with the

‘*true*’ streamline, i. e. Van Doren’s “*functional streamlining*”.

In Germany, at the very beginning of plastics design, one of its pioneers mentioned above, Christian Dell, also designed in 1929/30 among many other objects the first plastic table lamp, compression moulded in phenolic resin (cf. Figure 22). It already exhibits the typical round corner characteristics, but also some sharp edges at the very bottom and the lampshade.^[32,33]



Figure 22 Christian Dell,^[d] 1929/30: table lamp, pressed phenolic resin, H. Römmler AG, Spremberg, Germany.^[47]

Some more examples are shown, such as the phenolic resin cabinet Geadux 112 L from 1932, moulded by AEG, Henningsdorf, Germany (cf. Figure 23),^[62]



Figure 23 Walter Maria Kersting,^[9] 1932: Radio Geadux 112 L, pressed phenolic resin radio cabinet, AEG, Berlin, Germany.^[62,63]

and the Volksempfänger VE 301 W from 1933 (cf. Figure 24),^[62,64] both designed by Walter Maria Kersting (cf. chapter 4).^[9]



Figure 24 Walter Maria Kersting,^[9] 1933: Radio Volksempfänger VE 301 W, pressed phenolic resin radio cabinet.^[47]

In the UK, we find a comparable design language. Among others, the AC 74 phenolic resin radio cabinet was designed 1933 by Serge Chermayeff^[i] for the British Ekco E.K.Cole Ltd. (cf. Figure 25). From 1933-36, Chermayeff was in partnership with Erich Mendelsohn, who had left Germany. Both had a common architecture office in London and were realising many projects together.^[22,65] So, as one of the earliest plastics designers in the UK, Chermayeff was additionally well acquainted with the 'round corner' characteristics of Mendelsohn's architectural language (cf. chapter 3).

As another example from the UK, the UAW 78 radio phenolic resin cabinet, designed 1937/38 by Misha Black^[j] for the

British Ekco E.K.Cole Ltd. (cf. Figure 26) and the Zenith radio from 1938 (cf. Figure 27) is shown.



Figure 25 Serge Chermayeff,^[i] 1933: Radio AC 74, phenolic resin radio cabinet, EKCO E.K.Cole Ltd., UK.^[47]

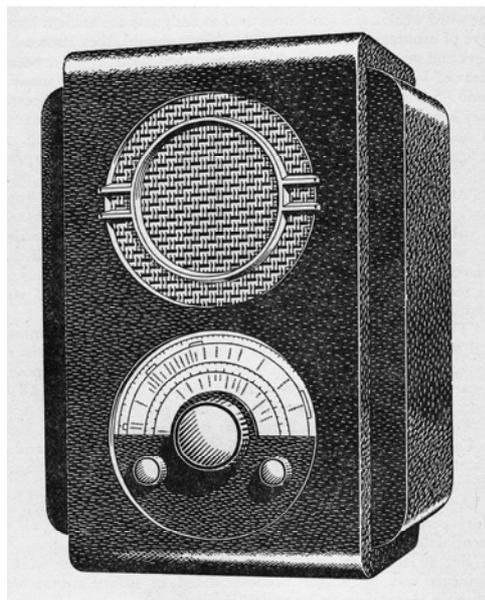


Figure 26 Misha Black,^[j] 1937/38: Radio UAW 78, pressed phenolic resin radio cabinet, Ekco E.K.Cole Ltd., UK.^[66]

[i] Serge Chermayeff, 1900-1996. Chechen born British architect, interior and industrial designer, writer, and co-founder of architectural societies, among others the American Society of Planners and Architects. 1930s: designer of many pressed phenolic resin radio cabinets for EKCO Ltd., UK. 1940-41: Professor at California School of Fine Arts. 1946-52: director of Institute of Design, Chicago, USA.

[j] Misha Black, 1910-1977. British architect and designer. 1933: Founding Artist's International Association. 1943: Founding the graphic and interior design company Design Research Unit. 1959-75: Professor of industrial design at the Royal College of Art, London.

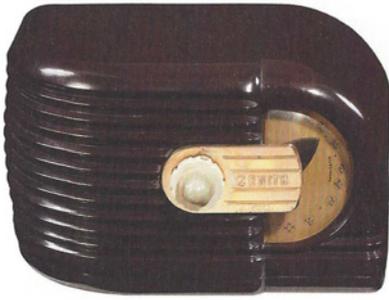


Figure 27 1938: 6 D 311, pressed phenolic resin radio cabinet, Zenith Radio Corp., USA.^[67]

Also phenolic resin radio cabinets cast in a mould were oriented towards rules 1-4, as shown in the case of the Radio designed by Norman Bell Geddes or the Fada radios 200 Bullet from 1940 (cf. Figure 28, 29).



Figure 28 Norman Bell Geddes,^[k] 1940: Radio Patriot 400, cast phenolic resin cabinet, Emerson Radio & Phonograph Corp., USA.^[67]



Figure 29 1940: Radio 200 Bullet, cast phenolic resin cabinet, Fada Radio Electric Corp., USA.^[67]

Likewise, cameras with pressed phenolic resin cases, designed by Walter Dorwin Teague (cf. Figure 30, 31) and

many other product categories are subjected to rules 1-4.



Figure 30 Walter Dorwin Teague,^[l] 1936: Camera Bantam Special, pressed phenolic resin case, Eastman Kodak Company, USA.^[67]

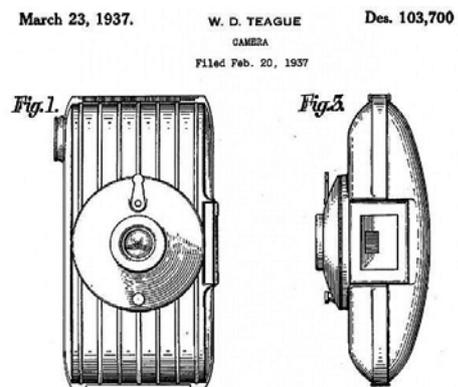


Figure 31 Walter Dorwin Teague,^[l] 1937: Camera Bullet, pressed phenolic resin case, Eastman Kodak Company, USA.^[68]

Van Doren described a pressed phenolic resin box: “The surfaces are severely simple, with large, soft radii, to bring out the maximum richness of the plastic material”.^[69]

Astonishingly at first glance, many artists, working on early plastics design, used the round corner stylistics also for objects, where compression or casting mould techniques do not play any role. Examples for that are wooden radio cabinets, e.g. the 811 tombstone, Zenith Radio Corp., USA, 1934 or the F-63, General Electric, USA, 1937 (cf. Figure 32a,b).

[l] Walter Dorwin Teague, 1883-1960. US first generation industrial designer pioneered the education of industrial design. From 1930 onward: Longstanding, close cooperation with Eastman Kodak Company, USA.

[k] Norman Bell Geddes, 1893-1958. US theatre and industrial designer.

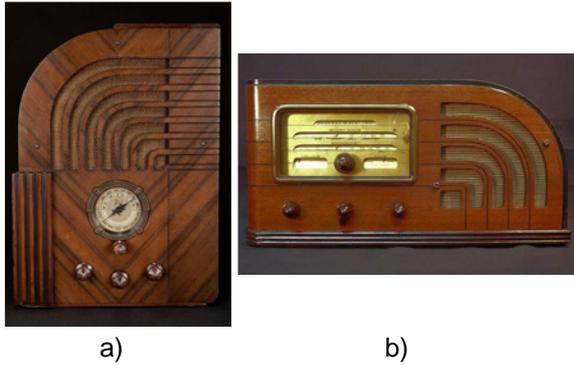


Figure 32 a) 1935: 812 tombstone radio, wooden cabinet, Zenith Radio Corp., USA.^[70]
 b) 1937: F-63 radio, wooden cabinet, General Electric, USA.^[71]

Furthermore, round corner stylistics can be found in furniture, cf. Figure 33. Apparently, this design language had accepted in general as modern and up to date.



Figure 33 a) 1930s: Chest of drawers, wood.^[72]
 b) 1930s: Sideboard, wood.^[73]

Consequently, the round corner stylistics was also used in architecture since the middle of the 1920s, as shown in chapter 3 (Erich Mendelsohn).

A further significant example is the so-called 'Shell Building' ('Shell-Haus'), realised 1930-32 by the architect Emil Fahrenkamp ^[m] in Berlin. Its famous

wavelike, elegant façade (cf. Figure 34) is immediately reminiscent of the undulated round corner curve in Figure 14d.



Figure 34 Emil Fahrenkamp,^[m] 1932: Shell Building, wavelike façade, Berlin.^[74]

A model of 1929 shows beside round corners further horizontal ribs, limiting the window belts of the main façade. They have apparently not been realised (cf. Figure 35).^[75]

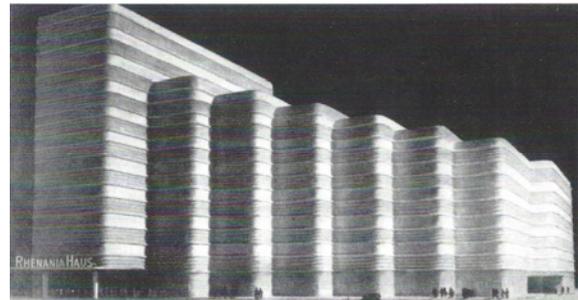


Figure 35 Emil Fahrenkamp,^[m] 1929: model of the Shell Building, Berlin.^[75]

A photo during the construction in 1931 clearly shows the cubic steel skeleton construction (top of the left main tower), finally covered with the undulating round corner surface (cf. Figure 36).



Figure 36 Emil Fahrenkamp,^[m] 1931: Shell Building in construction, Berlin.^[76]

[m] Emil Fahrenkamp, 1885-1966. German architect. 1937-1946: Director of the Düsseldorf Academy of Arts.

The question remains, why Fahrenkamp did not simply overlay the skeleton construction in a sharp, cubic manner, as an architectural design more oriented on functionalism principles would have done. Such examples are found in one of Hans Poelzig's numerous draft drawings from 1928 for the Tietz Department Store (Warenhaus Tietz) in Breslau (today Wrocław, cf. Figure 37) or of course in the Bauhaus Building itself (cf. Figure 38).

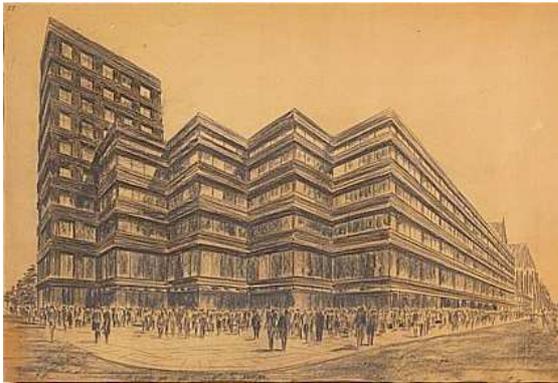


Figure 37 Hans Poelzig,^[n] 1928: draft drawing for the Tietz Department Store (Warenhaus Tietz), Breslau (today Wrocław).^[77]

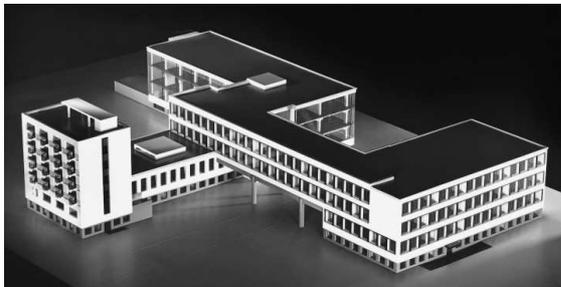


Figure 38 Walter Gropius,^[o] 1926: Bauhaus Building, Dessau, Germany.^[78]

With respect to the Shell Building, Brigitte Jacob described the different

[n] Hans Poelzig, 1869-1936. German architect and designer. 1919: chairman of the Deutscher Werkbund (German Association of Craftsmen). 1923-33: Professor at Technical University of Berlin

[o] Walter Gropius, 1883-1969. German architect. 1919-1928: Founder and director of the Bauhaus School in Weimar and Dessau.

motivation of Fahrenkamp (translated): *“The swinging, bent composition of the curtain-wall facing is in its character decorative and prestigious”,^[79]* i. e. it is not purely functional from an architectural point of view.

This seems very similar to the definition, which Van Doren gave in 1944 for industrial design that beyond pure function, the aim of *“the modern industrial designer is ... to enhance the desirability of these products by attracting buyers by applying a shrewd knowledge of consumer psychology; and employing to the fullest the aesthetic appeal of form, color and texture”.*^[80] In summary also other factors than only the function are important for the impacts of design and architecture.

Furthermore, the very important consumer psychology and topical aesthetics have always something to do with youth and modernity.^[81] And since the 1920s, an aesthetic canon was evidently fully up-to date for many areas, which was symptomatic and typical of a new area of material use.

In principle, the definition of an artistic movement may be given as characteristics of forms or patterns being repetitive, recognisable, significant and typical during a period and independent of a special implementation group of objects.^[82]

In consequence, the term ‘Matrix Design’, seems to be adequate for the objects in question, formed either by a matrix (cast or pressed) or inspired by the outcoming artistic look-and-feel language.

8. The ‘Matrix Design’ in ornament

Following the rule 5 mentioned above (cf. chapter 6), the moulding engineer has to introduce ribs, reeds, flutes, but also notches, either inside or outside of an object (cf. Figure 8, 9). As an early example, a radio cabinet from ca. 1930, not yet with round corners, but already with internal stiffening ribs is shown in Figure 39.

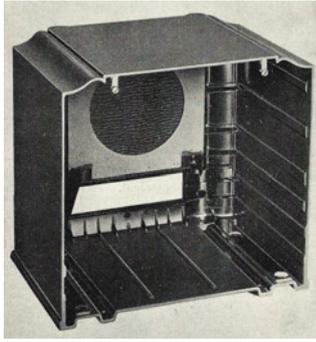
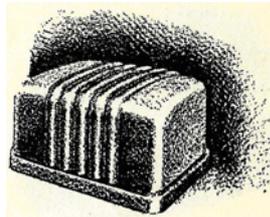
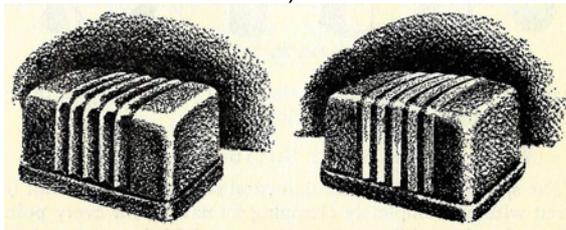


Figure 39 Ca.1930: Internal stiffening ribs, pressed phenolic resin radio cabinet.^[50]

As already mentioned in chapter 6, external stiffening is used moreover to create patterns in low relief, even without a constructive necessity for stiffening and dividing large plane surfaces, to avoid visible flow lines. Examples are given by Harold Van Doren,^[83] like convex ribs (reeds, rods) (cf. Figure 40a), concave flutes (cf. Figure 40b) or flattened triangles (cf. Figure 40c). They are machined in the die, simply and with low costs.



a)



b)

c)

Figure 40 Harold Van Doren,^[h] 1940: Decoration of pressed phenolic resin boxes with a) convex ribs, b) concave flutes, c) flattened triangles.^[83]

For the urea resin cabinet of the RCA 9-SX 'Little Nipper' radio (1939), 'flattened triangles' were used to cover the loud speaker. Five ribs (right below) serve as pure decoration and the knob (right below) is easy to grip because of the flutes around (cf. Figure 41).



Figure 41 1939: 9-SX 'Little Nipper' radio, pressed urea resin radio cabinet, Radio Corporation of America (RCA).^[84]

However, in the majority of cases, patterns with ribs have been used to form elementary, unpretentious ornaments, as shown in the masterly designed homewares, typical of the period, cf. figures 42-44.



Figure 42 Unkown designer, 1930: Round container, pressed phenolic resin, Rosenthal Presswerk AG, Germany.^[47]



Figure 43 Unkown designer, probably Ludwig König,^[e] since ca. 1933.^[85] Household articles, pressed urea resin 'Pollopas', Dynamit Nobel AG, Germany.^[86]

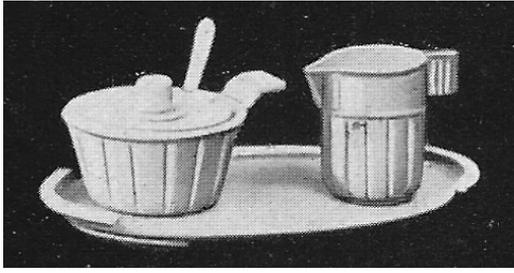


Figure 44 Friedrich Adler,^[f] 1933/34: Cream and sugar set, Bebrit-Werk. Bebra, Germany.^[87,88]

Many artists, among them also those working often on early plastics design, transferred this ornamental language to non-plastics products such as metal work (cf. Figure 45-47), glass ware (cf. Figure 48, 49), wooden furniture (cf. Figure 50) and also to architecture (cf. Figure 51, 52).



Figure 45 1936: Box 14 Trolix, pressed phenolic resin, Agfa-Werk, Germany.^[67]



Figure 46 a) 1930s: Wine cooler, ice box, silver plated cleading, Christian Dior, France.^[89]

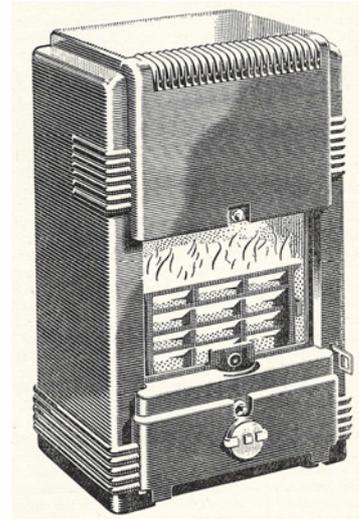


Figure 47 Raymond Loewy,^[p] 1937/38: "Otto" stove, cast iron, Swedish-British AGA Company.^[90,91]



Figure 48 Wilhelm Wagenfeld,^[q] 1936: Biscuit jars, pressed glass, VLG Weißwasser Werk Kamenz, Germany.^[92]



Figure 49 Walter Dorwin Teague,^[l] Edwin W. Fuerst 1939: 'Embassy' line of wine and liquor glasses, crystal glass ware, Libby Glass Co. USA.^[93]

[p] Raymond Loewy, 1893-1986. French born US industrial and graphics designer. One of the exponents of the Streamline Moderne.

[q] Wilhelm Wagenfeld, 1900-1990. Important German industrial designer, disciple of the Bauhaus.



Figure 50 Since 1934: Desk, 'Doric' line, Kittinger Authentic Furniture, USA.^[94-96]



Figure 51 Harry Weedon,^[r] 1937: Swiss Cottage Odeon Cinema, London.^[97]



Figure 52 Harry Weedon,^[r] Andrew Mather, 1937: Interior of the Leicester Square Odeon Cinema, London.^[98,99]

With respect to the different examples and the definition given in chapter 7, the term 'Matrix Design', seems likewise to be adequate for that decoration variant.

Of course, both the form and the ornament characteristics of the 'Matrix Design' have often been combined, as shown above in numerous examples.

9. Other 'Styles' of the 'Plastics Age'

Meikle stated that "*Designers of plastic moldings would succeed only by treating plastics as an artificial material, by using simple machine-cut forms to get that verve and dash which is so expressive of contemporary life*".^[100] The related term 'Machine Art', which can also be found in the literature,^[101] is more general and does not imply the typical conditions of moulding.

Another term sometimes to be found, the 'Bakelite Style' "*was in truth*" not "*uniform*",^[102] because it comprises all variations of Art Déco; e. g. the 'Zigzag Style' (cf. figure 53) and the 'Stepped' or 'Mastaba Style' (cf. figure 54) etc.



Figure 53 Art Déco, Zigzag Style, ca. 1925: Bowl and two vases, celluloid, France.^[103]

[r] Harry Weedon, 1887-1970. British architect, 1930s: Best known for the architectural design or construction supervision of 258 Odeon Cinemas in Britain.



Figure 54 Harold Van Doren,^[h] John G. Rideout, Art Déco, Stepped Style, 1933: Radio Skyscraper 66, pressed urea resin, Air-King Products Co., USA.^[67]

The term ‘*Bakelite Style*’ would also include the ‘*Streamline*’ (‘*true, functional streamlining*’^[59]).

From the end of the 1930s until the 1950s, the latter casually evolved from the ‘*Matrix Design*’ by using ellipsoid or hyperbolic forms or parts of them instead of circular ones (cf. figure 54, 55). This was already described in chapter 7.



Figure 55 Gio Ponti,^[s] Streamline, 1940: Table microphone, pressed phenolic resin, Società Radio Brevetti Ducati, Bologna, Italy.^[47]

[s] Gio Ponti, 1891-1979. Italian architect, industrial and furniture designer, artist, publisher. 1936-1961: Professor of architecture at Politechnic University of Milan



Figure 56 André Mounique,^[t] Streamline, 1945: Desk Lamp Bolide (Lucidus Bloc), lamp shade and stand of pressed phenolic resin, Société des Etablissements Nouvelle JUMO, Bagnolet, France.^[104-106]

By the way, a ‘*true streamlining*’ architecture in ellipsoid or hyperbolic forms did not really exist in the 1930s and subsequently. Only recently, some tall buildings have been constructed fulfilling aerodynamic necessities, e.g. ‘The Gherkin’ in London, (Sir Norman Foster, 2003, cf. figure 57),^[107] or the Guangzhou International Finance Centre in formerly Canton (Wilkinson, Eyre, 2008).^[108]



Figure 57 Sir Norman Foster, 2003: ‘The Gherkin’, London.^[109]

[t] André Mounique, 1945: the owner of the Société Nouvelle des Etablissements JUMO, Bagnolet, France (together with his partners Yves Jujeau and Pierre Mounique) took the patent for the lamp.

10. Conclusion

In chapter 3, the development of an architectural language by *casting fluid material* (industrial composite material reinforced concrete) into a mould (i.e. a matrix as the formgiving element) as a *plastic and fluid vision* was discussed. Herefrom, *the poetics of the round corner* emerged as a typical architectural form in Germany since the middle of the 1920s.

In chapter 6, principles of compression moulding techniques using matrices as form giving elements as well of plastics as of metal sheets were presented. Among them, the round corner principle and rib ornaments play a significant role.

In chapters 7 and 8 these principles were related to the design of plastic objects and were termed as 'Matrix Design'.

Furthermore, the subsequent influence on objects of other material groups was elucidated for the 1930s period. Many artists, also those working often in early plastics design, transferred the form and ornamental language to non-plastics products. This was done with moulding (matrix using) processes, e.g. pressed glass or cast iron. But the same design language was also found in wooden objects or in architecture, where moulding/matrix techniques did not play any role.

It was furthermore shown that architecture may influence design and vice versa. Both sequences are affected by historical, social and technical factors. In principle equivalent interdependencies between architecture and industrial design were recently described by Tom Steiner as "Smartphone Architecture" and "Desktop Architecture".^[110]

The 'Matrix Design' comprises a typical period of design and architecture from the middle of the 1920s until the end of the 1930s. Plastics design apparently played an important interactive role during this time.

Jeffrey Meikle reported that "...the plastics industry and the new profession of industrial design developed together during the Depression years". And that "the close relationship between plastic and industrial design became an unquestionable axiom", asserting that "modernistic trends have greatly boosted the use of plastics, which in turn by their beauty have boosted modernism".^[111]

Apparently, this process began in Germany from 1929/30 onward by the long time forgotten pioneers of plastics design Friedrich Adler,^[f] Christian Dell,^[d] Walter Maria Kersting,^[g] Ludwig König^[e] and others.^[31,33]

In the USA and Britain, this development proceeded somewhat later on since 1933 by numerous, likewise well-known designers.

As a consequence of technical construction rules for the production of objects made of phenolic and urea resins mostly compression moulded characteristics of a design type were developed, which on its part used round corner forms and/or often ribbed but sometimes also fluted ornaments.

Originating from different roots from the middle of the 1920s onwards, the 'Matrix Design' in form and ornament is characterised directly by a matrix process (casting or pressing of different materials) or indirectly inspired by its outcoming artistic look-and-feel language, furthermore by the high technological level and hence the imagination of dynamics, modernity and youthfulness, on the whole by positive feelings of success. It became altogether so typical for a modern sense of life and was so successful for product placement or marketing and in architecture that its design principles became internationally widespread.

The chosen term 'Matrix-Design' seems to be much more causal, illustrative and explanatory than the 'Form around 1930' and 'Technodesign', coined by Selle^[12] only with respect to German design history

(cf. chapter 2) and the misleading “*minor or nonfunctional streamlining*”, used by Van Doren in the USA.^[59] (cf. chapter 7), all introduced for the same phenomena.

To avoid a discussion at this point on the tremendous difficulties of the concept of a ‘style’,^[112,113] we here do not adopt the term ‘*matrix style*’ but ‘*Matrix-Design*’.^[1]

In summary, the one and a half decades between the middle of the 1920s until the end of the 1930s were - among other movements – widespread, substantially and internationally characterised by the ‘*Matrix Design*’, influencing form and ornament either by different matrix processes or inspired by its artistic, social and economical impressions of design and architecture, in line with the times.

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References

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- [1] This article is essentially precisising, complementing and extending an earlier publication: Günter Lattermann, *Der Matrizenstil/The Matrix Style*, in Romana Breuer, Petra Hesse (ed.), “*RADIO Zeit – Röhren-geräte, Design-Ikonen, Internetradio/RADIO Days – Tube Radios, Design Classics, Internet Radio*”, Kerber Verlag, Bielfeld 2016, p. 48-55
- [2] Hans-Ulrich Kölsch, *Bakelit und Design - Formgebung und frühe Interpreten*, in Ulrich Löber (ed.), “*Bakelit - Ein Werkstoff mit Zukunft*”, Begleitpublikation zur gleichnamigen Ausstellung, Landesmuseum Koblenz, Koblenz 1993, p. 81-93
- [3] Gerda Breuer, *Design und Material exemplarisch – Einblicke in eine reibungsvolle Allianz*, in Gerda Breuer, Kerstin Plüm (eds.), “*Stiftung Design-*

-
- Sammlung Schriefers”, Wienand Verlag, Köln 1997, S. 101-118
- [4] Gerda Breuer, *Der Bauhaus-Drücker*, in Ursula Kleefisch-Jobst, Ingbeorg Flagge (eds.), “*Architektur zum Anfassen. FSB Greifen und Griffe*”, Anabas Verlag Günter Kämpf GmbH & Co. KG, Frankfurt am Main 2002, p. 57-68
- [5] der bogen, *Journal der Bauhaus-Universität Weimar* 5 (2002), p. 6
- [6] Alexander Luckman, *Erich Mendelsohn: an Investigation into the Likeability of Buildings*, Global Issues, May 6 (2013); URL: http://www.headroyce.org/upload/Global_Ed/likeability_of_buildings.pdf
- [7] Daniell Bell, *Zur Auflösung der Widersprüche von Modernität und Modernismus. Das Beispiel Amerikas*, in Heinrich Meier (ed.), “*Zur Diagnose der Moderne*”, Piper Verlag GmbH, München 1990, p. 21-67
- [8] Christopher Wilk, *What is modernism?*, in Christopher Wilk (ed.) “*Modernism: Designing a New World 1914-1939*”, V & A Publications, London 2006, p. 11-21
- [9] Joan Marter (ed.), *The Grove Encyclopedia of American Art*, Vol. 1, Oxford University Press, Oxford etc. 2011, p. 139-148
- [10] Stephanie Barron, Sabine M. Eckerman (eds.), *New Objectivity: Modern German Art in the Weimar Republic 1919-1933*, Prestel Verlag, München 2015
- [11] Arne Sildatke, *Dekorative Moderne – Das Art Déco in der Raumkunst der Weimarer Republik*, Dissertation FU Berlin, LIT Verlag Dr. W. Hopf, Berlin 2013, p. 468
- [12] Gert Selle, *Geschichte des Design in Deutschland*, Campus Verlag GmbH, Frankfurt am Main 2007, p. 182-191
- [13] Hans Wichmann, *Design contra Art Déco. 1927-1932, Jahrfünft der Wende*, Prestel Verlag, München 1993, p. 17 ff.
- [14] Reyner Banham, *Theory and Design in the First Machine Age*, 2nd. Edition, The MIT Press, Cambridge MA, 1980, p. 9 ff.
- [15] Harold Van Doren, *Industrial Design, a practical guide*, McGraw-Hill Book Company Inc. New York etc. 1940, 12th edition
- [16] Photo: Wikipedia

- [17] Bruno Zevi, *Erich Mendelsohn – The Complete Works*, Birkhäuser Publishers, Basel etc. 1999, p. XLIX
- [18] *ibid.*, p. 65
- [19] Erich Mendelsohn, *Das Gesamtschaffen des Architekten, Skizzen, Entwürfe, Bauten*, Rudolf Mosse Buchverlag, Berlin 1930, p. 24
- [20] Bruno Zevi, *loc.cit.*, p. LXXV
- [21] *ibid.*, p. L, LI
- [22] Donald Leslie Johnson, Donald Langmead, *Makers of the 20th century Modern Architecture: a Bio-critical Sourcebook*, Fitzroy Dearborn Publishers, London etc. 1997, p. 207
- [23] *ibid.*, p. 118-120
- [24] Photo: Wikipedia
- [25] Bruno Zevi, *loc.cit.*, p. 142-151
- [26] Photo: Wikipedia, Bundesarchiv, Bild 102-07016 / CC-BY-SA 3.0
- [27] Francis D.K. King, *Architecture – Form, Space, & Order*, 4th edition, John Wiley & Sons, Hoboken 2015, p. 90
- [28] Gert Kähler, *Architektur als Symbolverfall - Das Dampfermotiv in der Baukunst*, Friedr. Vieweg Verlag, Braunschweig 1981
- [29] Johannes Schleuning, *Die Siedlung Römerstadt in Frankfurt a.M. von Ernst May*, diplom.de, 2000, p. 69
- [30] Photo, URL: http://www.geopfad-frankfurt.de/docs/station_02.html
- [31] Edward Lucie-Smith, *A history of industrial design*, Phaidon Press, London 1983, p. 99
- [32] Günter Lattermann, *Resopal – Weit mehr als Laminat/Much more than a laminate*, in Romana Schneider, Ingeborg Flagge (eds.), “Original Resopal – Die Ästhetik der Oberfläche/The Aesthetics of Surface”, jovis Verlag GmbH, Berlin 2006, p. 10-19
- [33] Günter Lattermann, *Bauhaus ohne Kunststoffe? – Kunststoffe ohne Bauhaus?*, *form+zweck* 20 (2003), p. 110-127
- [34] Jeffrey L. Meikle, *American Plastic - A Cultural History*, Rutgers University Press, New Brunswick 1995, p. 110-111
- [35] Hui Li, *Chinese Glass Before the Han Dynastie*, Dissertation Eberhard-Karls University Tübingen, Tübingen 2008, p. 132, 134
- [36] Christiane Sellner, *Glas in der Vervielfältigung: Gepresstes Glas vom Gebrauchsgegenstand zum Kunstobjekt*, Band 8 der Schriftenreihe des Bergbau- und Industriemuseums Ostbayern, Theuern 1986, p. 12
- [37] *ibid.*, p. 14,15
- [38] *ibid.*, p. 19
- [39] Drawing after^[38]: Günter Lattermann
- [40] URL: www.glas-musterbuch.de
- [41] Pierre Lallemand, *Le Papier mâché*, Editions Pierron, Sarreguemines 1999
- [42] Roger Newport, *Plastics and Design*, in Susan Mossman (ed.), “Early Plastics, Perspectives 1850-1950”, Leicester University Press, London 1997, p. 72-112
- [43] M. Michel Chevalier, *L'Exposition Universelle de 1862*, Imprimerie et Librairie centrales des Chemins de Fer, Paris 1862, S. 69-71
- [44] Gaston Vermosen, *Bois Durci – un plastique naturel/a natural plastic*, 1855-1867, Eigenverlag, S. 41
- [45] URL: <http://www.authorstream.com/Presentation/raza123-1201096-history-of-plastics/>
- [46] *Römmeler-Buch*, H. Römmeler AG, Preßstoffwerke Spremberg N.-L., Spremberg 1938, S. 28-42
- [47] Photo: Lattermann Collection, Bayreuth
- [48] Günter Lattermann, *Das Stapelservice von Christian Dell*, in Gerda Breuer (ed.) “Designgeschichte ausstellen”, Bergische Universität Wuppertal, Wuppertal 2005, p. 102-109
- [49] Dietmar Linke, Günter Lattermann, *Geschichte und Restaurierung der Kaffeekanne des gelben Resopal-Geschirrs von Christian Dell*, e-plastory 2013, Nr. 1
- [50] Alfred Hermanni, *Elektrotechnische Erzeugnisse aus Kunstharz-Preßstoffen und ihre Konstruktion*, in “Verwendung und Zusammensetzung, Konstruktion und Fabrikation sowie Prüfung von Preßstofffabrikaten, Vorträge gehalten auf der Leipziger Frühjahrsmesse 1935”,

- Fachgruppe 7 „Isolierstoffe der Wirtschaftsgruppe Elektroindustrie (ed.), Berlin 1935, p. 38-58
- [51] VDI-Richtlinien Gestaltung von Kunstharzpreßteilen, VDI-Verlag, Berlin 1939
- [52] R. Nische, W. Esch, *Untersuchung an Eß- und Trinkgeschirren aus Kunstharz-Preßstoffen*, Kunststoff-Technik und Kunststoffanwendung 10 (1940), p. 57-62
- [53] J. H. Dubois, *Plastics – a simplified presentation of the manufacture and use of the important plastics materials and products with tables of their properties and the basic design information required by engineers and designers*, American Technical Society, Publishers, Chicago 1943, p. 255-279
- [54] Christian Bonten, *Kunststofftechnik für Designer*, Carl Hanser Verlag, München etc. 2003, p. 115-129
- [55] *Bakeliet, techniek-vormgeving-gebruik*, Museum Boymans - van Beuningen, Rotterdam 1981, p. 35
- [56] Christian Kleinen, Reiner Langen, *Das Zinkwalzwerk Hoesch und die Geschichte der frühen Walztechnik*, v. d. Linnepe Verlagsgesellschaft mbH & Co KG, Hagen 1981, p. 9-16. URL: http://www.kreuzau.de/ug/downloads/geschichte_anhang/Anhang_11.1.pdf
- [57] Harold Van Doren, *Industrial Design, a practical guide*, McGraw-Hill Book Company Inc. New York etc. 1940, 12th edition
- [58] *ibid.*, p. 303
- [59] *ibid.*, p. 139-145
- [60] Hans Gerhardt, Albert Höfner, *Deutsche Roh- und Werkstoffe*, 3. Auflage, Naturkunde und Technik Verlag Fritz Kanpp, Frankfurt am Main 1940, p. 219
- [61] Jeffrey L. Meikle, *American Plastic*, loc. cit., p. 105
- [62] Günter Lattermann, *Walter Maria Kersting – Pionier des Kunststoffdesigns/Walter Maria Kersting – Pioneer of Plastics Design*, in Romana Breuer, Petra Hesse (ed.), “RADIO Zeit – Röhren-geräte, Design-Ikonen, Internet-radio/ RADIO Days – Tube Radios, Design Classics, Internet Radio”, Kerber Verlag, Bielfeld 2016, p. 40-47
- [63] Photo: AEG prospectus 1933
- [64] Günter Lattermann, *Der Volksempfänger*, in Kai Buchholz, Klaus Wolbert (eds.), “Im Designerpark – Leben in künstlichen Welten”, Häussermedia Verlag, Darmstadt 2004, p. 940-941
- [65] Joan Marter, *The Grove Encyclopedia of American Art*, Oxford University Press, Oxford etc. 2011, p. 448
- [66] John Gloag, Grace Lovat Fraser, *Plastics and Industrial Design*, G. Allen & Unwin Limited, London 1945, p. 36
- [67] Museum für Angewandte Kunst Köln. Photo: Sascha Fuis Fotografie, Köln.
- [68] Walter D. Teague, *Design for a camera*, US Patent US103700S, 23 march 1937
- [69] Harold Van Doren, *Industrial Design*, loc. cit., p. 139-145
- [70] Photo, URL: <http://www.decophobia.com/zenith+model+811+812+art+deco+radio+export+version/>
- [71] Photo, URL: http://antiqueradio.org/GE_F-63_Radio.htm
- [72] Photo: sellingantiques.co.uk
- [73] Photo: artdeco.uk
- [74] Photo: Wikipedia, Beek100
- [75] Brigitte Jacob, *Emil Fahrenkamp: Bauten und Projekte für Berlin*, jovis Verlag GmbH, Berlin 2007, p. 219
- [76] *ibid.*, p. 223
- [77] Photo, URL: <http://wroclawzwyboru.blox.pl/2009/03/UI-Swidnicka-wg-Hansa-Poelziga.html>
- [78] Photo, URL: https://dokuwiki.noctrl.edu/lib/exe/detail.php?id=ger%3A201%3A2010%3Afall%3Aberlin&media=ger:201:2010:fall:gropius_bauhaus_modello.jpg
- [79] Brigitte Jacob, loc. cit., p. 259
- [80] Harold Van Doren at the 1944 meeting of the Associated Industries of New York State, *Product Engineering* 15 (1944), p. 434
- [81] Patrick T. Vargas, Sukki Yoon, *Advertising Psychology*, in Charles Spiegelberger (ed.), “Encyclopedia of Applied Psychology”, Academic Press, Cambridge MA, 2004, p. 53-64
- [82] Angelika Linke, *Stil und Kultur*, in Ulla Fix, Andreas Gardt, Joachim Knappe (eds.), “Rhetorik und Stilistik: ein internationales Handbuch historischer

- und systematischer Forschung”, Walter de Gruyter GmbH & Co KG, Berlin 2009, p. 1135
- [83] Harold Van Doren, *Industrial Design*, loc.cit., p. 97
- [84] Photo, URL: <http://www.decophobia.com/prodimg/rca-9sx-radio-bakelite-plaskon-little-nipper.jpg>
- [85] Advertisement: *Pollopas für Haus und Küche*, Die Schaulade 9 (1933), p. 68
- [86] *Tropas Waren*, price list Nr. 7 (1938) p. 10
- [87] Matrix list, 1934, Bebrit-Werke, Bebra, Germany
- [88] Photo: Price list Nr. 242, 1935, Bebrit-Werke, Bebra, Germany
- [89] Photo, URL: http://www.1stdibs.com/furniture/diningentertaining/barware/ultra-chic-modernist-midcentury-silver-plate-wine-cooler-christian-dior/id-f_2117083/
- [90] John Gloag, Grace Lovat Fraser, *Plastics and Industrial Design*, loc. cit., p. 44
- [91] *The 1951 Design Congress & the Story of the AGA Cooker – Celebrating 70 years of the Design Council*, 1951, pp. 5, 14, 18.
URL: http://www.agaliving.com/media/2431324/agaandthedesigncouncil_lr.pdf
- [92] Photo: Joachim Rossow Collection, Berlin
- [93] Photo, URL: http://www.modernismgallery.com/prodimg/embassyoutout%281%29_t.jpg
- [94] Photo, URL: <https://www.antiquehelper.com/item/337583>
- [95] URL, <http://modernism.com/items/39/bedroom-suites/1406-1227-american-art-deco-kittinger-bedroom-set>
- [96] URL: <http://modernism.com/designers-and-manufactures/kittinger-company>
- [97] Photo, URL: <http://modernism-in-metro-land.tumblr.com/image/18064667829>
- [98] Photo, URL: <https://www.linkedin.com/pulse/venue-spotlight-presenting-odeon-leicester-square-steven-white?forceNoSplash=true>
- [99] Dennis Sharp, *Twentieth Century Architecture – A Visual History*, The Images Publishing Group Pty Ltd., Mulgrave, Australia 2002, p. 108
- [100] Jeffrey L. Meikle, *American Plastic*, loc. cit., p. 114
- [101] John Gloag, Grace Lovat Fraser, *Plastics and Industrial Design*, loc. cit., p. 38
- [102] Jeffrey L. Meikle, *American Plastic*, loc. cit., p. 118
- [103] Kölsch Collection. Photo: Atelier Müller, Essen.
- [104] Museum für Angewandte Kunst Köln. Photo: RBA Köln, Marion Mennicken.
- [105] André Mounique, *Retractable office lamp*, US Patent 2 543 926, Application in France 1945, in USA 1946.
- [106] Wolfgang Hornick, *Industriemöbel*, SammlerJournal, Juli 2011, p. 63-66
- [107] Brent Richards, *New Glass Architecture*, Yale University Press, New Haven 2006, p. 210-217
- [108] Dave Parker, Antony Wood (eds.), *The Tall Buildings Reference Book*, Routledge/Taylor and Francis, New York 2013, p.37
- [109] Photo, URL: http://londontopia.net/wp-content/uploads/2015/06/The-Gherkin_safra-group.jpg
- [110] Tom Steinert, *Some Observations on the Interdependence of Architectural and Industrial Design*, Wolkenkuckucksheim/Cloud-Cuckoo-Land 32 (2014), p. 159-180.
URL: http://cloud-cuckoo.net/fileadmin/hefte_de/heft_32/article_steinert.pdf
- [111] Jeffrey L. Meikle, *American Plastic*, loc. cit., p. 106
- [112] Bryan Lawson, *How Designers think - The Design Process Demystified*, 4th edition, Elsevier, Amsterdam etc. 2005, p. 162
- [113] Annely Rothkegel, *Stil und/oder Design*, in Eva Maria Jakobs, Annely Rothkegel (eds.), “Perspektiven auf Stil“, Max Niemeyer Verlag, Tübingen 2001, p.77-87