DesignAR: Augmented Reality Designing Prototype
Towards a Media Semantic Taxonomy for Art Educational Implementation

Regina Maria Bäck

Department of Art Education and Art Didactics
Katholische Universtität Eichstätt-Ingolstadt
85072 Eichstätt

reginabaeck@posteo.de

Rainer Wenrich

Department of Art Education and Art Didactics
Katholische Universtität Eichstätt-Ingolstadt
85072 Eichstätt

rainer.wenrich@ku.de

Birgit Dorner

Department of Social Work
Katholische Stiftungshochschule
University of Applied Sciences

81667 München

birgit.dorner@ksh-m.de

Abstract—In the present work, DesignAR, a prototype of Augmented Reality based designing application is presented as a tool for art educational implementation. In addition, a taxonomy for Augmented Reality-related media art analysis is outlined, tracing semantical dimensions with a specific focus on the role(s) of the user when engaging with the artwork. To exemplify both DesignAR as well as the taxonomy as introduced, *Human Cell, Pixel kernel* is presented, inviting the user to reimagine the relationship of the individual within digital transformation. Both application DesignAR and taxonomy are to be employed in future art educational contexts e.g., teacher training or secondary art education.

Keywords-AR-Designing; Art Education; Prototyping; Media Art; Taxonomy.

I. INTRODUCTION

Augmented Reality designing tools offer diverse opportunities in the field of art education with emerging concepts for classroom implementation [1]. With current artistic practice as part of the *Black Lives Matter* movement e.g., *Breonna's Garden* [2], inviting for participatory cocreation, AR art is addressing core societal challenges. When it comes to introducing Media Art with the means of Augmented Reality, didactical positions are still pioneering [3].

When considering classroom implementation, data protection and usability for teachers and students both alike are vital, with prototyping evolving ideally in iterative development cycles [4]. DesignAR was developed accordingly in iterative cycles with art teachers' feedback following the principles of Grounded Theory Methodology. In this context, DesignAR is offering a variety of drawing options and designing features to be employed in art education. Along with the taxonomy for media art analysis, results are vital as didactical material to introduce art educators and students to Augmented Reality in artistic practice.

In the following, we are looking at artistic positions and related work in the field of art education. Next, DesignAR is presented as application for augmented designing. A taxonomy is presented to introduce and analyze AR-related artwork. Finally, the artwork Human Cell, Pixel Kernel is presented exemplifying ways of creating via DesignAR in the complexity of spatial creating and meaning-formation.

II. RELATED WORK

The term Augmented Reality Art (AR Art) is defined as "artwork exhibited in a real-world environment using AR technology" [5] subdividing artwork in pre-AR and post-AR as interactive and low-cost form of artwork [5]. In terms of art theory and semantics, there are a few positions suggesting taxonomies classifying via AR Art analysis [6] or evolving rather in proximity to media semantics [7][8]. Also, AR-related artwork is analyzed in relation to the internet cultural phenomena of interconnectedness [9]. A few positions address AR as similar to a choreographer-cocreator relationship as overlay for dance [10] drawing on media art philosophy e.g., AR-perception as reciprocal aesthetic transaction [11].

In terms of prototyping, pioneering concepts of Augmented Reality Designing were either mimicking traditional forms of painting [12] or exploring unique interfaces, even with the creator's breath as part of Augmented Designing [13]. As pioneers of AR art, the artist collective ManifestAR is to be mentioned laying foundations of public interventions of AR artwork. Here, early forms of co-creative AR-supported designing settings were evolving [14].

Artistic positions blending artistic practice with art theory are vital as predecessors, similarly combining AR-based designing tools with concepts of media art e.g., Jess Herrington [15]. Artie Vierkant is to be mentioned, exploring the borders of image and object via AR both artistically as well as via art theory (Image Object, 2018) [16][17].

Social AR forms of Augmented Reality creation and sharing are increasingly prominent, also as platform for artists e.g., with *Lens Studio (Snapchat)* [19], inviting to feed into platforms with easy-accessible ways of AR-filter-creating. Next to social media-related applications, there is a number of

AR designing applications currently available such as graffiti-style *PaintAR* [19] or *Adobe Aereo* [20] and *AR Makr* [21].

Now, when it comes to art educational conceptualization and evaluation of AR drawing, there are a variety of positions, ranging from paper-based augmented drawing for primary and secondary school [22] to gamification and AR overlay [23]. Media Art classes in the field of AR in higher education are relevant to the prevailing work, for blending AR artwork and didactical conceptualization at university level [18][25].

III. DESIGNAR

In this section, the architecture of DesignAR is outlined along with a taxonomy for AR-related artwork.

A. Prototyping

DesignAR was developed in iterative cycles. The initial prototype was part of an art historical city guide as prototype dedicated to redesigning an existing memorial with basic features, (e.g., adding text/coloring existing shapes and adding 2D images) as participatory elements in a guided city tour on the Revolution of Bavaria (1918/1919) [26][27].

For the next developing steps, DesignAR was designed with the aim of implementing features for a wider creative choice in virtual designing as follows. In a study with art teachers (N 20) and artists (N6), media cultural framings and didactical employment were analyzed [28]. The results obtained through Visual/Grounded Theory analysis hint to cultural effects of media in the acceptance of technology. Some were riding the line of engagement and distancing while others were either affirmative or skeptically biased in their decision-making and conceptualizing towards classroom implementation. Eventually, a variety of potential projects and methods for art education were put together, from the interpretation of 2D paintings in 3D to architectural redesign or poster presentation in 3D [28].

B. Architecture

DesignAR employs Google *ARcore* [23], with simultaneous location and mapping technology, relying on the mobile devices' sensors e.g., RGB camera and accelerometer, gyroscope, and magnetometer. It is is based on Unity/C# with elements defined as Game Objects [24].
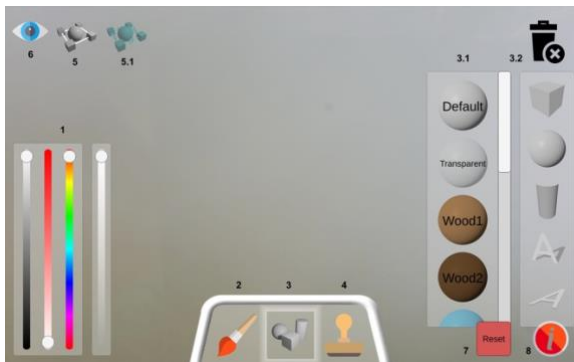

Figure 1. DesignAR UI

Features of DesignAR:
1. Color Picker/RGB/Transparency/Dark/Bright.
2. Drawing tool: related to device position and drawing on surface.
3. Brush styles: oil color/text marker/curls.
4. Inserting Objects: cube/sphere/cylinder/text editor.
4.1. Texture for objects: wood/plaster/gold/silver/transparent
5. 2D-Picture Stamp tool, access to picture gallery of device
5.1. Group objects and navigate in groups.
5.2. Ungroup objects.
6. UI mode vs. camera mode.

DesignAR is currently available for Android, planning to be released for android and ios as next step.

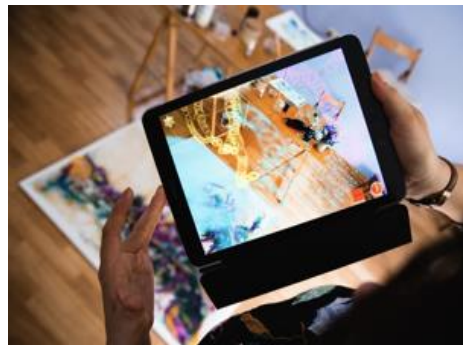Figure 2. DesignAR exploration: Navigating 3D Objects

Figure 3. DesignAR, Interpreting 2D Paintings (Ledényi, Bäck 2019)

C. Taxonomy

In the following, a taxonomy to introduce AR-related artwork is presented. It is understood as a taxonomy for a first introduction to AR art, with future positions of AR-related art to be blending as variations further on. It is also understood as a media semantical classification based on the analysis of AR-related artwork and art theory (c.f. related work). The model is extending existing concepts of AR-based taxonomies [5][9], now with a closer look at the roles of the user when engaging with AR-related artwork. After all, multiple dimensions e.g., tactile or audio-augments also are to be

considered, with respect to blind users as inclusive forms of AR-related artwork.

TABLE I. TAXONOMY OF AR-RELATED ARTWORK

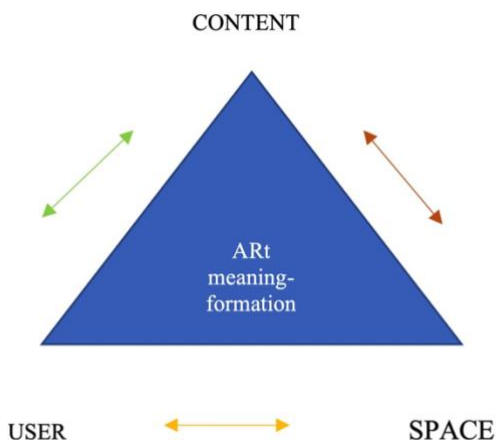| *USER*	*CONTENT*	*SPACE*
Role Observer Creator Choreographer Embodiment **Combination of roles** **User Consent vs. Intervention**	**2D/3D** **Moving/ static** **Audio/Tactile** **Motif**	**Flexible vs. Site-specific vs. User-centered** **Private/Public Curated vs. intervention**
SOCIALAR		
Singular vs collaborative artwork **Sharing & Remix** - sharing of individual artwork - shared objects via database (Adobe Aereo)		

CONTENT

Figure 4. Taxonomy embracing User, Content, and Space, and relations as ARt meaning formation

Besides architecture of AR-related artwork, it is vital how meaning is conveyed into interrelation: **User-Content relation:** Which role is assigned to users? Are users rather observers or creators e.g., AR-drawing filter *Drawing with Jelly*, Jess Herrington (2018) [31]. Are they embodying in hybrid filter artwork (e.g., Internet Dream, Jess Herrington 2019) [32]? Are users also choreographers, i.e., with performance and dance to be augmenting via AR (*Soi moi*, n+n corsino, 2009) [33]. Is there a combination of roles e.g., creator/observer? After all, is there user consent or an

intervention without awareness of participants (EIO: *Coin Chase*, Mat Rappoport 2012) [34]? **Content-Space relation:** How does content as augmented information relate to space? Is there a reconstructive to transformative take on actual spaces? It may be not relating to a specific site, but rather to the user (e.g., *Internet Dream*, Jess Herrington) [32]. **User-Space-relation:** How do users relate to the site within the Artwork? Here, navigational features or shifts of perspectives are examples as explored in artistic practice (Craig Freeman/William Tilson: *Imagining Place*, 2008) [35].

D. DesignAR: Human Cell, Pixel Kernel

In *Human Cell, Pixel Kernel* (Figure 5), virtual representations of cells are floating around the user. Via DesignAR, a selection of cells is offered to stamp in the individual's surroundings. Viewers also may add other AR objects as inspired by the theme. *Human Cell, Pixel kernel* employs the metaphor of a petri dish where the individual viewer is attributed to be floating amidst other "participants", eventually blending the roles of observer, creator, and (imaginatory) embodiment. In *Human Cell, Pixel Kernel*, questions of autonomy are addressed: "Are we passive or active amidst digital transformation?".

Figure 5. Human Cells, Pixel Kernel, Screencast DesignAR (Bäck, 2019)

IV. CONCLUSION / FUTURE WORK

We presented an AR-based designing prototype along with a taxonomy of AR-related artwork at the intersection of user, space, and content. With respect to art educational employment, the taxonomy could be introduced encouraging to look for individual examples. With respect to prevailing studies on media culture relating to technology acceptance [28], it would be interesting to look at art educators' encounters of Media Art also inviting to reflect upon media cultural self-awareness.

Also, re-evaluating DesignAR for an inclusive educational practice is considered as viable for a novel research focus. For instance, how are affordances of deaf vs. hearing students with respect to AR designing tools e.g., focus of attention when

using in public space? It is vital to pursue further research to foster inclusive and safe criteria of AR based applications.

The next steps for app design improvement are potentially the programming for iOS besides android as it is in the current state. Additional features such as inserting individual 3D objects in motion with co-creative interfaces would be fruitful considering classroom implementation as peer-to-peer or teacher-peer interfaces. Here, gaining insight in qualities of augmented imagination in the sense of re-imagining space via DesignAR would be interesting.

ACKNOWLEDGMENT

REFERENCES

[1] https://cospaces.io/edu/lesson-plans.html/ 2021.06.1.

[2] https://breonnasgarden.com/ 2021.06.14.

[3] K. Kreuß and M. Büchting, "Digitale Landschaft," in Blattwerke 11, Museum Sinclair-Haus, Bad Homburg v. d. Höhe, 2019. [Online]. Available from https://kunst-und-natur.de/museum-sinclair-haus/vermittlung/blattwerke/blattwerke/blattwerke-11-digitale-landschaft/ 2021.05.4.

[4] R. Jabangwe, H. Edison, D. Nguyen, D. Anh, "Software Engineering Process Models for Mobile App Development: A Systematic Literature Review," Journal of Systems and Software, vol. 145, pp. 98-111, Nov. 2018, doi: 10.1016/j.jss.2018.08.028

[5] V. Geroimenko, "Augmented Reality Technology and Art: The Analysis and Visualization of Evolving Conceptual Models," 16th International Conference on Information Visualisation, Jul. 2012, pp. 445-453, ISSN: 2375-0138, ISBN: 978-1-4673-2260-7, doi: 10.1109/IV.2012.77

[6] P. Lichty, The Aesthetics of Liminality: Augmentation as an Art Form. In: Geroimenko V. (eds) Augmented Reality Art. Springer Series on Cultural Computing. Springer, Cham. 2014, pp. 99-125, doi: https://doi.org/10.1007/978-3-319-06203-7_5

[7] P. Lichty, Making Inside the Augment: Augmented Reality and Art/Design Education. In: Geroimenko V. (eds) Augmented Reality in Education. Springer Series on Cultural Computing. Springer, Cham. 2020, pp. 261-278, doi: https://doi.org/10.1007/978-3-030-42156-4_15

[8] M. Qu, "The Aesthetic Experience of Augmented Reality Art", Proceedings of the 23rd International Symposium on Electronic Arts (ISEA 2017), 2017, pp. 79-86, ISBN: 978-958-759-161-3.

[9] T. Margolis, Immersive Art in Augmented Reality. In: Geroimenko V. (eds) Augmented Reality in Education. Springer Series on Cultural Computing. Springer, Cham, 2020, pp. 149-159, doi: 10.1007/978-3-319-06203-7_8

[10] P. Varanda, "Soi Moi: The Techno-Soma-Aesthetics of a Dance for the iPhone," Body, Space and Technology, vol. 18(1), pp. 267-296, Mar. 2019, doi: http://doi.org/10.16995/bst.314.

[11] F. Popper, From Technological to Virtual Art. Cambridge, MA: MIT Press (Leonardo), 2007. doi: https://doi.org/10.1162/leon.2008.41.2.192

[12] M. W. Krueger, "Environmental technology: making the real world virtual," Communications of the ACM, vol. 36(7), pp. 36-37, Jul. 1993, doi: https://doi.org/10.1145/159544.159563

[13] S. Eroglu, S. Gebhardt, P. Schmitz, D. Rausch, and T. W. Kuhlen, "Fluid Sketching ― Immersive Sketching Based on Fluid Flow," Conference on Virtual Reality and 3D User Interfaces (VR) IEEE, Mar. 2018, pp. 475-482, ISBN: 978-1-5386-3366-3, doi: 10.1109/VR.2018.8446595

[14] http://www.willpap-projects.com/Docus/Projects_List/MainProjectsFrameset.html/ 2021.06.3.

[15]https://medium.com/@herrington.jess/ and https://www.jessherrington.com/draw-jelly/ 2021.06.3.

[16] Artie Vierkant: Rooms Greet People by Name / Galerie Perrotin, New York, 2018. [Online]. Available from: https://www.youtube.com/watch?v=ZNQ2B6fLSWs/ 2021.06.11.

[17] http://kunst.uni-koeln.de/monthly/the-image-object/ 2021.05.4.

[18] https://mechthildschmidtfeist.com/ 2021.06.10.

[19] https://lensstudio.snapchat.com/ 2021.06.4.

[20] https://apps.apple.com/de/app/paint-ar/id1347083887/ 2021.05.24.

[21] Adobe Aereo. [Online]. Available from: https://www.adobe.com/de/products/aero.html/ 2021.05.24.

[22] AR Makr. [Online]. Available from: https://apps.apple.com/de/app/ar-makr/id1434081130/ 2021.05.24.

[23] D. Smith, Augmented Reality in Art Education. Tucson, AZ: The University of Arizona, 2016. [Online]. Available from: http://hdl.handle.net/10150/621860/ 2021.06.12.

[24] S. Oberhuber, T. Kothe, S. Schneegass, and F. Alt, "Augmented Games: Exploring Design Opportunities in AR Settings with Children," Proceedings of the 2017 Conference on Interaction Design and Children (IDC '17), Jun. 2017, pp. 371-377, ISBN: 978-1-4503-4921-5, doi: 10.1145/3078072.3079734

[25] M. Naimark, VR / AR Fundamentals — Prologue, 2018. [Online]. Available from: https://michaelnaimark.medium.com/vr-ar-fundamentals-prologue-b7aa3d119087/ 2021.05.10.

[26] R. M. Bäck, D. A. Plecher, R. Wenrich, B. Dorner, and G. Klinker, "Mixed Reality in Art Education," Conference on Virtual Reality and 3D User Interfaces (VR) IEEE, Mar. 2019, pp. 1583-1587, ISBN: 978-1-7281-1377-7, doi: 10.1109/VR.2019.8798101

[27] https://www.demokratiegeschichten.de/erinnerung-an-kurt-eisner-1867-1919-politiker-demokrat-pazifist/ 2021.06.10.

[28] R. M. Bäck, R. Wenrich, and B. Dorner, "Getting There? Together. Cultural Framing of Augmented and Virtual Reality for Art Education," the 7th International Conference of the Immersive Learning Research Network (iLRN 2021), Jun. 2021, pp. 312-319, in press.

[29] https://developers.google.com/ar/discover/ 2021.06.2.

[30]https://docs.unity3d.com/2020.2/Documentation/Manual/class-SpriteRenderer.html/ 2021.05.4.

[31] J. Herrington, Drawing with Jelly, 2020. [Online]. Available from: https://www.jessherrington.com/draw-jelly/ 2021.06.13.

[32] J. Herrington, Internet Dream, 2019. [Online]. Available from: https://www.jessherrington.com/865004006353/ 2021.06.25.

[33] Soi moi, n+n corsino, 2009. [Online]. Available from: https://www.youtube.com/watch?v=mI0MoIb5CgE/ 2021.06.10.

[34] M. Rappoport, Coin Chase, 2012. [Online]. Available from: https://images.app.goo.gl/9TZq9o1w5cSwKhCU9/ 2021.06.22.

[35] https://johncraigfreeman.wordpress.com/imaging-place/ 2021.06.22.