The Multiple 'Means' of Drawing for Design. Tests in Repurposing Industrial Products

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Abstract

Drawing plays a specific role in forming a code of thought, which is built through progressive layering and unfolds above all in writing, whatever the instrument used. In this sense, its multiple prerogatives articulate that indispensable yet necessary language, not only to communicate a design project but also to implement that fundamental procedure of controlling the design process. From an operational point of view, this translates into the practice of using different of drawing to tell about the project.
With this in mind, this article presents some experiences in research and teaching conducted in an experimental/laboratory form on the subject of repurposing certain existing industrial products by studying their ability to accept modifications on different levels. This creative process for a renewed concept/functionality of products was conducted through two closely related phases. The first is cognitive and aimed at activating processes of true appropriation/reconstruction of the design process through graphical operations to 'recognize' the object. The second is to study appropriate transformations aimed at re-presenting the modified product according to different planes of communication or different problematic levels of in-depth examination.

Keywords: product design, drawing, transformation, cognitive models, interpretational/descriptive methods

Design: definitions, processes, objectives

Tomas Maldonado developed a definition of design, adopted at the ICSID Congress of 1961, as the act of "coordinating, integrating, and articulating all those factors that participate in the process to constitute a product", i.e. a complex action referring to factors related to the use, enjoyment, consumption, and also the manufacture of a product [Di Lucchio 2013, p. 321]. In the reality of developing a project, the notion of design is thus redefined "as a conscious activity, virtuous feedback capable of formalizing […] new products for old and new needs" [Paris 2013, p. 12].
Design always calls upon a target; the objective of meaning determines an effect of meaning for the user through a product that is presented as the answer to a question, although it may not yet be explicit. Design is therefore not merely technical practice but also a mental activity in which the question of how to act must follow the question of why (and for whom) [Zingale 2009, pp. 193-197].
Design also involves the discipline of ergonomics in both functional and perceptual/cognitive terms. Le Corbusier had already envisaged the possibility of creating *objets-membres humains*, understood as *objets-types* ergonomically 'harmonized' to humans according to dimensional standards [Le Corbusier 1925, pp. 77, 78]. Today, reference is made to anthropometry, which studies the relationship between human body measurements (static and dynamic) and the dimensions of environments and products. The path of ergonomics then evolved from the concept of anthropocentric design (User-Centred Design)

as defined by the American psychologist Donald A. Norman, according to whom the definition of a product must start from the needs and interests of the user, aiming at products that are usable and understandable, and which also offer pleasure and gratification [Norman 1995, p. 209]. The psychologist, defining the term 'conceptual model' as a mental representation (model) of the function of a product, stated that "the designer must ensure that everything in the product is consistent with the right conceptual model and exemplifies its function" [Norman 1995, p. 212].
Design, implementing an articulated system of skills and knowledge, is called to operate according to open and flexible interdisciplinary modes relying on blending and connections [Imbesi 2015, p. 43]. Thus, the intention that moves it –that is, the process that leads from the idea to the object– requires a method. In this respect, Bruno Munari wrote that "the method of design is nothing more than a series of necessary operations arranged in a logical order dictated by experience […]. Creativity does not mean improvisation without a method. The series of operations in the design method consist of objective values that become operational tools in the hands of creative designers. […] Whatever the problem is, it can be dismantled into its components. […] Having solved the small problems one at a time, they are recomposed coherently according to all the functional, material, ergonomic, structural, and formal characteristics. 'Beauty is the consequence of what is right', as a Japanese rule says" [Munari 1991a, pp. 16, 17, 42].

Drawing: descriptors, prerogatives, and modalities

We draw for various reasons: to ask and answer questions, analyse and understand, memorize and highlight, etc. In sum, its main descriptors refer to prefiguring, understanding, and communicating.
The concept of creative drawing is used in reference to a practice that constructs means of anticipating reality and its outcomes. In this case, since it involves an active operation of project ideation, verification, and control whose recursive graphical immediacy allows the idea to form through action, it is perhaps more appropriate to refer to the act of to draw [Casale, Inglese 2013, pp. 138-140].
This statement, which would seem to favour above all the idea-forming prerogative of drawing, in reality does not at all exclude the practice for cognitive/referential and analytical purposes, but rather intends to understand it again and orient it towards its deepest meaning: as another manifestation of an instrumentality appropriate for a thought participating in the goal. In fact, drawing plays the specific role of forming a code of thought which is built through progressive layering and unfolds above all in writing, that is, acting as a true language which explains concepts through signs, whatever the instrument used (analogue, digital, material).
Therefore, drawing is said to have cognitive prerogatives when it works to analyse and memorize, when it triggers a series of considerations about the graphical operation, activating methods of deconstructive/reconstructive observation, and when it activates forms of both selective and associative thinking and mental processes of discrimination/discretization that develop capabilities of both specific analysis and synthesis, describing in detail on different planes of interpretation or problematic levels of in-depth study.
Drawing can be said to be communicational when, following a critical reading, it makes specific features comprehensible or when it "transforms the imaginative complexity of the future reality into its synthetic evolution" [Casale, Inglese 2013, p. 138]. In these cases, the effectiveness of drawing with respect to communicative synthesis can be effectively explained by the fact that "The verb 'to draw' defines the activity; and in addition to deriving, like a lemma, from *signum*, sign, it is also related and akin to the verb 'to designate', to indicate precisely, to name. Hence, the act is also defined as the procedure of processing the acquired knowledge" [Bertocci 2021, p. 23]. Through drawing, it is therefore possible to build models of understanding and communication based on the fundamental conceptual operations of recognition and interpretation.
In relation to these prerogatives, drawing relies on a variety of tools and techniques.
The freehand sketch is a unique moment of preparatory observation and/or self-communication used to define an idea (whether creative or analytical) that, through a personal and intimate graphical register, allows for immediate perceptive verification; "The designer can use it as a note to remember something that he has in mind, that he has discovered, that he wants to modify […] to specify a constructive detail, an attachment between two different materials, a joint, a way of arranging the elements in a whole, an operational sequence" [Munari 1991a, p. 65]. It is a valuable notational system featuring conciseness, rapidity, density (of external and internal information), and freedom from any code; an open tool like a work in progress [Belardi 2004, pp. 42-50] (fig. 1).

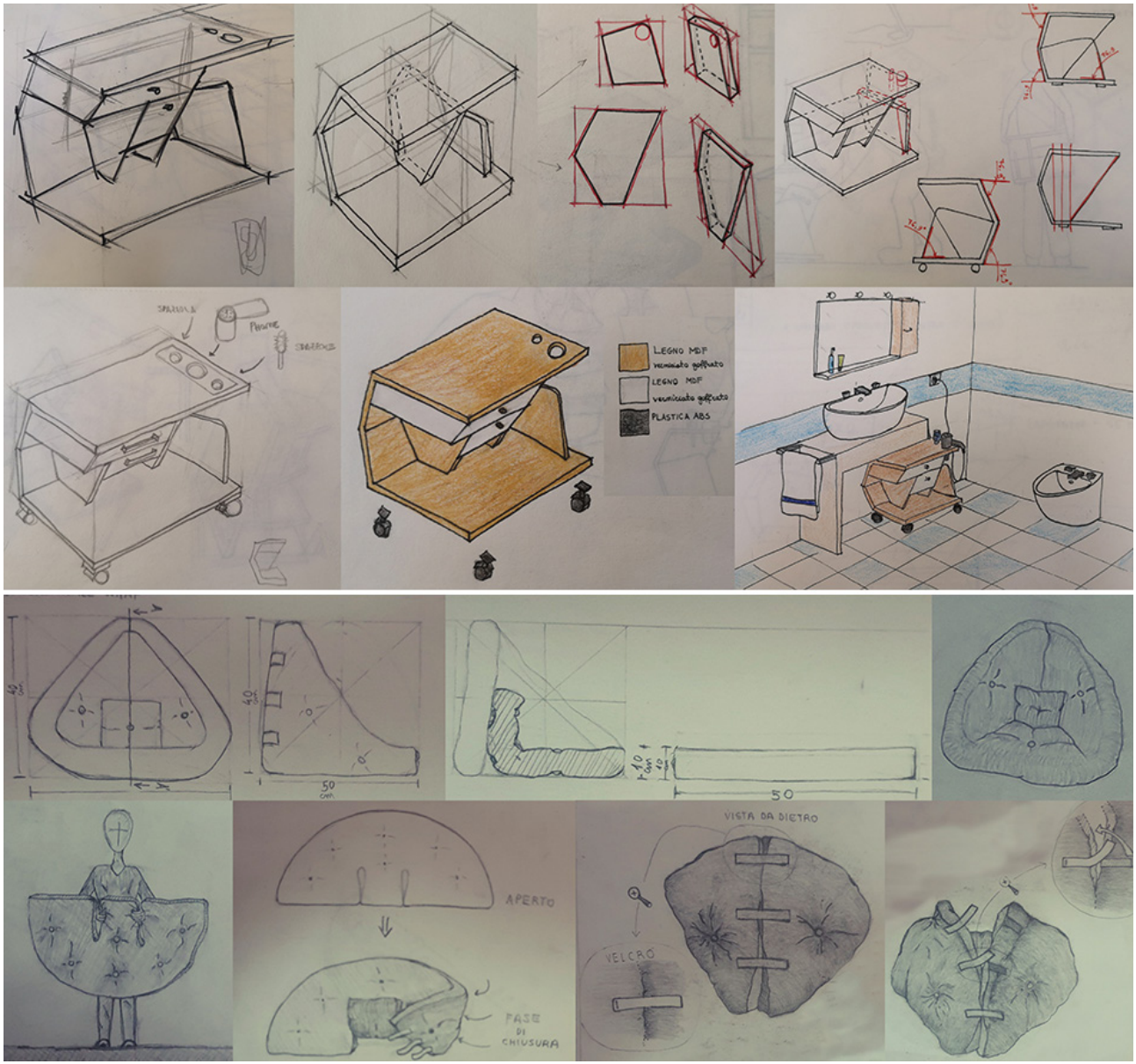
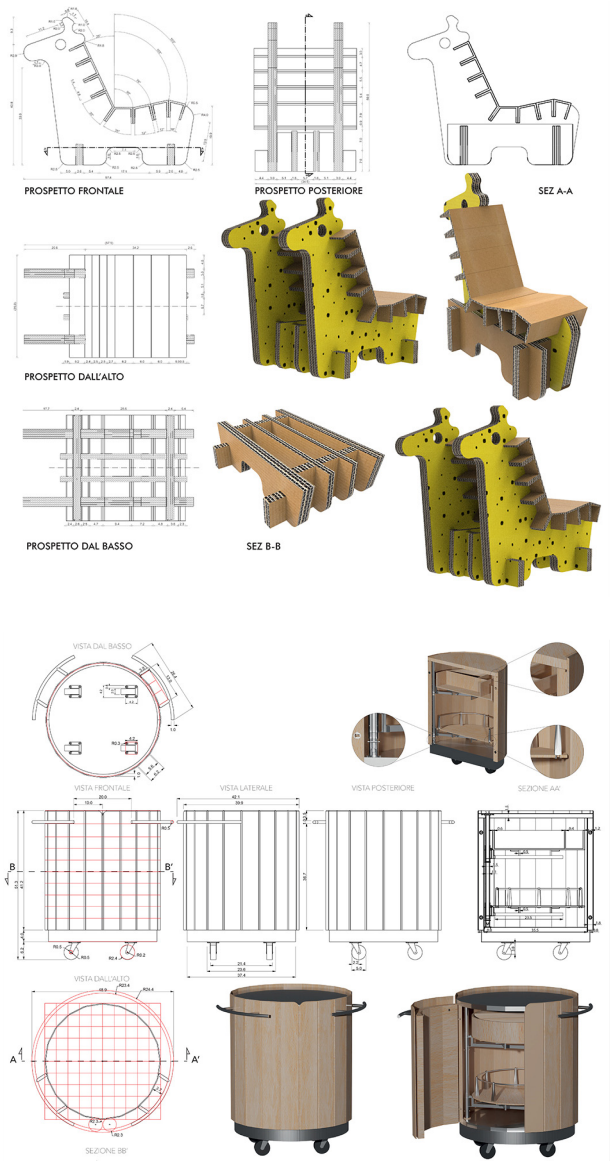


Fig. 1. Study sketches of a cabinet (students Davide Pranzetti, Ivan Rebichini) and "kids' nesting" chair (students Andrea Nicolardi, Giovanni Sasso).

Fig. 2. Technical drawings and illustrations of a "kids" chair (students Alessio Persichini, Andrea Pettorino) and cabinet (students Chiara Scaramucci, Arianna Veronesi).



At the other end, but not in the opposite sense, digital modelling tools now also play a central role in the process of prefiguration and the technical-formal control of a product. Their evolution has gone far beyond the function of simple reproduction, making them creative tools that can simulate our work in real time.
It goes without saying that in all of this, the methods of descriptive geometry play a pertinent and effective role in relation to the prerogatives of drawing, representing the complexity of what is real or imagined.
In relation to the purposes occasionally identified and with the integrated, complementary support of tools, methods, and techniques, it is therefore possible to identify two different basic approaches to drawing, one based on the rigour of measurements and a formalized language, the other operating predominantly through perceptual verisimilitude.
The technical drawings, scaled and dimensioned, can identify both the objectives of the 'geometric-metric control' of dimensions-proportions of even the smallest details and 'analytic goals' that disassemble and isolate characteristics of a product, enabling the verification of multiple aspects.
Figurative/illustrative drawings make considerable use of graphics that are more intuitive, appealing, effective, and understandable to non-experts. They may use schematic and/or plausible representational modes depending on whether they need to illustrate technological-material parts, assembly instructions, exterior/interior relationships, or offer a realistic presentation of the spatiality/three-dimensionality of an object/environment as it will be perceived (fig. 2).
Having said this, although technical and figurative drawings refer to different registers of representation and feature different communication strategies, both actually combine different levels of iconism/symbolism according to the type of information to communicate. In other words, they fuse both mimetic and notational characters in an interacting way, building knowledge through coherent acts of inclusion and exclusion [Pascolini 2006, p. 138].

Drawing and design: narrative and descriptive functions

The drawing/design relationship is a mutual and non-neutral support of one with respect to the other: "drawing while designing and designing while drawing" [Maldonado 1998, pp. 102], an interacting co-existence between the means and the end that allows a solution to be sought and identified.

Planning a design object is a complex multidisciplinary process in which drawing, through its varied systems and tools (from the most traditional to the most innovative), serves as essential support in managing the concept and information through images. Its multiple prerogatives (analytical, developmental, illustrative) articulate an indispensable yet necessary language used not only to communicate a design project, but also to implement the essential aspect of controlling the design process. From an operational point of view, this translates into different means of drawing to tell about the project.
Drawing plays a dual role here. It has a narrative function when, for example, it tells about the design concept or the function of an object in terms of both user interaction and the sequences of actions to assemble the constituent parts. On the other hand, it has a descriptive function when it expresses more specific aspects of the project (dimensions, shape, ergonomics-function, construction of the constituent parts, colours-materials, prototyping).
Therefore, since "the more aspects we know about something, the more we appreciate it and the better we can understand the reality of it" [Munari 1991b, p. 78], it is more correct to speak of 'multiple, compound' drawing because it targets different levels of detail and is necessarily addressed to different subjects (customer; production chain; advertising system; sales chain; purchaser/end user). It follows that a good designer should above all clarify to himself the different aspects of complexity so they can then be made intelligible to the different subjects with adequate graphical responses, i.e., codes of communication aimed at and suitable for the specific request expressed in each case. Hence, there is no single drawing, but rather a strategic, structured, complex, and effective combination of interconnected graphic elaborations, each with a very precise narrative/descriptive scope. The drawings are all strongly interrelated and interdependent, in mutual relation with one another according to a selective (first) and associative (later) mode of thought and operation which constitute, as a whole, that necessary multiple, structured, exhaustive representation.
In other words, when going from the conceptual to the communicational-representational plane, a good designer must know how to discern (interpret and synthesize) the characteristics of the object with reason to highlight and thus conceive drawings that are re-presentations of the object, introducing in each only those signs that are capable of isolating/emphasizing a particular characteristic.

Re-presenting/repurposing products

In the framework of the considerations mentioned above, the following presents the assumptions and results of several research and teaching experiences conducted in an experimental/laboratory form [1], on the subject of revisiting/repurposing several existing industrial products. This creative process for a renewed concept/function of products starts with a profound knowledge about them and studies the possibilities of making modifications on different levels.
As a theoretical support but also an operational outline to support both analysis and then the project, reference was made to the 'Munari method' [Munari 1991a, pp. 35-63, 102-108]. This method, which still serves as a basis for discussion today, proposes ways that are still valid for reasoning about 'what, how, why, and for whom'. Two particular experiments were conducted, differentiated by themes and thus also by the resulting specific objectives.
The chair is an object against which all major designers have measured themselves and which, in its apparent simplicity, actually also meets functional needs other than 'sitting'. With this in mind, the theme of the first experience was a kids' version of selected chairs –among which students could choose– which could be of different volumetric types: soft and conformable, rigid modular/conformable and non-conformable (solid and hollow volumes), cartoon chairs (boxy volumes created by folding or interlocking). The development of the topic was not only limited to reproportioning the object for the purposes of correct posture and thus the understanding that the objective is not achieved by a trivial scaling, but also to intervene on the characteristics of the object with small but substantial modifications specifically aimed at children. In fact, since "for a child, the object can be like a large toy" [Munari 1991a, p. 188], in this perspective, the object chair should be conceived as easy to use, fun, brightly coloured, made of light, resistant materials, easily manoeuvrable, free of hazards, and capable of stimulating the imagination [Munari 1991a, pp. 248, 252]. Moreover, since "all objects that we come into contact with are, in a certain sense, interactive, even those that appear completely passive to us" [Polillo 1993, p. 50], it is necessary to focus on the development of the object's readiness to 'interact', not only to clarify the purpose for which it is intended, but also to lead to evolution in the child's actions [Manzini 1990, p. 137].

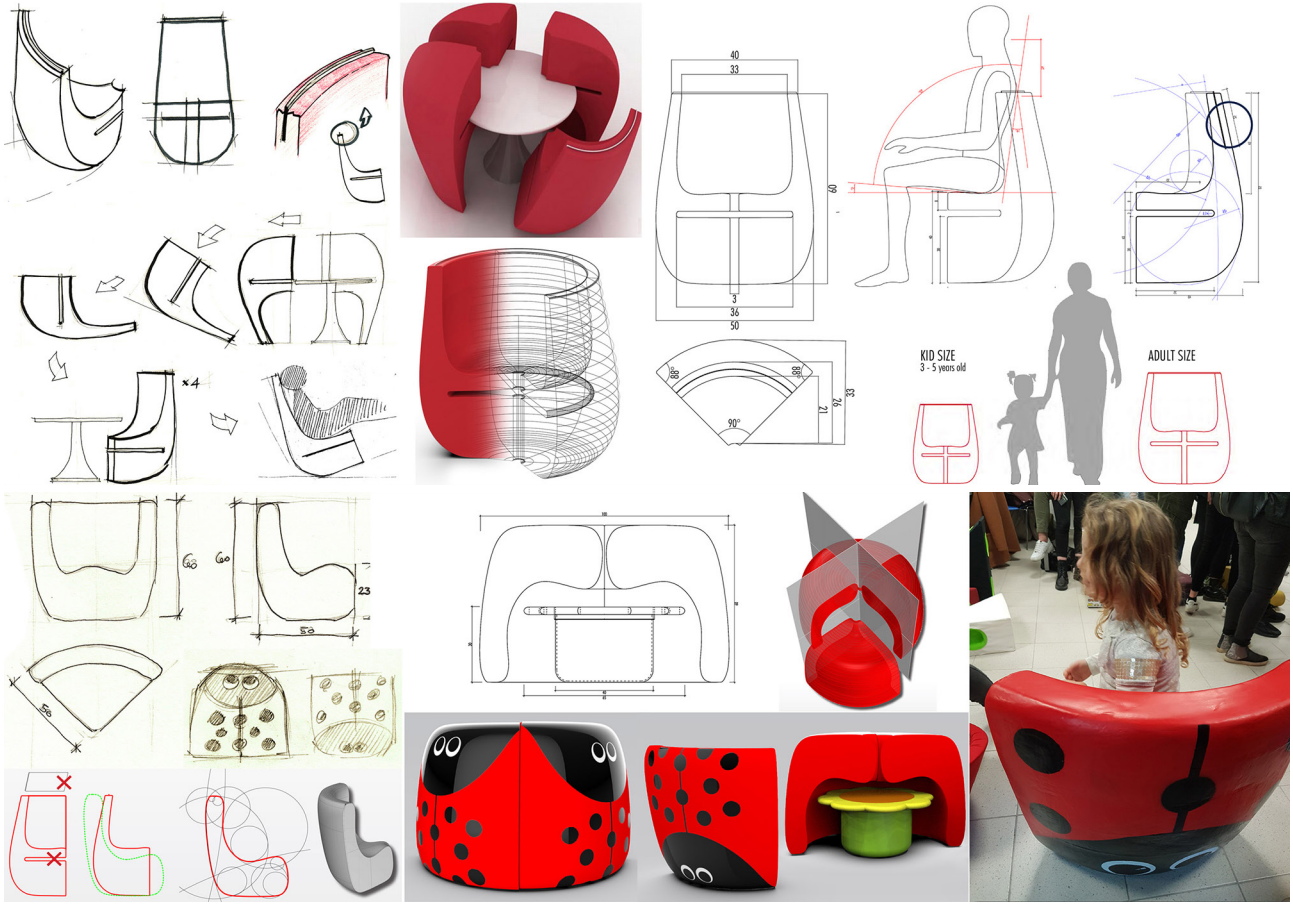


Fig. 3. Multiple drawings (from sketch to prototype) for modifications of a "kids" chair. Above: the original chair; below: the modified chair (student Laura Veccia).

Therefore, if the object has the capacity to stimulate curiosity and provide enjoyment, children are inclined to redefine their aims and behaviour towards it. The goal of the experience was thus to devise a kids' redefinition of the chair that encouraged children to discover new, different, and personal uses of the object, to interact with it in a creative and innovative way, exploring its possibilities (fig. 3).
In this sense, shape, colours, and materials are characteristics through which the object transmits and receives input. The tactile and visual sensations generated by these aspects serve as channels through which the child can glimpse/invent a playful side to the chair. For this reason, the object must be manageable and constituted formally/materially such that no harm can be done (no sharp corners or edges, abrasive or toxic materials, etc.).
In this experience, a prototype testing day was held, inviting a group of 3 to 5-year-old children. This occasion proved to be a fundamental opportunity for the students to both verify experimentally how much children do not want 'a chair to be just a chair', trying to turn it into a game (even the least 'interactive' objects), and obtain important feedback on the validity of their design choices relating to object characteristics such as weight, resistance, colours, etc. (fig. 4).
The second experience focused on small, commercially available storage furniture. This theme was addressed with a view to repurposing that adequately reinterprets the qualities and/or defects of the cabinets in relation to various small appliances to be stored in them because "by observing not only the formal characteristics, but also the material, chromatic, tactile, or other characteristics of an object, one can think of transforming it into something else" [Munari 1991a, p. 322]. This is therefore a reasoned transformation which, in order to be addressed, had to consider several factors: the overall dimensions not only of the appliance to be stored within, but also any accessories or other items related to its use; the user's actions resulting from the new functionality; and the consequent adaptability to new spaces. In this case, the transformation moved towards searching for the potential of the object, its dynamism as a variation of its potential performance, the possibilities of partial change in appearance, shape, structure, colour, hierarchy, and level of relationships between its constituent elements, as well as its capacity to be integrated with new elements. This design approach to a renewed concept of a product introduced ideas such as: creative reuse, upcycling, transformation, reinterpretation, repurposing design, and the theory of affordances [Gibson 1979] (fig. 5).

Fig. 4. Prototype testing of the "kids" chairs. Examples of children's playful interpretation of the object (photos by the author and participants).

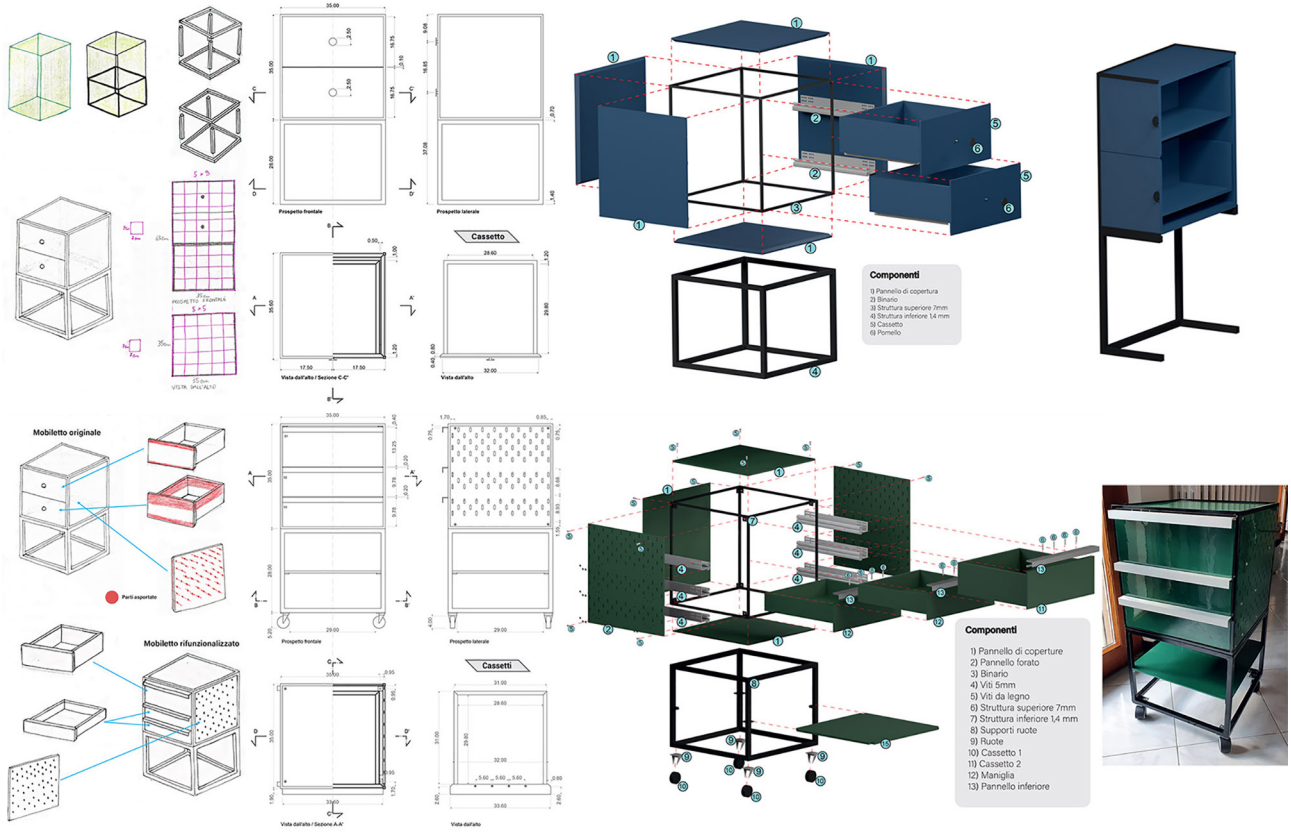


Fig. 5. Multiple drawings (from sketch to prototype) for repurposing a cabinet. Above: the original; below: the modified cabinet (students Simone Pompei, Leonardo Zazzetta).

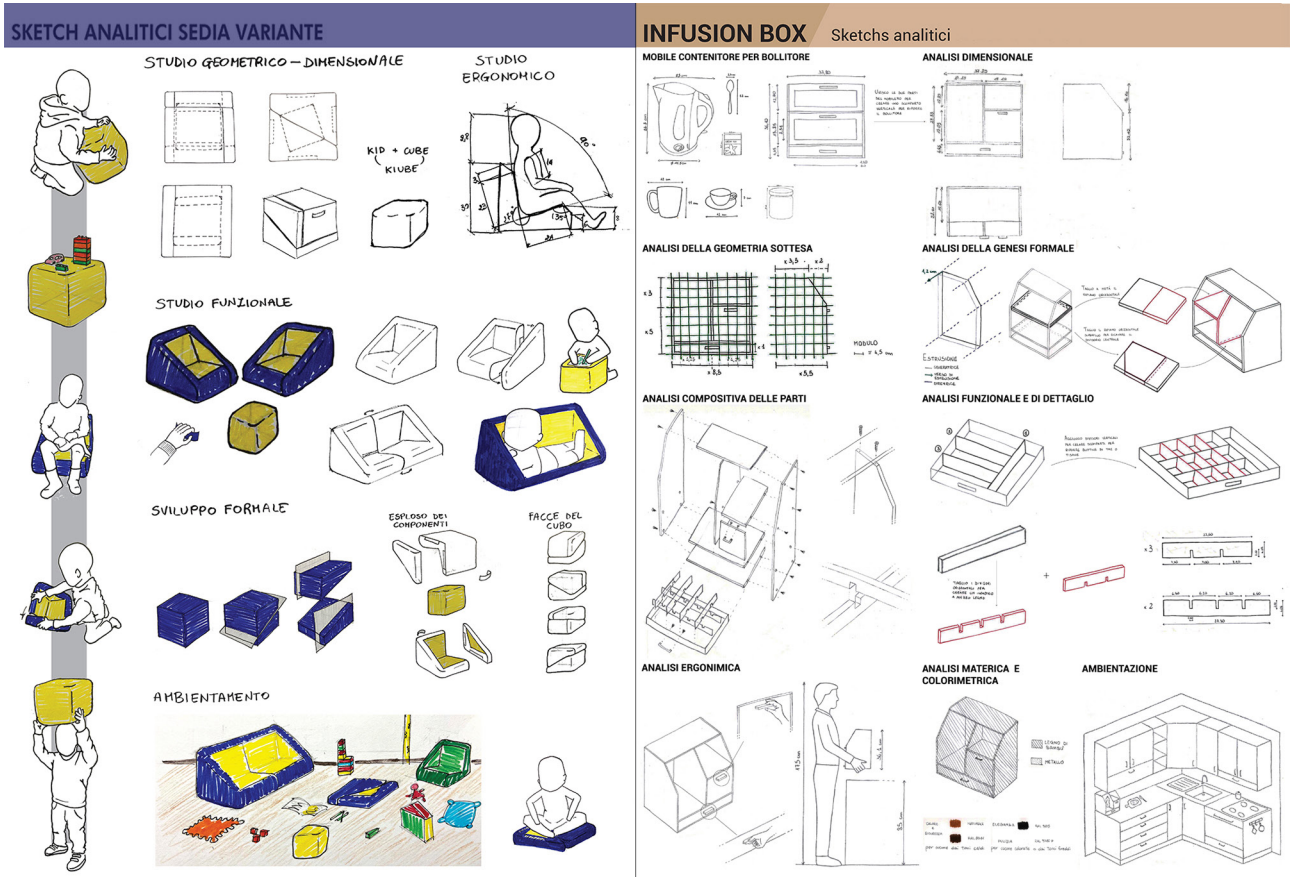
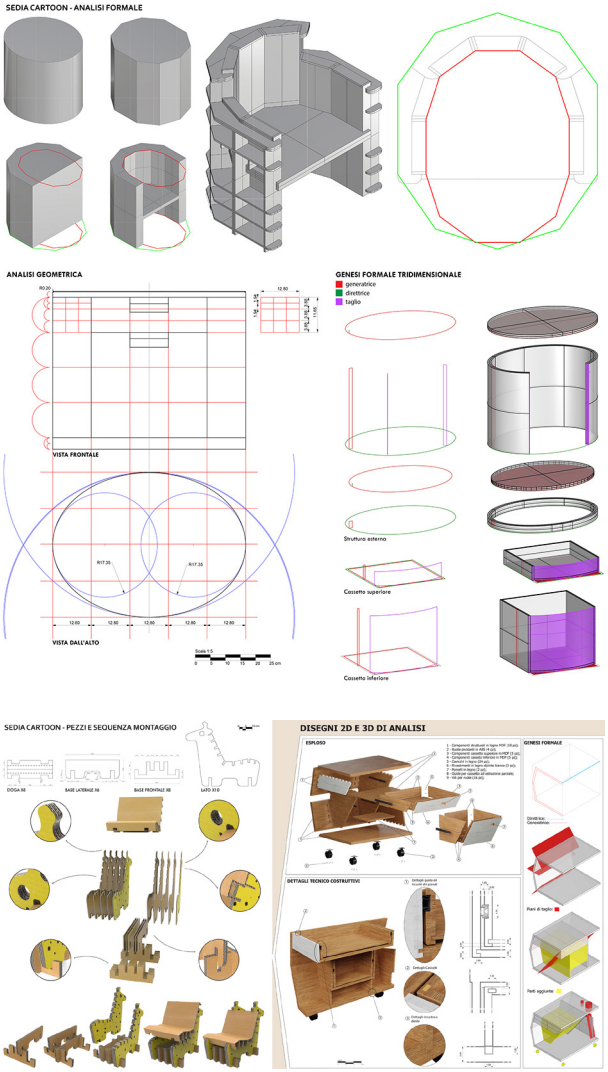


Fig. 6. Sketches of the phase to study targeted modifications. Left: a "kids" chair (students Paolo Rollo, Ventruti Erika); right: a cabinet (students Vanessa Moretti, Francesca Romano).

On a more conceptual level, this design for transformation places the treatment of objects already on the market within design for sustainability with respect to which the concept of innovation is read in terms of new functionalities and even minimal improvements. It is a conscious reflection on the culture of recovery and sustainable consumption that avoids the logic of disposability [Dal Falco 2007, pp. 80-87].
The procedure followed for both experiments was organized in two phases, which were, however, understood as parts of a single process in the sequential development of appropriate, diverse (theoretical-practical) steps, which corresponded to the same number of moments of graphical rendering.
The first phase, to understand the object, aimed to activate processes to truly appropriate/reconstruct the design process through the graphical operations of recognizing the object in its specifics.
The second phase –studying targeted modifications and creating life-size prototypes of the new version– intended to retrace the same modes of drawing, making them suitable for re-presenting the modified product according to different orders of in-depth study. The drawing-design practice was implemented following the same procedure as for the cognitive phase, that is, starting with a preliminary study of the context of the object (brand, designer, and similar products) and then experimenting with operations for its transformation/re-presentation with the introduction of an appropriate set of modifications (geometry-shape, ergonomics-conformation, construction-aggregate, material-colour, perception).
In both experiments, great importance was placed on the habit of making graphical notes in a notebook, as a form of continuous dialogue with oneself and support for the analytical/creative reasoning process, without fear of making mistakes but rather aiming to understand the means and sense to render content with a few but significant signs (fig. 6).
The shape, first of all, is the first aspect that establishes a certain programme of use for a product. Therefore, based on the principles of form theory, students were encouraged to recognize the morphological structure of the object (with reference to the three basic types of volume: solid, box, and net) as a property that is relevant for both the configuration process and shape manipulation [Cervellini 2012]. The formal genesis was analysed/studied first of all to accurately identify profiles in their true form,

Fig. 7. Geometrical-formal analysis of a "kids" chair (students Matteo Perticarà, Luca Rossetti) and cabinet (students Federico Marasca, Deborah Sorci).

Fig. 8. Axonometric exploded view and relationship between the parts/assembly of a "kids" chair (students Alessio Persichini, Andrea Pettorino) and cabinet (students Davide Pranzetti, Ivan Rebichini).



that is, the geometry of the surfaces that make up the object (basic geometric shapes, directrices and generatrices), then to correctly define the solids and their combinatorial interactions/properties, and, finally, to implement modifications through the variations identified (fig. 7). As a result, the rendering of the conformation of the object, in terms of defining all the constituent parts and their reciprocal relationships, was expressed in particular by processing the appropriate sections and exploded views accompanied by close-up 3D/2D details (joints, couplings, etc.) (fig. 8).
The ergonomic study was approached starting with the characteristics of the user group (age, anthropometric parameters, physical and perceptive abilities, possible attitudes and expectations etc.), of the activities related to use of the object (presumed needs) and the context of use, but also duly considering the cognitive and perceptive aspects of the relationship between shape and function (fig. 9). In this sense, it was important to try to understand that shape is an intrinsic component of function which includes as a design value not only the mere practicality of its use but also the aesthetic-emotional aspect of the object. Therefore, with respect to usability, the pleasantness (aesthetics) is not an excrescence but rather an intimate quality of the relationship that the object establishes and entertains with the user [Bollini 2021, pp. 844-846].
"For a designer, the problem of colour has two aspects: using the coloured material produced by industry and incorporating the colour element into the design of objects. […] There is also a functional aspect of colour tied to visual communication and psychology" [Munari 1991b, pp. 356, 357]. Therefore, when choosing modifications in this sense, the emotional dynamics that each colour or colour combination generates in relation to the particular aspects of the subject must be considered. Moreover, since each colour changes according to the underlying material, studies on colours and materials (with textures or patterns, if present) have necessarily considered not only the technical dimension but also the perceptual-sensory dimension of these aspects since they determine an important visual-tactile impact that must convey both mental/sensory and practical sensations (visual and usage comfort) (fig. 10).
The students were also asked to prepare appropriate illustrative images to create a small catalogue/brochure of the object. The eminently informational-promotional scope of such graphical products requires a particularly effective language of strong communicational synthesis to enhance

Fig. 9. Ergonomic analyses of uses for a "kids" chair (students Matteo Morganti, Kevin Usein) and cabinet (students Federico Marasca, Deborah Sorci).

Fig. 10. Colorimetric-material studies for a "kids" chair (students Matteo Morganti, Kevin Usein) and cabinet (students Federico Marasca, Deborah Sorci).

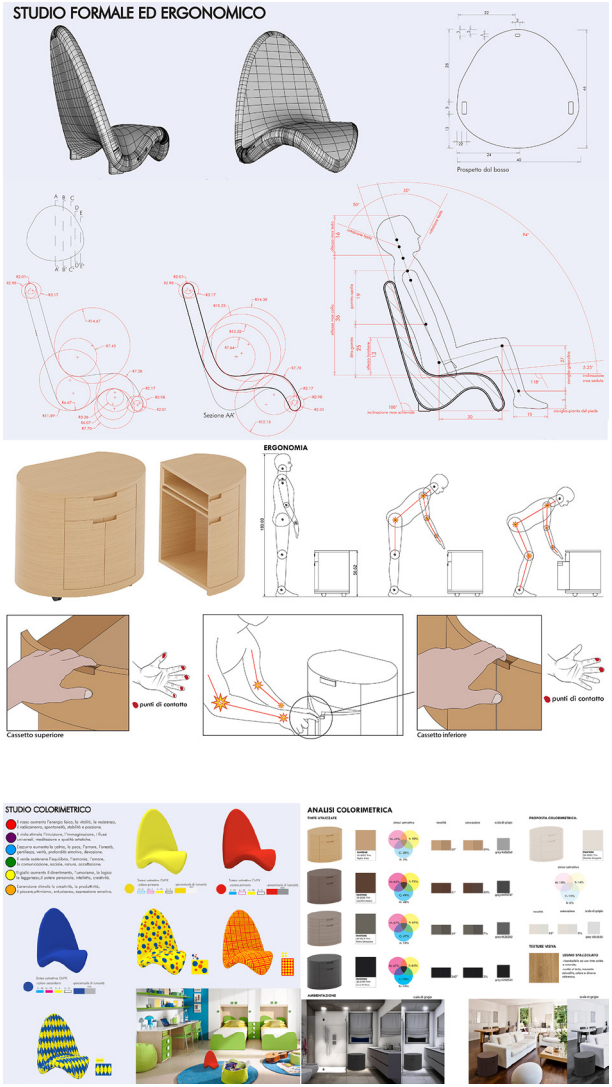


Fig. 11. Graphics for small informative-illustrative catalogues. Above: "kids" chair (students Sophia Malaguti, Milena Mercanti); below: cabinet (students Vanessa Moretti, Francesca Romano).

the object in whole or in part. Therefore, the goal was a skilful mix of synthetic black-and-white drawings designed to convey intuitive technical information and realistic illustrative images of the object setting (fig. 11).
"Modelling life (when you can) means testing the true qualities of the object, correcting any errors, and making all necessary checks before starting production" [Munari 1991a, p. 194]. For this purpose, full-scale material prototypes (of the transformed/proposed object) were produced using different materials identified according to the morphological characteristics of the object (solid, box, grid-like). The process started with a careful study and digital drawing of all the parts, systems of joint and connections, and then moved on to fabrication using laser cutting machines and 3D printers in the workshop. Direct involvement in the creation/production process, making the object with one's own hands according to the 'learning by doing' method and with the emotional component of first being able to make the object and then being able to look at it, touch it, and test it, was decisive for the learning process (fig. 12). On the other hand, the focus on 'know-how' as a qualifying element [Micelli 2011] has deep historical roots in the design culture and also fosters the acquisition of a critical capacity regarding industrial production and what the market offers [Mari 1974].

Conclusions

Drawing and constructing images, proceeding from perceptual imitation to representational thinking through visual modes/models, is the first means of approach to knowledge about the world that we use as children and then, paradoxically, often lose as we grow up.
In this sense, exercising the concrete practices of drawing, learning to manage and use this system of specific and multiple modalities, is considered to be the most appropriate method for students to discover and recognize their relevance and effectiveness, as much in the self-communication of one's own work as in highlighting and clarifying ideas and concepts for others. Employed with this understanding, drawing becomes a true language of study, reflec-

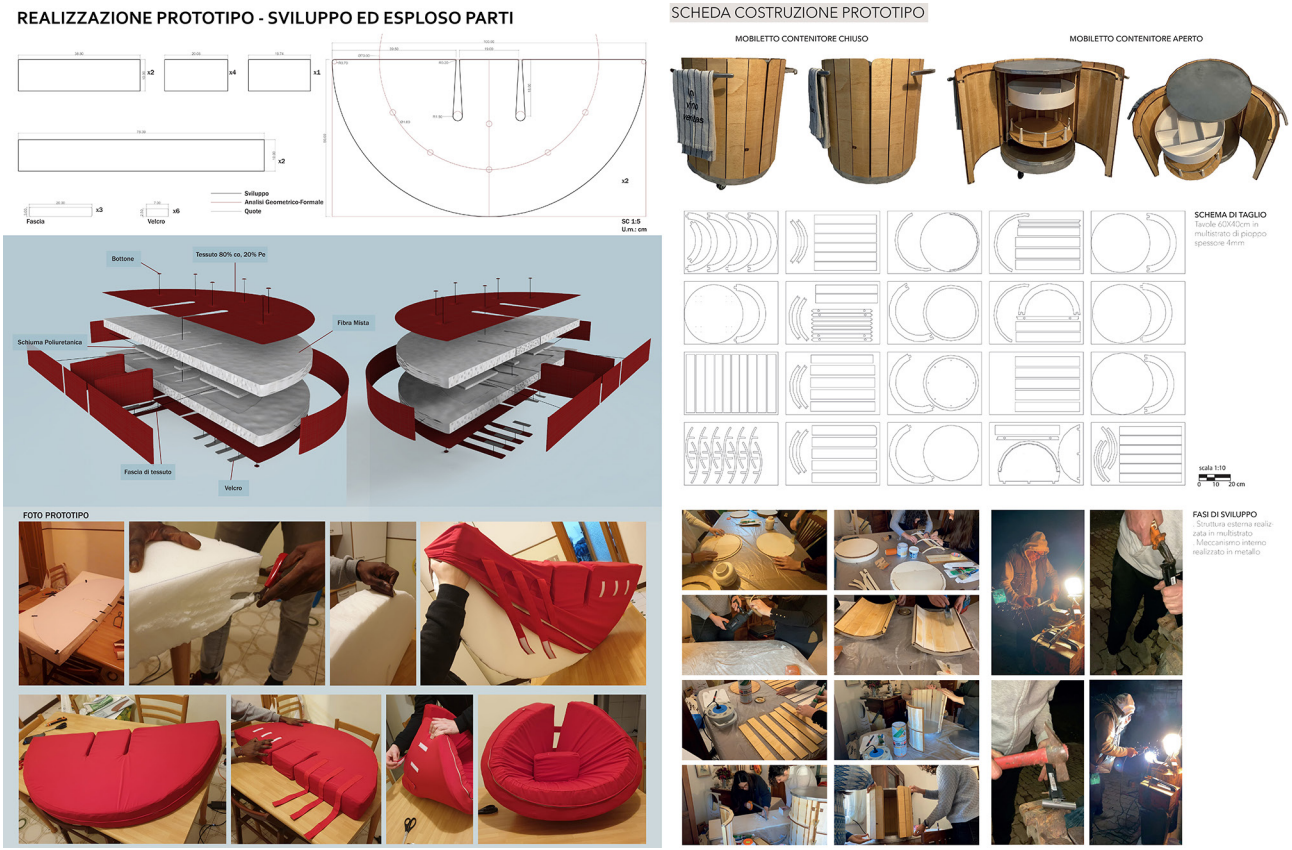


Fig. 12. Laboratory phase of making prototypes for a "kids" chair (students Andrea Nicolardi, Giovanni Sasso) and cabinet (students Chiara Scaramucci, Arianna Veronesi).

tion, investigation, and verification to understand, interpret, and bring out even hidden content, making it explicit. Not only communication, but a tool for control that highlights concepts through signs.
Therefore, from a theoretical-conceptual point of view and also concrete application, the main objective identified by the experiences presented herein was to present the acquisition of that gradual –representational– communicational process based on the correspondence between interpretational models of an object and instrumental/operational models. In other words, the aim was to build a critical awareness of drawing methods, techniques, means, and content, that is, explaining the substantial relationship between graphic elaborations (relevant, correct, and exhaustive) and their exploratory, revelatory, prefigurative, and expressive potential of all that underlies the ideation of a design product.

Notes

[1] The experiences were part of the User-Centred Design Laboratory's Representation and Modeling Techniques course in the Bachelor of Industrial and Environmental Design at the School of Architecture and Design, University of Camerino, a.y. 2019/20 and a.y. 2021/22.

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