LONG PAPER

Universal and ecological design in media accessibility: finding common ground

Irene Hermosa-Ramírez[1] ⬡

Abstract

This article cross-checks universal design and ecological design in the context of media accessibility (with an emphasis on audio description, captions, audio subtitling, sign language interpreting, touch tours), aiming to identify practices that adhere to both design approaches. Following a literature review, a theoretical commentary is presented. Therein, each of the seven universal design principles (Connell et al. in The principles of universal design, 1997. https://projects.ncsu.edu/design/cud/about_ud/udprinciplestext.htm) is assessed in the light of ecological design. Three different outcomes are found when connecting universal design and ecological design principles: (1) certain universal design principles overlap with ecological design principles; (2) others are divergent with ecological design principles and (3) some are complementary, that is, they are unrelated but may be reconcilable. Universal design principles one and two (equitable use and flexibility in use) are harmonious with principles of ecological design in several ways. Principles three (simple and intuitive use), four (perceptible information) and seven (appropriate size and space) remain seemingly unrelated to ecological design principles, though they could be reconciled if certain changes were undertaken. Principles five (low physical effort) and six (appropriate size and space for approach and use) of universal design could be antagonistic with ecological design in some regards.

Keywords Universal design · Ecological design · Design principles · Media accessibility

1 Introduction

Universal design was first coined by architect Ronald Mace [23] and is generally understood to be "the design of all products and environments to be usable by people of all ages and abilities to the greatest extent possible" [5]. The principles of universal design were conceptualised at the Center for Universal Design at North Carolina State by Connell et al. [5]. Though subsequently adapted to different domains and disciplines (see, for instance, universal design for learning [35] and universal design for ergonomics [30]), the original seven principles have remained consistent and widely deployed. They are: (1) equitable use, (2) flexibility in use, (3) simple and intuitive use, (4) perceptible information, (5) tolerance for error, (6) low physical effort and (7) appropriate size and space for approach and use.

Firstly, in the context of media accessibility (MA), universal design is a broadly applied paradigm, often alluding to the notion that accessible products benefit a vast array of users and not just the intended end users [38], in this case, people with sensory disabilities. Examples from the MA literature often allude to the use of captions by foreign language learners and people in noisy environments, and, more recently, the wider use of audio description (AD) for its cognitive and linguistic benefits [25]. However, such applications of universal design have received criticism because media access services shifting or broadening target to users without impairments may risk a process of re-erasure by prioritising the needs of normative and able-bodied people [9]. That is, captions can indeed be useful for language learners, but the needs and requirements from their primary users should prevail when producing them. Similar risks have been identified in a scenario where creative approaches to MA may compromise their ultimate access goal: "art over access" [10].

Secondly, universal design incorporates the idea that the product in question is to be created without the need for adaptation or specialised design, that is, it is "born

✉ Irene Hermosa-Ramírez
  Irene.hermosa@uab.cat

1 Department of Translation and Interpreting, Autonomous University of Barcelona, Bellaterra, Spain

accessible" [32]. In this regard, several authors have further discussed the fact that "conventional" [40] or "traditional" media access services—meaning "exclusive; neutral; non-auteur; third-party and post-hoc" [10]—are at odds with these principles. Particularly, Udo and Fels [41] and Romero-Fresco [36] acknowledge that "traditional" captions and audio description (AD) are not examples of universal design because they are not created with the creative team. Following this logic, director-led [42] media access, integrated media access [11] and accessible filmmaking [36] would better fit the universal design paradigm. Moreover, Greco [13] points out that the uncritical application of universal design to MA may overlook proactive, user-centred and participatory approaches, which are increasingly advocated for in the scope of media access service provision (see [7]). Bearing these ideas in mind, the present article will include commentary on traditional, integrated and participatory media access services and the application of both universal design and ecological design principles therein.

The present article is structured in two main parts: first, the terminology and principles of ecological design are presented through a literature review. Second, each of the seven universal design principles [5] is discussed in detail—in the context of MA—in relation to the principles of ecological design from the literature review. In this sense, the article replicates the structure of Udo and Fel's [41, 42] studies, which question the adherence of television subtitles and AD, and traditional live AD to the principles of universal design, respectively. Our study reflects on how each of the universal design principles adhere to, are complimentary to or diverge from principles of ecological design, by seeking examples from media access services. The ultimate aim of the article is to fill a research gap on the intersection between universal design and ecological design in the scope of MA. Similar theoretical proposals have been conducted in engineering [29] and industrial design [44], from which this paper draws inspiration. The precise research questions that guide this study are: How do universal design principles relate to those of ecological design? How to combine them in the scope of MA? The conclusions of the article will circle back to this question.

2 Literature review: principles of ecological, green, sustainable or eco-design?

Before introducing the steps followed for the literature review, it is necessary to present a preliminary discussion on the terminology of ecological, green or sustainable design. Before the turn of the century, Pauline Madge [24] already found a number of terminological nuances in this regard. In historical terms, the "ecological" terminology dates back to the early days of the environmental movements (1960s

and 1970s) and has been utilised ever since as an umbrella term. Sustainability also stems from the 1970s and is originally related to the capacity of the ecosystems to absorb the environmental effects of human activities. As for "green", it became the "buzzword" of the 1980s [24]. Most recently, the Sustainable Development Goals adopted by the United Nations in 2015 and, more precisely, goal 12 (Ensure sustainable consumption and production patterns), have mainly adapted the "sustainable" terminology. Nonetheless, for this paper, "ecological design" will be employed (1) to make the most of its broadness in meaning and (2) because it is the most frequently used term in the literature review. For our purposes, it refers to "any form of design that minimises environmentally destructive impacts by integrating itself with living processes", and as "effective adaption to and integration with nature's processes" [43].

The first challenge in comparing ecological design principles with those of universal design is that, unlike the latter, the set of principles of ecological design is not uniform: since the 1990s, there have been several proposals stemming from different areas. As a result, a literature review was necessary to identify principles that could be applicable to MA as well. To narrow down the search, "ecological design", "green design" and "eco-design" + "principles" were searched in the Article title field within the Web of Science and Scopus databases. The resulting publications were assessed, as well as the references from these publications.

The literature review purposely leaves out certain proposals that relate mostly to specific disciplines. This is the case of Krusche, Althaus, Gabriel and Weig-Krusche's [21] design principles for ecological building construction or eco-architecture, Benyus' [3] proposal of "biomimicry", the biophilic design proposal [19] and Mitsch and Jorgensen's [28] principles for ecological engineering. A review of these proposals deriving from different disciplines is presented below (Table 1), in chronological order. This table largely overlaps with the one presented by Apul [2] in her own literature review.

In her literature review, Apul [2] recognises three main themes within the overall ecological design principles: human dimension, learning from nature (biomimicry) and incorporating nature. As explained in the coming sections, the human dimension will be the most "comparable" one between universal design and ecological design, as "[s]ome key words and ideas included within this theme are beautiful, creative, socially just, healthy, respectful, educational, value-driven, including stakeholders in the design process and meeting the needs of humans". The "biomimicry" dimensions—energy source, mass and energy flow, etc.—have thus far been less explored within the scope universal design and MA.

As an introductory note, the principles of ecological design that more closely relate to universal design stem from

Table 1 Ecological design principles (updated from Apul, 2010, 149–150)

Authors	Terminology	Design principles
McDonough and Braungar [26]	Design for sustainability	(1) Insist on rights of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition (2) Recognise interdependence (3) Respect relationships between spirit and matter (4) Accept responsibility for consequences of design (5) Create safe objects of long-term value (6) Eliminate the concept of waste (7) Rely on natural energy flows (8) Understand the limitations of design (9) See constant improvement by the sharing of knowledge
Bergen, Bolton and Fridley [4]	Ecological design (originally, ecological engineering)	(1) Design consistent with ecological principles (2) Design for site-specific context (3) Maintain the independence of design functional requirements (4) Design for efficiency in energy and information (5) Acknowledge the values and purposes that motivate design
Anastas and Zimmerman [1]	Green design (originally, green engineering)	(1) Designers need to strive to ensure that all material and energy inputs and outputs are as inherently non-hazardous as possible (2) It is better to prevent waste than to treat or clean up waste after it is formed (3) Separation and purification operations should be designed to minimise energy consumption and materials use (4) Maximise mass, energy, space and time efficiency (5) "Output-pulled" versus "input-pushed" (6) Embedded entropy and complexity (7) Targeted durability, not immortality (8) Design for unnecessary capacity or capability (e.g. "one size fits all") solutions should be considered a design flaw (9) Minimise material diversity (10) Integrate local material and energy flows (11) Design for commercial "afterlife" (12) Renewable rather than depleting
Shu-Yang, Freedman and Cote [37]	Ecological design	(1) Meet the inherent needs of humans (2) Move towards resource sustainability (3) Maintain ecological integrity (4) Emulate natural ecosystems (5) Eliminate natural debt (6) Protect natural habitat (7) Increase environmental literacy
McLennan [27]	Sustainable design	(1) Respect for the wisdom of natural systems: The Biomimicry principle (2) Respect for people: The human vitality principle (3) Respect for place: The ecosystem principles (4) Respect for the cycle of life: The "seven generations principle" (5) Respect for energy and natural resources: The conservation principles (6) Respect for process: The holistic thinking principle
Van der Ryn and Cowan [43]	Ecological design	(1) Solutions grow from place (2) Ecological accounting informs design (3) Design with nature (4) Everyone is a designer (5) Make nature visible
Hossain and Ahmad [17]	Design for the environment	(1) Ensure sustainability of resources (2) Ensure healthy inputs and outputs (3) Ensure minimal use of resources in production and transportation phases (4) Ensure minimal use of resources during use (5) Ensure appropriate durability of the product and components (6) Enable disassembly, separation and purification (7) Ensure appropriate training program for all stages of individuals in the value chain in order to enhance consciousness about environment

the works of Shu-Yang et al. [37]—initially envisaged for urban planning, industrial parks and networks, architecture and products and Van der Ryn and Cowan's [43] principles, from the field of architecture. Taking into consideration all of the cited works in the literature review, the following sections focus on each of the principles of universal design individually in an attempt to reconcile both visions in the context of MA.

3 Principle one: equitable use

"The design is useful and marketable to people with diverse abilities" [5].

As Udo and Fels [41, 42] also highlight in their articles, the equitable use principle is perhaps the most prominent and "defining" principle in universal design. It is also one that directly applies to MA. In this regard, audiovisual products, cultural events and art venues are to be enjoyed by all. Additionally, the guidelines for the first principle indicate that segregation and stigmatisation of users are to be avoided,[1] and that the design will be appealing to all users. Most relevant for our purposes, they highlight the need to provide the same means for all users—either identical or equivalent. Though this has been a largely applicable notion in MA, even appearing in definitions of AD, the notion of providing an "equivalent" experience for people with disabilities has received some criticism [14, 20], as the medicalist implication is that an individual needs "fixing". Nonetheless, in the context of MA, the equitable use principle has been advocated for in the switch from traditional post-hoc access services, totally removed from the creative team, to integrated access services [11] and participatory approaches [7]. Greco [12] reconciles both approaches in the concept of poietic design, an approach where the "design process is a co-construction where makers and users, as well as other agents, must work together".

An applied case study of MA products which are marketable to audiences with and without disabilities are "open" access services, which are delivered to the entire audience and not just the "intended" end users: open AD, open captions and, most frequently, surtitles, among others. Recent examples in AD can be found in Thompson's [39] blindness gain proposal, Dokumaci's [8] stop-time as a rule of description and Lopez et al. [22] enhanced audio description project, which provided AD for all audience members and thus "removed the potential segregation generated by the

fact that in traditional AD only visually impaired audience members wear headphones in the cinema".

The question here is how these conditions relate to ecological design. When cross-checking equitable use with ecological principles, a near-exact match is found in Shu-Yang, Freedman and Cote's [37] principle one: "meet the inherent needs of humans"; McLennan's [27] second principle: "Respect for people—The human vitality principle", if the focus is placed on the appealing qualities of the product or service.[2] More generally, this principle relates to the overall "human dimension" theme distinguished by Apul [2] in her literature review of ecological design principles. This leads us to the conclusion that universal design is perfectly compatible with ecological design when it comes to the first principle.

In practice, an additional argument that stems from universal design which has been applied to accessible filmmaking [36] is that "born accessible" [32] products and services require less resources in the long run, as such products do not need to be "amended" to suit the needs of users at a later stage. These resources are often cited to be monetary or related to human resources, but they too involve natural resources.

4 Principle two: flexibility in use

"The design accommodates a wide range of individual preference and abilities" [5].

The guidelines for the second principle highlight the need of providing a choice of methods to use the product or service. In MA, some frequent access service choices are subtitles and transcriptions of video and audio materials; audio introductions in replacement of printed programmes; AD or touch tours instead of visual access to stage performances, etc. Regarding the flexibility of these provisions, several authors have called into question access services that are only offered on restricted dates, particularly in the context of the scenic arts. For instance, AD may only be offered in one or two sessions per run of a show. In this regard, technological developments such as semi-live pre-recorded AD and automatically cued AD may be able to enhance flexibility in use as their implementation becomes widespread [16]. Udo and Fels [42] propose another alternative in this sense, the "on-demand" approach to AD (or sign language interpreting), where users are able to fix a date to attend a performance.

---

[1] One could, however, agree that certain access service provisions—involving, for instance, the booking of a sign language interpreter or AD for only one function—have traditionally limited the equitable use principle, as explained further in Sect. 4, devoted to the flexibility in use principle.

[2] In this regard, it is unclear to what extent "open" access services meet the needs of audiences that are not their main target, or whether "open" access services require fewer natural resources than traditional access services.

In this regard, on-demand approaches and, above all, "reusable" access services meet several of the cited ecological design principles: "move towards resource sustainability" [37], "respect for energy and natural resources: The conservation principle" [27], "ensure minimal use of resources in production and transportation phases" [17] and "maximize mass, energy, space and time efficiency" [1]. Considering this, the principle of flexibility does fit with ecological design principles.

Another guideline from this principle which is particularly relevant to media access services refers to the adaptability to the user's pace, in other words, personalisation and participatory approaches. In terms of personalisation, Orero [33] outlines several features that can be personalised in the scope of AD: narratives, sound tracks, reproduction rate and language. This personalisation shift would, indeed, make the "one size fits all" approach to media access invalid. Granted their many benefits, if personalisation efforts are cross-checked with ecological design principles, some discrepancies arise. Though personalisation can meet the "design for site-specific context" principle [4], there is the argument to be made that personalisation may also be more resource intensive.

In terms of participatory approaches, however, universal design and ecological design principles may very well find common ground. The growing practice of including the users' input in the design of MA products and services connects with ecological design principle "everyone is a designer" [43]:

> "Ecological design suggests a deeply participatory process in which technical disciplinary languages and barriers are exchanged for a shared understanding of the design problem. Ecological design changes the old rules about what counts for knowledge and who counts as knower".

Taking into consideration all of the mentioned factors, flexibility in use mostly adheres to ecological design principles, though personalisation efforts in the future should take resource consumption into consideration during the design of the product.

5 Principle three: simple and intuitive use

"Use of design is easy to understand, regardless of user's experience, knowledge, language skills, or current concentration level" [5].

Importantly for the purposes of MA, guidelines of the simple and intuitive use principle recommend that the design eliminates unnecessary complexity, accommodates diverse ranges of literacy and language skills, introduces information by importance and is consistent with user'

expectations and intuition. In this regard, AD and captions are generally understood to be easy to use once activated, but, at times, it is the steps of activation and deactivation that may be hindering [41]. In this regard, designers should not only provide accessible products that are easy to understand and use, but also ensure that users can find accessibility features easily.

Regarding the point about expectations and intuition, very many recent studies in MA have purposefully been user-centred. These studies have focused on preferences and opinions, as well as lexical and syntactical comprehension, speed of delivery, etc. [6]. Increasingly, experimental studies have taken a more central role in MA [14, 34]. To the best of our knowledge, user-centred studies in MA have not yet considered ecological principles and sustainability within their research topics or processes. The present special issue will hopefully serve as a stepping stone towards this aim.

Circling back to our original questions, on the one hand, simplicity and ease of use are not prevalent notions in ecological design principles. On the other hand, simple designs do tend to be less resource-intensive. Here, we propose an analogy between a necessary wariness towards "art over access" [10] with one towards "sustainability over access".

6 Principle four: perceptible information

"The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities" [5].

The guidelines of the forth principle can be applied to MA quite literally, particularly, "[u]se different modes (pictorial, verbal, tactile) for redundant presentation of essential information"; "[m]aximize "legibility" of essential information" (…); [p]rovide compatibility with a variety of techniques or devices used by people with sensory limitation [5].This principle somewhat overlaps with the guidelines of "flexibility in use", especially when it comes to the different methods of use, and the discussion of personalisation in Sect. 4 is also relevant here. In the context of MA, Udo and Fels [42] recognise that it is the director's responsibility (or the creative team's, or that of the designers of a product or service) to "decide the method and style of that communication". This is not only the vision advocated for in director-led accessibility, but also in accessible filmmaking [36] and in integrated accessibility [11].

The perceptible information principle does not, however, appear to be clearly related to any of the ecological design principles from the literature review. This does not mean that the principle is irreconcilable with ecological design. For instance, we may come up with complimentary guidelines:

Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information **prioritising the most sustainable option**.

Or

Provide compatibility with a variety of techniques or devices used by people with sensory limitation **prioritising the most sustainable option**.

The most sustainable option here would entail "eliminating the concept of waste", "relying on natural energy flows" [26] and "design for efficiency in energy and information" [4], that is, biomimicry themes in ecological design [2]. It is true that, at face value, using different modes to present information or increasing personalisation options inherently requires more resources. However, the principle of perceptible information does not need to be opposed to ecological design principles: they can work together and they can be combined, as demonstrated by the two above cited guidelines.

7 Principles five, six and seven: tolerance for error, low physical effort and appropriate size and space for approach and use

"The design minimises hazards and the adverse consequences of accidental or unintended actions" [5].

"The design can be used efficiently and comfortably, with a minimum of fatigue" [5].

"Appropriate size and space for approach, reach, manipulation and use regardless of body size, posture or mobility" [5].

Principles five, six and seven are grouped together because they are the most far removed from typical media access services, as Udo and Fels [41] and [36] also recognise that they were envisioned with a different type of accessibility in mind. In general terms, we find a dichotomy between the fifth and sixth principles and a common understanding of the "natural design" [43], which may not be the most tolerant for error or it may be physically demanding.

In terms of tolerance for error, misunderstandings and errors of miscommunication in AD and captions [41] are to be avoided by hiring trained professionals and by gathering and consecutively applying feedback from users. Though not envisioned for MA and, again, seemingly unrelated to this field, we do find two examples from the ecological design principles that could evoke tolerance for error: "Designers need to strive to ensure that all material and energy inputs and outputs are as inherently non-hazardous as possible" [1] and "Create safe objects of long-term value" [26]. However, this parallel is certainly not evident.

In terms of the low physical effort and appropriate size and space for approach principles, it is worth clarifying that AD, captions, audio introductions and audio subtitles are to follow standards and recommendations for comfort, comprehension and, again, ease of use. In our case, low physical effort and, more specifically, low cognitive effort and thus reduced cognitive fatigue can be linked to appropriate size and number of words per minute in captions, good quality post-production mixing for AD or programmes in easy language. Furthermore, physical settings (such as theatre venues, cultural heritage sites and natural parks) do require a guaranteed level of physical comfort [41], as does the placement of sign language interpreters in live events, and the hardware that is utilised to activate and follow access services. Though with a slightly differently nuance in meaning, "efficiency" is a keyword here that may help us reconcile universal design with ecological design: "design for efficiency in energy and information" [4]. Yet again, it is worth clarifying that this ecological design principle does not refer exactly to the same notion of that of universal design.

As for the seventh and last principle—appropriate size and space—we feel compelled to cite the expanding practice of personalisation in media access services yet again. This principle may be applicable to the choice of changing the size, position and colour of captions and the option to alter the reproduction rate of AD, just to name a few. Nonetheless, and as a final remark regarding the last set of universal design principles, the ultimate responsibility in terms of sustainable practices should not be a burden placed on people with disabilities and other beneficiaries of universal design.

All in all, and considering the convergences and discrepancies between universal and ecological design, a proposal of possible applications merging both visions in MA could involve:

(1) a "respectful" design that meets the "inherent needs of users" [37] in the form of participatory approaches [7], also alluding to the ecological design principle that "everyone is a designer" [43];

(2) "born accessible" [32] products and services (integrated AD [11], accessible filmmaking [36]) that also anticipate production or design strategies that consume the least possible amount of natural resources;

(3) "reusable" access services, such translation templates for AD [18] or semi-live pre-recorded and automatically cued AD [16];

(4) the incorporation of the addenda "prioritising the most sustainable option", "aiming for the most efficient option in terms of energy and information" [4] and "maximising mass, energy, space and time efficiency" [1] to universal design guidelines whenever possible, as exemplified in the fourth principle of universal design;

(5) a degree of caution to avoid prioritising "sustainability over access" whenever ecological design principles are

applied. For example, providing AD in a live event does consume more resources than not offering the service at all, but sustainability should not come at the expense of accessibility service users. The suggestion here is for audiovisual production companies, cultural venues, heritage sites, etc. to reduce their carbon footprint elsewhere, in an effort to respect the Convention on the Rights of Persons with Disabilities.

8 Conclusions

The present theoretical contribution serves as an exploration of a "universal ecological design" paradigm in the scope of MA. Its conclusions point to two universal design principles (one and two) closely overlapping with principles of ecological design, while others (three, four and seven) seemingly remain unrelated. The unrelated nature of the perceptible information principle and ecological design, for instance, could be settled by merging guidelines or creating complementary ones. Lastly, principles five and six of universal design could be antagonistic with ecological design, though this poses an opportunity for development and further reflection from proponents of both designs.

A shared feature of universal design and ecological design that we hope sticks in MA and beyond is that of "prevention instead of treatment". This overarching principle is fostered by the involvement of end users in MA designs, as advocated for in participatory approaches to media access services [7].

An aspect which has not been discussed thoroughly in this article, but that would deserve further attention, are the implications of one particular principle of ecological design in relation to universal design: "design for unnecessary capacity or capability (e.g. "one size fits all") solutions should be considered a design flaw" [1]. The ecological impact of personalisation in MA could be a subject of concern in our field going forward. Another possible avenue of research that may well be worth exploring is the testing of sustainable MA services with users.

Ultimately, this study has found five possible applications of a "universal ecological design" in MA. Among them, ecological practices in MA could include "upcycling" (for instance, reusing time-codes when producing an AD in several languages) [31] and translating template AD files [18]. In keeping with a critical lens, the burden of minimising the use of natural resources should, however, never be placed on people with disabilities and, generally, on the quality of media access services.

Declarations

References

1. PT Anastas JB Zimmerman 2003 Design through the 12 principles of green engineering Environ. Sci. Technol. 37 5 94A 101A https://doi.org/10.1021/es032373g
2. D Apul 2010 Ecological design principles and their implications on water infrastructure engineering J. Green Build. 5 3 147 164 https://doi.org/10.3992/jgb.5.3.147
3. J Benyus 1997 Biomimicry: innovations inspired by nature HarperCollins New York
4. SD Bergen SM Bolton JL Fridley 2001 Design principles for ecological engineering Ecol. Eng. 18 201 210 https://doi.org/10.1016/S0925-8574(01)00078-7
5. Connell, B.R., Jones, M., Mace, R., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M., Vanderheiden, G. G.: The principles of universal design (1997). https://projects.ncsu.edu/design/cud/about_ud/udprinciplestext.htm
6. E Giovanni Di 2018 Audio description and reception-centred research E Giovanni Di Y Gambier Eds Reception Studies and Audiovisual Translation John Benjamins Amsterdam & Philadelphia 225 250
7. E Giovanni Di 2018 Participatory accessibility: Creating audio description with blind and non-blind children J. Audiovisual Transl. 1 1 155 169 https://doi.org/10.47476/jat.v1i1.50
8. Dokumaci, A.: Disability as method: interventions in the habitus of ableism through media-creation. Disability Stud. Quart. **38**(3), (2018)
9. Ellcessor, E.: Blurred lines: Accessibility, disability, and definitional limitations. First Monday, **20**(9), (2015)
10. L Fryer 2018 The independent audio describer is dead: Long live audio description! J. Audiovisual Transl. 1 1 170 186 https://doi.org/10.47476/jat.v1i1.52
11. L Fryer A Cavallo 2021 Integrated Access in Live Performance Routledge, Abingdon, Oxon New York
12. GM Greco 2019 Accessibility studies: abuses, misuses and the method of poietic design C Stephanidis Eds HCII 2019 Springer Cham 15 27
13. GM Greco 2019 Towards a pedagogy of accessibility: The need for critical learning spaces in media accessibility education and training Linguistica Antverpiensia New Ser. Themes Transl. Stud. 18 23 46 https://doi.org/10.52034/lanstts.v18i0.518

14. GM Greco 2022 The question of accessibility C Taylor E Perego Eds The Routledge handbook of Audio Description Routledge Abingdon and New York 13 26

15. GM Greco A Jankowska A Szarkowska 2022 Addressing methodological issues in experimental research in audiovisual translation Transl. Spaces 11 1 1 11 https://doi.org/10.1075/ts.00030.int

16. I Hermosa-Ramírez 2020 Delivery approaches in audio description for the scenic arts Parallèles 32 2 17 31 https://doi.org/10.17462/para.2020.02.02

17. Hossain, M. S. J., Ahmad, N.: Green design principles and trends of using them among Bangladeshi consumer goods manufacturers. In: IEEE International Conference on Industrial Engineering and Engineering Management (2011). IEEE, Singapore, pp. 467–471. https://doi.org/10.1109/IEEM.2011.6117961

18. A Jankowska M Milc L Fryer 2017 Translating audio description scripts… into English SKASE. J. Transl. Interpret. 10 2 2 16

19. SR Kellert 2018 Nature by Design: The Practice of Biophilic Design Yale University Press Yale

20. G Kleege 2016 Audio description described: Current standards, future innovations, larger implications Representations 135 1 89 101 https://doi.org/10.1525/rep.2016.135.1.89

21. Krusche, P., Althaus, D., Gabriel, I., Weig-Krusche, M.: Ökologisches Bauen. Bauverlag GmbH, Wiesbaden & Berlin (1982)

22. M Lopez G Kearney K Hofstädter 2021 Enhancing audio description: Inclusive cinematic experiences through sound design J. Audiovisual Transl. 4 1 157 182 https://doi.org/10.47476/jat.v4i1.2021.154

23. R Mace 1985 Universal design, barrier free environments for everyone Design. West 33 1 147 152

24. P Madge 1997 Ecological design: a new critique Des. Issues 13 2 44 54 https://doi.org/10.2307/1511730

25. Mazur, I.: Audio description: Concepts, theories and research approaches. In: Bogucki, L., Deckert, M. (Eds.), The Palgrave Handbook of Audiovisual Translation and Media Accessibility (pp. 227–247). Springer, Cham (2020). https://doi.org/10.1007/978-3-030-42105-2_12

26. W McDonough M Braungart 1992 The Hannover Principles: Design for Sustainability The World's Fair Germany

27. JF McLennan 2004 The Philosophy of Sustainable Design Ecotone Publishing Kansas City, MO

28. WJ Mitsch SE Jorgensen 2004 Ecological Engineering and Ecosystem Restoration Wiley Hoboken, NJ

29. D Nieusma 2004 Alternative design scholarship: Working toward appropriate design Des. Issues 20 3 13 24

30. N Olguntürk H Demirkan 2009 Ergonomics and universal design in interior architecture education J. Facul. Architect. 26 2 123 138 https://doi.org/10.4305/METU.JFA.2009.2.7

31. Oncins, E.: Upcycling audio description: Towards a more sustainable model. In: Conference presentation. ARSAD: 8th Advanced Research Seminar on Audio Description, Barcelona (2021)

32. Orero, P.: Born accessible: beyond raising awareness. Position paper (2020). https://ddd.uab.cat/pub/estudis/2020/222130/Policy_Paper_final.pdf

33. P Orero 2022 Audio description personalisation C Taylor E Perego Eds The Routledge Handbook of Audio Description Routledge Abingdon & New York 407 419

34. P Orero S Doherty JL Kruger A Matamala J Pedersen E Perego P Romero Fresco S Rovira-Esteva O Soler-Vilageliu A Szarkowska 2018 Conducting experimental research in audiovisual translation (AVT): A position paper J. Special. Transl. 30 105 126

35. K Rao MW Ok BR Bryant 2014 A review of research on universal design educational models Remed. Spec. Educ. 35 3 153 166 https://doi.org/10.1177/0741932513518980

36. P Romero-Fresco 2013 Accessible filmmaking: Joining the dots between audiovisual translation, accessibility and filmmaking J. Special. Transl. 20 2 201 223

37. F Shu-Yang B Freedman R Cote 2004 Principles and practice of ecological design Environ. Rev. 12 2 97 112 https://doi.org/10.1139/a04-005

38. MF Story JL Mueller RL Mace 1998 The Universal Design File: Designing for People of All Ages and Abilities North Carolina State University Raleigh, NC

39. H Thompson 2017 Reviewing blindness in French fiction, 1789–2013 Palgrave, London. https://doi.org/10.1057/978-1-137-43511-8

40. JP Udo D Fels 2009 Suit the action to the word, the word to the action: an unconventional approach to describing Shakespeare's Hamlet J. Visual Impair. Blind. 103 3 78 183 https://doi.org/10.1177/0145482X0910300307

41. JP Udo DI Fels 2010 The rogue poster-children of universal design: closed captioning and audio description J. Eng. Des. 21 2–3 207 221 https://doi.org/10.1080/09544820903310691

42. JP Udo DI Fels 2010 Universal design on stage: live audio description for theatrical performances Perspectives 18 3 189 203 https://doi.org/10.1080/0907676X.2010.485683

43. S Ryn Van der S Cowan 2007 Ecological Design, 10th Anniversary Island Press Washington, DC

44. Xin, Z., Mei, Y., Chenglong, W., Lirong, W.: Study of sustainable factors in universal design. In: IEEE 10th International Conference on Computer-Aided Industrial Design & Conceptual Design, pp. 1412–1415 (2009). https://doi.org/10.1109/CAIDCD.2009.5374950