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Reinterpretation of the Artwork Atelje by Gabrijel Stupica into Didactic and Tactile Products

ABSTRACT

Visual artworks are usually experienced through sight, which can limit meaningful engagement for children and for blind and partially sighted (BPS) users. This practice-based study examines how Gabrijel Stupica's Atelje (Studio, 1979–1985) can be reinterpreted as a coordinated set of didactic, interactive and tactile products while retaining a recognisable relationship with the original painting. The developed set comprised a 20-piece and a 154-piece jigsaw puzzle with dedicated packaging, an insert puzzle with removable figures, and two tactile three-dimensional (3D) face reliefs. Production combined image processing, vector drawing, laser cutting, ultraviolet (UV) inkjet printing, 3D modelling and fused deposition modelling (FDM) 3D printing in polylactic acid (PLA). Prototype development examined cutting accuracy, piece fit, material stability, edge finishing, tactile clarity and visual contrast. A formative session with nine children aged 6–13 years, most partially sighted and one with very limited residual vision, was used to identify practical issues in the insert puzzle and to compare the two tactile face versions. Repeated jigsaw-piece geometries were redesigned after they allowed incorrect assembly; manual edge finishing improved the insert puzzle; and the simplified facial relief supported clearer tactile recognition than the more source-derived version, which preserved more of the irregular visual character of the painting but required slower exploration. The findings indicate that accessible reinterpretation depends on selective translation rather than direct reproduction: material, geometry and post-processing must be aligned with the intended perceptual task. The study demonstrates a feasible workflow for developing related didactic and tactile products from one complex artwork and identifies directions for further co-design and structured user testing.

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KEY WORDS
Artwork reinterpretation, tactile reproduction, inclusive design, didactic products, 3D printing, UV printing

1. Introduction

Museums and galleries increasingly treat access as part of interpretation rather than as an additional service. This is especially relevant to visual art, where colour, pictorial detail and the protected surface often carry most of the information. For children, museum learning is strengthened by hands-on activity, play and opportunities to construct meaning through interaction (Andre, Durksen & Volman, 2017; Falk & Dierking, 2018).

Jigsaw puzzle play is also associated with spatial transformation skills because children repeatedly compare, rotate and fit visual forms (Levine et al., 2012). For BPS users, the visual emphasis can create a more fundamental barrier when an artwork cannot be touched or when important information has no non-visual equivalent. Multisensory museum practice therefore treats touch as an interpretative mode in its own right, not simply as a substitute for sight (Axel & Levent, 2003; Levent & Pascual-Leone, 2014; Pye, 2007).

Tactile access, however, does not result from converting every visible detail into relief. Touch gathers information locally and sequentially, so recognisability depends on clear contours, sufficient feature separation, an appropriate scale, and a manageable amount of information.

Studies of tactile graphics, 3D printed cultural objects and multimodal museum interfaces consistently show that direct visual fidelity can conflict with tactile legibility (Avni et al., 2025; Bruns et al., 2023; Cavazos Quero, Iranzo Bartolomé & Cho, 2021; Karaduman, Alan & Yiğit, 2023; Wu et al., 2022). The design task is therefore interpretative: features that are visually subtle may need to be enlarged or emphasised, while dense or redundant detail may need to be removed.

A comparable issue arises when art is adapted for children. Simplification is helpful only when it offers a clearer route into the artwork rather than simply reducing its complexity. Reviews of children's museum learning emphasise interaction, scaffolding and hands-on exploration as key elements of meaningful engagement (Andre, Durksen & Volman, 2017).

A complex painting may therefore benefit from several complementary forms of access: visual assembly can support close looking, removable components can reveal spatial relationships, and tactile relief can make a selected motif available through touch. Using more than one product also avoids treating a single adaptation as universally suitable for every user or task.

Digital graphic prepress and contemporary fabrication technologies make such parallel reinterpretations practical. Raster processing and vector drawing allow selected elements to be isolated, reformatted or simplified; laser cutting translates vector contours into physical components; UV inkjet printing reproduces colour on rigid substrates; and FDM 3D printing can turn linework into raised relief. Yet each transfer from image to object changes the information available to the user. Material behaviour, cutting tolerances, surface finish and relief geometry therefore become part of the communication design rather than secondary production details (Dizon et al., 2021; Montusiewicz, Barszcz & Korga, 2022; Urbas, Pivar & Stanković Elesini, 2016).

The study addresses these questions through Gabrijel Stupica's *Atelje* (Studio, 1979–1985), a large, visually layered painting built around repeated human figures, subdued colour fields, collage-like interventions and irregular contours (Figure 1). Instead of producing a single simplified copy, the project developed a family of related products from the same source image: two jigsaw puzzles of different levels of difficulty, packaging that extends their didactic function, an insert puzzle with removable figures, and two tactile face reliefs that deliberately differ in graphic complexity.

Three questions guided the work: how can the visual identity of one complex artwork be retained across products intended for different modes of perception; how do graphic prepress, material choice and manufacturing constraints influence the resulting interaction; and what can an initial evaluation with BPS children reveal about tactile simplification, edge quality and recognisability? The study is practice-based and prototype-oriented. The user session described below was formative rather than a controlled usability experiment, so its observations are used to refine design decisions rather than to support claims about general accessibility performance.



» **Figure 1:** *Gabrijel Stupica, Atelje (Studio, 1979–1985), the shared visual source for all developed products. Tempera and collage on canvas, 285 × 415 cm, Galerija Božidar Jakac, Kostanjevica na Krki*

2. Materials and methods

2.1. Artwork source and reinterpretation strategy

The experimental work grew out of the interdisciplinary project *Popotovanje papirnatih figuric* (*Journey of Paper Figures*), in which *Atelje* served as a shared source for products designed for different users and modes of engagement. The artwork itself was not altered as the subject; instead, its visual information was reorganised through format, material and interaction. The product family was structured around three modes: visual assembly through jigsaw puzzles, combined visual and tactile exploration through an insert puzzle, and tactile interpretation through 3D facial reliefs. Packaging for the two jigsaw puzzles was designed as part of the didactic experience rather than as storage alone.

A consistent design principle was applied across the prototypes: preserve a recognisable relationship with *Atelje*, but do not transfer complexity mechanically when it would reduce usability. The jigsaw puzzles retained the complete composition, the insert puzzle

separated individual figures from the pictorial field, and the tactile reliefs reduced a selected face to its contour and key internal features. In products oriented towards BPS users, shape, edge definition, relief, size and contrast were treated as functional information.

This approach follows tactile-design research, in which selective simplification and the organisation of salient features are more important than reproducing every visual detail (Cavazos Quero, Iranzo Bartolomé & Cho, 2021; Wu et al., 2022). The design logic of the five product groups is summarised in Table 1.

Table 1

Product groups, intended users, materials and main production processes

Product	Primary user group	Main material	Digital prepress	Production
Small jigsaw puzzle (20 pieces)	Younger sighted children	White acrylic glass, 3 mm	Image prepress; vector puzzle geometry	Laser cutting; UV inkjet printing
Large jigsaw puzzle (154 pieces)	Older / more experienced sighted children	Cardboard, 1.5 mm	Image prepress; denser vector puzzle geometry	Laser cutting; UV inkjet printing
Insert puzzle	Sighted and BPS children	Acrylic glass, 3 mm + foamed PVC, 5 mm	Figure isolation; vectorisation	Laser cutting; UV inkjet printing; bonding; hand finishing
Tactile face reliefs	BPS children	White PLA	Vector drawing; 3D modelling in Blender	FDM 3D printing; sanding; colour accents
Puzzle packaging	Puzzle users	Corrugated board, 1.5 mm	Dieline adaptation; graphic design	Digital printing; lamination; CNC cutting and creasing

2.2. Jigsaw puzzles and packaging

The small jigsaw puzzle was designed in A4 format with 20 pieces and produced from 3 mm white acrylic glass. The large puzzle used an A3 format with 154 pieces. Acrylic sheets of different thicknesses and levels of transparency were trialled for the larger version, but 1.5 mm cardboard was selected for the final prototype because it was lighter, easier to handle and closer to the material behaviour of a conventional jigsaw puzzle. Adobe Photoshop and Adobe Illustrator were used to prepare the artwork, define the formats and draw the cutting geometry. A regular grid provided the initial structure, but the tabs and sockets of individual pieces were then altered manually so that neighbouring pieces did not repeat the same geometry.

Laser cutting was performed on a HyperCUT PRO-6090 system, and the image was printed using an Apex MT-FP6090 UV inkjet printer. A generative image-extension tool was used solely to extend the peripheral areas of the image required for print bleed; the central pictorial content used for recognition remained unchanged.

After cutting, the rigid substrates were cleaned and carefully aligned for printing to ensure accurate registration between the printed image and the puzzle piece geometry. Packaging was developed as part of the product rather than as a neutral container. Dielines were adapted in Pacdora and refined in Adobe Illustrator. The small box measured approximately 200 × 100 × 40 mm and the large box approximately 260 × 150 × 50 mm. Both were made from 1.5 mm corrugated board laminated with printed self-adhesive sheets, then cut and creased on an Esko Kongsberg X20 computer numerical control (CNC) system. The larger box included internal dividers for sorting pieces by colour or form; the smaller box incorporated a simple creative activity based on the human figure motif. In this way, the packaging continued the interpretive logic of the products after the puzzle itself had been stored.

2.3. Insert puzzle

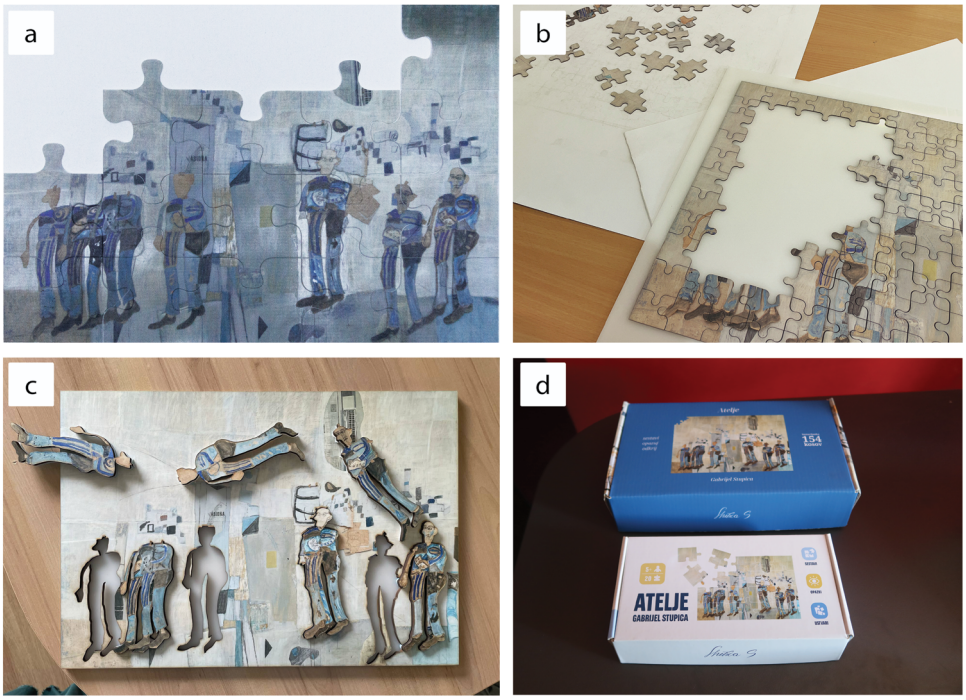
The insert puzzle translated the painting into a removable figure-ground system. Human figures were isolated from the artwork in Adobe Photoshop and redrawn as vector contours in Adobe Illustrator. Three technical files were prepared: one for the removable figures, one for the corresponding openings in the upper layer and one for the supporting base. The bottom layer was cut from 3 mm acrylic glass and the upper layer from 5 mm foamed PVC. The materials also worked as tactile cues, because the acrylic base is relatively smooth while the foamed PVC surface is more textured.

The image was printed onto the foamed PVC using UV inkjet printing, and the layers were bonded after cutting. Because several figures in *Atelje* have thin limbs and partly abstract contours, the vectorisation had to balance a recognisable silhouette with mechanical durability. The intended interaction was simple: a user could remove a figure, explore it as an independent shape, and then locate the corresponding recess within the full composition.

2.4. Tactile face reliefs

A facial detail from *Atelje* was selected for the tactile products and translated into two relief versions. The first, source-derived version followed the visible contours of the painting more closely. Key facial lines were manually traced in Adobe Illustrator and exported as scalable vector graphics (SVG). In Blender, the curves were converted to editable geometry, extruded and joined to a rectangular base so that the raised lines formed a single printable object. A second version intentionally reduced irregularities and internal detail. A generative image tool was used to create an initial symmetrical reference, which was then manually edited and redrawn before the same vector-to-3D workflow was repeated. The generated image therefore served as an intermediate design aid rather than as final printable geometry.

Both reliefs were manufactured on an ELEGOO Neptune 4 Plus using FDM with white PLA filament. Printed edges and selected surfaces were sanded, and the raised facial lines were emphasised in black to increase contrast for users with residual vision. UV inkjet printing was also trialled on the relief surface, but the height difference between the base and raised lines made accurate colour registration more difficult than on a flat substrate. The two versions were produced at a comparable overall size so that the principal difference during tactile exploration was graphic complexity rather than scale. The resulting product set is shown in Figure 2.



» **Figure 2:** *Final didactic products derived from Atelje: (a) small 20-piece jigsaw puzzle, (b) large 154-piece jigsaw puzzle, (c) insert puzzle with removable figures and (d) packaging for the two jigsaw puzzles*

2.5. Formative user evaluation

A formative prototype session was conducted in cooperation with Centre IRIS for education, rehabilitation, inclusion and counselling of BPS people. Nine children aged 6–13 years participated, five boys and four girls. Most were partially sighted, and one participant had very limited residual vision. The session was designed as an initial prototype evaluation rather than a controlled user study.

Observations, spontaneous comments and a short discussion after use were therefore treated as qualitative design feedback, and no inferential statistical analysis was performed. The children explored the insert puzzle and both tactile face versions individually. For the insert puzzle, the observer noted how the figures were handled, whether their positions could be found and whether edges or material transitions interfered with use. For the tactile faces, the source-derived version was presented first and the simplified version second. Exploration strategy, orientation on the surface and recognition of basic facial features were observed, and exploration time was noted during development.

Because the presentation order was fixed and the sample small, time was not analysed as a quantitative outcome. An earlier workshop with children from Kindergarten Trnovo also informed the redesign of the small jigsaw puzzle after repeated piece geometry allowed physically plausible but visually incorrect assembly.

3. Results

3.1. Jigsaw puzzles and packaging

The first small jigsaw puzzle prototype revealed a design problem that was not apparent in the digital cutting file. Repeated tab-and-socket geometry allowed several pieces to connect in positions where the printed motif did not belong.

This became particularly clear during a workshop with children from Kindergarten Trnovo: *Atelje* contains repeated figures and subdued coloured areas, so the image did not always provide an immediate visual correction. Manually varying the piece geometry reduced this ambiguity and produced a more reliable final assembly. The 3 mm white acrylic substrate also provided a stable base for UV printing and gave the printed image a visually clean background.

Material trials for the large jigsaw puzzle revealed a different set of constraints. Transparent acrylic reduced colour density unless additional printed layers or an opaque underprint were used. Thicker acrylic was mechanically stable but required repeated laser passes, which caused local melting and slight deformation at some edges, reducing piece fit. The 1.5 mm cardboard used for the final version avoided these problems and produced a lighter object with handling characteristics closer to a conventional puzzle.

The packaging prototypes added educational functions but also revealed a tolerance issue. The large box used internal dividers that allowed pieces to be sorted, while the small box included space for a child to create an additional figure. Both boxes closed correctly before lamination; after printed self-adhesive sheets were applied to both sides of the board, the added thickness made closure less smooth. The result is a useful reminder that graphic finishing and structural packaging design cannot be separated. A revised dieline should allow for laminated thickness in flap and slot tolerances from the outset.

3.2. Insert puzzle

The insert puzzle was successfully produced as a layered object, and the removable figures could be matched with their corresponding recesses. Material contrast and the 3D edges supported exploration of the composition as a set of separate forms rather than a single image. However, several thin arms and legs inherited from the painted figures were mechanically vulnerable. Small differences in how acrylic glass and foamed PVC responded to laser cutting also produced minor contour mismatches, which required additional care during bonding and alignment. Formative use showed that surface finishing was a functional requirement, not a cosmetic one.

The children understood the basic principle of removing and replacing the figures, but some edges felt too sharp during tactile exploration. Light hand sanding improved comfort without changing the overall contour. Participants also suggested a black outline around the figures to strengthen visual separation for users with residual vision. Accurate cutting alone was therefore insufficient: edge quality, contrast and robustness were equally important to the usefulness of the object.

3.3. Tactile face reliefs

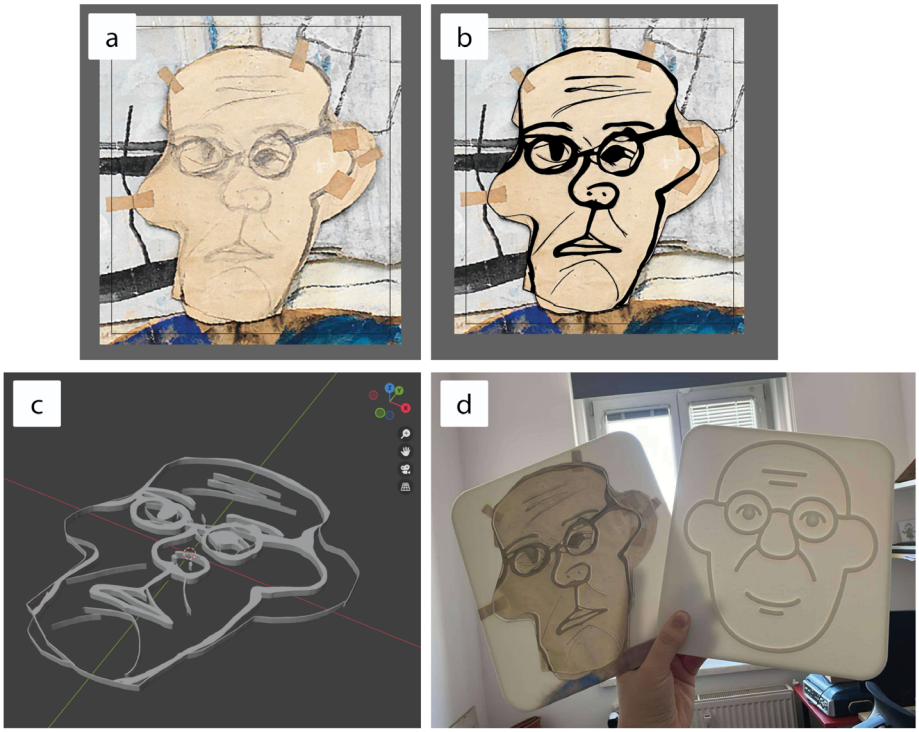
The tactile-face workflow required several iterations. SVG paths that were not fully connected produced fragmented geometry after import into Blender, and the source-derived face generated a relatively dense mesh because of its irregular lines and fine details. In an early print, the relief and base had not been joined into one solid model, so the raised layer separated locally from the backing surface. The geometry was corrected, and the relief was subsequently printed as a single, integrated object.

Post-processing further affected the final result. Sanding reduced small FDM irregularities and improved edge comfort, but it also showed that the part needed sufficient internal support to withstand abrasion without breaking the surface. Colour application by UV inkjet was less predictable on the relief than on the flat puzzle materials: the distance between the print head and the raised features produced slight registration errors and local colour spread. Manually applied black accents therefore provided more controlled visual contrast on the final prototypes. Post-processing should consequently be considered part of tactile design, particularly where roughness or finishing can change how a relief is explored (Dizon et al., 2021).

The clearest qualitative difference was between the two graphic versions of the face. The source-derived relief preserved more of the irregular line structure of the artwork, but it required slower, more focused exploration. The simplified version reduced competing contours and made the head outline, eyes, nose and mouth easier to follow in sequence. The two objects remained recognisably related to the same motif, yet they offered different levels of tactile complexity. The development workflow and the final tactile face reliefs are shown in Figure 3.

3.4. Formative user observations and exhibition deployment

During the Centre IRIS session, the children engaged with both product types. The insert puzzle was generally understandable once the task had been introduced, and the children relied on contour and shape to locate the removable elements. The most consistent criticism concerned edge comfort rather than the basic interaction.

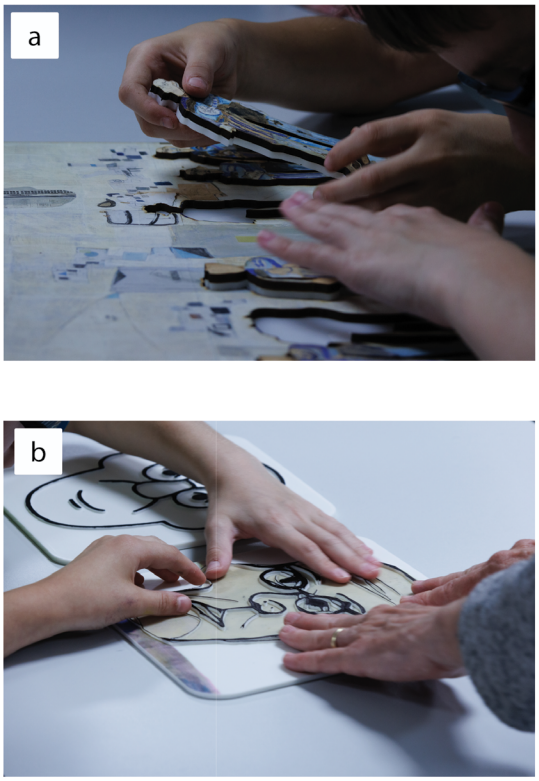


» **Figure 3:** *Development of the tactile face reliefs: (a) selected motif, (b) vector interpretation of the source-derived face, (c) 3D relief modelling in Blender, and (d) final source-derived, simplified tactile versions*

For the tactile faces, the simplified version supported clearer recognition of basic features, while the source-derived version required more time and attention. The relief height and overall object size were considered adequate for exploration. The children also responded positively to having both versions available, as the simplified face supported orientation while the more detailed relief maintained a closer connection with the artwork.

These observations are formative design evidence rather than a general measure of accessibility. The group was small, the age range broad, and the participants had different amounts of residual vision. No standardised questionnaire or quantitative recognition task was used, and the face versions were always presented in the same order. The value of the session lies instead in the concrete issues it exposed: sharp laser-cut edges, fragile contours, the burden of excessive line detail and the usefulness of stronger visual contrast.

The completed products were subsequently presented in the exhibition *Popotovanje papirnatih figuric* at Finžgarjeva galerija (Finžgar Gallery) from 27 May to 2 June 2025. Their installation showed that a single artwork can support several parallel forms of engagement, from conventional visual assembly to removable spatial elements and tactile relief. Exhibition deployment, however, should not be mistaken for validated accessibility; the prototypes remain a basis for further iterative testing. Examples of the formative evaluation are shown in Figure 4.



» **Figure 4:** *Formative evaluation with children from Centre IRIS: (a) exploration of the insert puzzle and (b) comparative tactile exploration of the facial reliefs*

4. Discussion

Across the product family, reinterpretation is a more accurate description of the design process than reproduction. Every prototype began with the same painting, yet the information that mattered shifted with the mode of interaction. The jigsaw puzzles relied on the relationship between piece geometry and the complete image; the insert puzzle relied on silhouette, edge quality and spatial matching; and the tactile faces relied on a hierarchy of raised lines that could be followed by touch. Treating all of these outputs as scaled copies would have ignored both perceptual and manufacturing requirements.

This distinction is especially important for tactile work. Vision can shift quickly between a whole composition and a small detail, whereas touch builds understanding through local, sequential contact. Dense line work that remains coherent to the eye can therefore become ambiguous under the fingers. The clearer response to the simplified face is consistent with research showing that tactile graphics benefit from reduced non-essential detail, adequate feature separation and a deliberate spatial hierarchy (Cavazos Quero, Iranzo Bartolomé & Cho, 2021; Wu et al., 2022). More broadly, 3D printed cultural objects are most effective when scale, material, and surface characteristics are designed for tactile use rather than inherited uncritically from the visual source (Bruns et al., 2023; Montusiewicz, Barszcz & Korga, 2022).

Simplification, however, is not automatically an improvement. The source-derived face retained more of Stupica's irregular visual character, and the children found value in comparing both versions. This points to a useful approach to art interpretation: a clear representation can establish orientation, while a second, richer version preserves complexity for further exploration.

Parallel representations therefore need not compete; they can offer different levels of access to the same motif, in line with multisensory museum approaches that combine complementary channels and degrees of detail (Avni et al., 2025; Levent & Pascual-Leone, 2014).

The insert puzzle illustrates a related shift from looking at an image to reconstructing it through action. Removing a figure, exploring its shape and returning it to the composition makes spatial relationships explicit in a way that the flat painting does not. This type of hands-on engagement is consistent with research on children's museum learning, which identifies interaction with objects and the environment as an important route to meaning-making (Andre, Durksen & Volman, 2017). The jigsaw puzzles operate differently but similarly require repeated comparison of shape, orientation and image information; puzzle play has been associated with children's spatial transformation skills (Levine et al., 2012).

Production decisions had direct consequences for use. Acrylic glass worked well for the small jigsaw puzzle but became less suitable as transparency or thickness increased. Cardboard produced a lighter large jigsaw puzzle; the layered insert puzzle gained useful material contrast but required careful registration; and the 3D reliefs showed that print geometry, infill, sanding and colour application cannot be considered separately. These observations support earlier work showing that manufacturing process, material and finishing influence the perceptual quality of tactile cultural heritage objects (Bruns et al., 2023; Montusiewicz, Barszcz & Korga, 2022).

Colour also played different roles across the prototypes. In the jigsaw puzzles it was the primary carrier of the painting's visual identity. In the BPS oriented products it was deliberately secondary: black accents on the tactile faces and the proposed outline around insert-puzzle figures were intended to support residual vision, while shape, contour and relief remained accessible through touch. This is consistent with multisensory approaches in which colour information is reinforced rather than left as the sole information channel (Cho, 2021).

One further point emerged from developing the products as a set. Inclusive interpretation does not have to mean producing a conventional object alongside a separate "special" version. Sighted children can use the insert puzzle and tactile reliefs, just as BPS children can engage with the same artwork narrative through non-visual information. Designing a family of related objects creates opportunities for shared use while still allowing different perceptual entry points. This principle is consistent with museum accessibility research that embeds inclusion within the main interpretative design rather than adding it afterwards (Avni et al., 2025; Avni, Danial-Saad & Kuflik, 2026).

The limitations of the evaluation remain important. Nine children cannot represent the range of BPS users, the age span was wide, and differences in residual vision were substantial. The fixed order of the facial relief presentation may have introduced a familiarity effect, and exploration time was not analysed under controlled conditions. The long-term durability of the materials, adhesives, paint and relief surfaces was also outside the scope of the work.

The next phase should therefore use iterative co-design, counterbalanced comparisons and task-based measures of recognition, placement, and comfort. It should also compare relief height, line width, surface texture, and more durable or lower-impact materials. A recent systematic review of museum accessibility similarly identifies structured stakeholder involvement and mixed-method evaluation as priorities for moving from promising prototypes to dependable inclusive experiences (Avni, Danial-Saad & Kuflik, 2026).

5. Conclusions

This study developed a coordinated set of didactic, interactive and tactile products from Gabrijel Stupica's *Atelje* using graphic prepress, laser cutting, UV inkjet printing, 3D modelling and FDM 3D printing. The main contribution lies not in any single technology, but in the way the same visual source was translated differently according to task and mode of perception.

The full painting could be retained where visual assembly was useful, figures could be separated where spatial placement mattered, and a selected face could be simplified where dense pictorial detail interfered with tactile recognition.

The production process showed that usability is shaped by seemingly small technical decisions. Repeated jigsaw-piece geometry allowed incorrect assembly, thick acrylic reduced cutting accuracy, laminated packaging altered closing tolerances, layered materials required careful registration, laser-cut edges needed manual finishing, and raised 3D geometry complicated colour application. Accessible products therefore depend on graphic translation, manufacturability and post-processing as much as on visual similarity to the source (Montusiewicz, Barszcz & Korga, 2022; Wu et al., 2022).

The formative session with BPS children was highly informative for comparing the two tactile face versions. The simplified relief was easier to interpret, while the source-derived version retained more of the visual irregularity of the painting. Rather than identifying one representation as universally preferable, the results support a layered approach in which different versions can serve orientation, comparison and deeper exploration. Further co-design and structured user testing are required before the prototypes can be treated as validated accessible products, in line with current evidence that stakeholder involvement and rigorous evaluation are central to effective tactile and multimodal museum design (Avni et al., 2025; Avni, Danial-Saad & Kuflik, 2026).

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