# Ao Alcance de Todos Música

*Tecnologia e Necessidades Especiais*

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# Towards a platform of alternative and adaptive interactive systems for idiosyncratic special needs

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## ABSTRACT

Eight participatory workshops were created as a hybrid situation wherein physical and virtual environments were designed to investigate responses of attendees when empowered by non-invasive sensor technology to interactively control responsive multimedia through motion. 144 disabled children and adults attended with caregivers and helpers. Targeted were fun experiences, social interactions, and recognised achievements. Evident was that the majority of disabled attendees joyfully, freely and creatively self-articulated and playfully interacted. However, traditional caregiver role in such situations is questioned following observations from the workshops. Specific design issues, targeted effect-goals, and attendee responses are reported in the paper. Conclusions reflect how such hybrid situations can offer opportunities to assess the dynamic relationships between technical set-ups and related human responses. Strategies are proposed towards future inter/multidisciplinary open research platforms to more fully examine potentials of motion-sensitive environments for this segment of society.

## 1. INTRODUCTION

The "Ao Alcance de Todos - Within Everyone's Reach" festival was hosted at Casa da Música, Porto, Portugal in April 2008. Included was the 'SoundScapes Virtual Interactive Space: ArtAbilitation Workshop 2' which consisted of eight one hour workshops. They were created as a hybrid situation wherein physical and virtual environments were designed to investigate responses of attendees when empowered by non-invasive sensor technology to interactively control responsive multimedia through motion. The situation is referred to as virtual interactive space (VIS) (Brooks 1999) wherein the SoundScapes motion-sensitive environment (MSE) enables interactive control of responsive multimedia. 144 disabled children and adults attended with caregivers. Additionally, a symposium for professionals was hosted immediately following the 8 workshops for approximately 35 professionals (international, national, regional, and local // social workers, psychologists, researchers, teachers, and students …) - many of whom had attended the workshops.

The festival was a week of publicly attended performance art events, workshops, and talks that highlighted the potentials from utilising technology as an alternative means of expression for disabled people. Third party holistic in-depth enquiry was undertaken with a research report imminent. The workshop series that is the focus of this paper was an element of the festival and as such contributes to the future report, therefore, the focus of this paper is restricted to the specific design, the associated effect-goals, and the resultant attendee responses observed in the workshop sessions wherefrom findings have been drawn.

### *1.1 Attendees and organisation*

Workshop attendees were from regional special needs institutes, schools and hospitals. All marketing, scheduling and organisation were administered by the educational services in Casa da Música, Porto, Portugal. This was the second ArtAbilitation workshop following a similar event at Casa da Música in April 2007 (see Petersson & Brooks 2007).

## 2. DESIGN

The workshops were created in a room of approximate dimension, 238 square meters floor area, 20 meters high (approx). A plan of the layout is illustrated in figure 1. The floor was black. A mirror-wall is on the right-hand side after the entrance. Large speaker systems were positioned to maximise vibration of the wooden floor. Truss box sections and black theatrical curtains were used to divide the room into five specific areas. Attendees experienced subsequent areas with each next environment hidden from view until a curtain was opened from the preceding area. This was to minimise attendee distraction. Hidden video cameras in accord with ethical stipulations were arranged throughout to record the attendee interactions. A researcher interview area was additionally established with suitable lighting and microphone for manual video camera recording.

Each area was designed with a specific attendee experience (goal-effect) in mind, and these are outlined in the text. Overall goals included generally stimulating, empowering and challenging the attendees towards experiencing self-driven fun, improved temporal social interactions, and a self-recognized sense of achievement. Physical movement was the input/control means. Doors were closed when the attendees arrived. All removed their shoes so that the vibrations resulting from the sound manipulations could be experienced via the wooden floor. After an introduction, including translation/signing, doors were opened for attendees to enter. Author, translator and technical crew combined in guiding the attendees in the workshop.

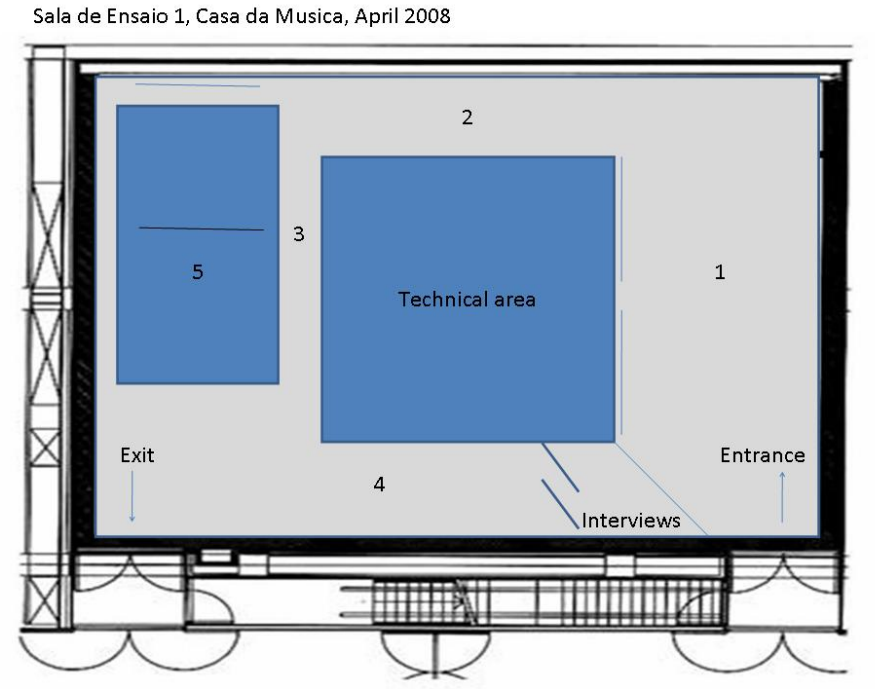



**Figure 1.** *Plan view of workshop area.*

### *2.1 Area 1*

A motion-sensitive environment was created as the first area. The area was accessed via a large double door 'Entrance' in Figure 1. A picture taken from the entrance is presented in figure 2. There was minimal lighting and upon first viewing without attendees being present to activate the motion sensors there was no image projections, hence the area was dark. On entering, the attendees paused as the author gave a demonstration of how physical articulation of one's own body within designated areas, or movement of mobile interactive structures (i.e. 'enhanced' window blinds) (Brooks 2005) could be explored to create and manipulate music, images and vibrations. Microphones were centrally mounted above attendee heads to capture utterances and other sonic attributes generated in the area and this was also demonstrated. Four 'SoundScapes programmed' Roland SP555 D-beam sampler units were used to manipulate the sonic content.

Each sensor device was mounted and secured on a music stand so as to be flexible to adapt from vertical to horizontal orientation with 360 degree directionality available according to the individual preferences. Dynamic pads enabled the triggering of preferred sounds. An onboard microphone input socket made it possible to convert attendee utterances into samples and effects for playback. Output from each of the sound

modules was mapped to visualisations on a PC. In this way attendees were empowered, to directly affect projected images (figure 2). In this way, the multimedia attributes of the area were dependent on input from the attendee, as otherwise - without movement or utterances there were no sounds, images or vibrations. The mirrored wall on the right of the entrance cannot be seen in figure 2 but this was consciously utilised as an environment design feature.

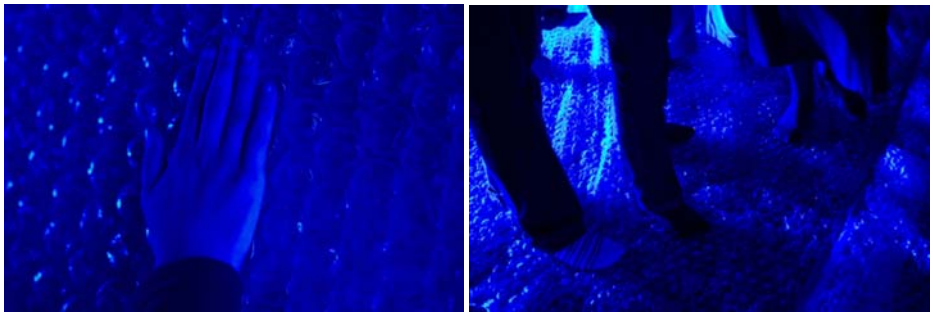
**Figure 2.** *Entrance view of area 1 – approximately 14 meters length x 6 meters wide. Two 4x4 meter back projected screens dominate in the figure by showing examples of the interactive images manipulated via motion. Two of the mobile interactive structures are located in-between and in front of the screens.*

A goal of the first area was to promote a sense of independence; a feeling of empowerment; and the sensation of control over own experience for the disabled attendees. The guides assisted by improvising interaction so as to optimise attendee experiences, and, where appropriate, disabled individuals were encouraged to explore without their caregiver. This was based upon prior observations where caregivers had been interpreted as unintentionally preventing the disabled person in their charge having an optimal experience through curtailing activities in order to ensure that they did not do any damage to equipment or themselves. However, this complex issue is beyond the scope of this paper to address other than reporting what was witnessed.

**Figures 3, 4 & 5.** *Image manipulation interactively controlled by disabled attendees in area 1.*

*2.2 Area 2*

A black heavy theatre curtain divided areas 1 and 2. Large 'bubble wrap' (figure 6 & 7) was used to cover the floor and walls. This design was based upon prior experience of how disabled people were observed to enjoy the feel underfoot and of squeezing and exploding the bubbles by hand. Blue LED lighting was used to replicate a swimming pool ambience which is acknowledged in the field of disability as mostly pleasing and positively familiar to attendees. Reverse-phase microphones were used to capture utterances and sounds from interactions, i.e. bubble wrap explosions, articulated utterances/clapping, and individual/group jumping and stamping. The microphone setup minimized sonic feedback due to the limited area size (see figure 1). A sound effect was used to enhance the sonic experience of this area. A goal of this area was to build upon attendee experience gained from area 1 so as to further free them of any preconceived rules or expectations in order for them to freely express themselves as they wanted. The design at the same time promoted physical activity, social interaction and above all "fun" through empowered ludic engagement.



**Figures 6 & 7.** *Large bubble wrap fixed to walls and floors in area 2 for individual or group exploration.*

*2.3 Area 3*

Area 3 (figure 8) was designed as a simple, empty and narrow passageway that was lined with black curtains on either side. It was sized so that each disabled person was encouraged to traverse alone without support (unless required) towards areas 4 and 5. The goal of this transitional area was to evoke a feeling of identity, confidence and self-esteem following experiences gained from the earlier areas.

**Figures 8 & 9.** [Left] **'***area 3' - the narrow curtained passageway;* [Right] *'area 4' – chill out + exhibition.*

*1.6 Area 4*

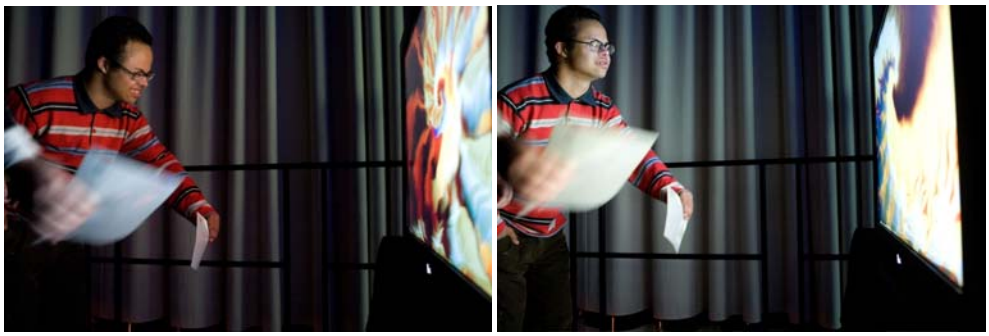
Area 4 (figure 9) was multi-functional with colourful bean bags. A goal of this area was to offer an integrated 'chill-out' zone/preparation space/… and exhibition place where achievements and experiences could be shared. Here, the next area (5) was introduced and questions were answered. Two wall spaces that bounded the 'Exit' (figure 1) were used as an exhibition place for digital paintings that the attendees created in area 5. The design was that attendees, where applicable, mounted their own picture on the wall.

*1.7 Area 5*

**Figures 10, 11, & 12.** *area 5 – set-up* [Left] *with printer behind:* [Centre & Right] - *Two female attendees on the platform exemplified how the control of interactive media through gesture can promote social interaction (Vygotsky 1978); peer learning (e.g. Rogoff 1990), and scaffolding (e.g. Wood et al. 1976).*

Prior areas were designed to prepare attendees for this final motion-sensitive environment which was realised as a multisensory platform/projection area (figure 10). Here, attendees received responsive multimodal stimulation as a result of their gestures. A black curtain divided areas 4 and 5. Upon entering area 5 attendees climbed onto a wooden platform about one meter high (wheelchairs were carried). Low frequency sub-woofers were mounted on the underside of the platform floor to maximize vibrations. Two SoundScapes programmed Roland SP555 units were positioned at an angle pointing toward where attendees were guided to stand or sit (figures 11 & 12). The movement-to-sound interaction was within two 3D infrared sensor spaces that responded at distance to a square reflective artefact (figures 13 & 14). A 42″ monitor was positioned for 'performer' monitoring of the manipulated visualisations created for the adaptive PC software Winamp[1]. A webcam was positioned on the monitor to capture attendee motion for image processing. Four meters behind the monitor a projected image on white curtain gave visual information feedback of how the attendee body movement and reflective artefact were dynamically painting (figures 11 & 12). An algorithm titled 'bodypaint'[2] created in the software programme Eyesweb[3] was used for the dynamic painting (Brooks & Hasselblad 2004). To create a digital painting print in real-time involved an 'in-action' screen capture of attendee interaction which was then transferred to the image editing software IfranView[4] to selectively extract, crop, resample and then print - all while the person was 'painting' as then the print was ready to hand to him or her as they descended from the wooden platform. This was given to the attendee so that he or she could mount in the exhibition area (figure 9) and then later keep as a souvenir to recall the experience.

A goal of this area targeted the attendee to associate the square reflective artefact movement to the change of sound, vibration and image. This was conceptualised as possibly being a suitable tool for therapists to work with for eye-to-hand coordination, concentration or awareness exercises.



**Figures 13 & 14.** *Using the square reflective artefact in hand to play and perform with sound and images.*

## 3. COMMENTS AND OBSERVATIONS

The holistic design was reverse engineered from area 5, where a multisensory platform environment acted as the conduit between attendees and the multisensory feedback. In this area attendees' self-articulation was designed to be at a more individual level, and guidance, where required, was at a more intense level. Previous areas (1-4) were preparation areas where each person, as a part of a group, progressed through the areas whilst being encouraged to freely express individually or collectively. Targeted from the prior areas was a progressively free mind-set towards creative expression and playful interaction without any rules or expectations. The prior areas also targeted to afford a sense of identity for the disabled attendee such that they perceived appropriate actions and discovered a sense of agency, and hence self-empowerment through 'actively self-doing'. This positive aspect was balanced by certain caregivers who were observed to curtail their charge in line with what Petersson (2006) calls a problematic 'power culture' in education. It was as if the caregiver, upon realising their disabled charge empowered, lost their umbilical contact to the workshop. In other words, observations were that they were lost without having the disabled person in their charge; however, this could also be associated to their knowledge of the person and instructions of their role for the workshop from leaders. It was also observed that other caregivers actively shared the performance space and encouraged interactivity by using the mediating stimuli as a communication aid for attendee articulation.

The mobile structures gave a tangible quality to the interactions in area 1. Some attendees 'played' the installation by moving the various 'enhanced' artefacts which were on wheels. At any time they could position the artefact and then perform in front of it alongside others who were active. The physicality of this interaction seemed pleasing for many of the attendees. Others found (or were guided to) sensor and microphone 'hot spots' so as to contribute to the multimedia collage in a more sedate way. However, it was also confusing when the groups were too big as association from one gesture to a single direct audiovisual feedback could not be easily detected and the active attendee needed to listen carefully if there were many colleagues in the area. The initial demonstration attempted to alleviate this problem by demonstrating the sounds in each active zone. During the actual session guides and caregivers helped attendees in this respect.

Indications of 'non-formal learning' (Petersson 2006) were observed for certain disabled attendees and caregivers as they recognised their control of interactive media through gesture. Disabled attendees, especially in area 5, displayed this phenomenon non-verbally and via their facial expressions, which typically changed from surprise to curiosity, interest, and then exploration with subsequent recognition of associations and continued playful interaction. This can be through the learning curve being negligible due to its direct and immediate causal response to action that complements an attendees' neurological response system i.e. suggested closure of the afferent efferent neural loop (Brooks et al. 2002). Additionally, indications from what was observed suggest that the control of interactive media through gesture promoted social interaction (Vygotsky 1978); peer learning (Rogoff 1990), and scaffolding (Wood et al. 1976) whereby the mediating technology all but 'disappeared' and the responsive content became as an inter-subjective other. Evaluations included exhibited aesthetic resonance (Ellis 1997, Brooks et al. 2002, Petersson 2006, Camuri et al. 2003).

Pride and self-esteem in exhibiting personally achieved paintings was observed (and reported by caregiver). Depending on disability most attendees knew where their painting was mounted in the exhibit and would take the guides to view. Following the cessation of the festival the pictures were sent to the attendees. Some attendees took their paintings home directly from the workshop to show their family and friends. Attending caregivers also received a painting of their participation. Throughout all 8 workshops, and in all 5 areas, joyful laughter was commonplace with many attendees excitedly exclaiming their enjoyment and fun.

## 4. DISCUSSION AND CONCLUSIONS

The positive responses from attendees, and comments received by attending caregivers and leaders at the closing 'professional symposium' suggest that this type of workshop format, where attendee perception and action is designed for, is opportune to observe an empowered situation. Attendee responses included that personal space was protected or shared; interactions were individually or collectively formed; play was solitary or universal. Attendee communication was also evident in, and between, the constructed spaces which added to the social interaction (Vygotsky 1978); peer learning (Rogoff 1990), and scaffolding (Wood et al. 1976) mentioned in section 3 of this paper. The interpretation that certain of the workshop attending caregivers were possibly being over-protective is acknowledged as purely speculative due to observer's lack of knowledge of the people concerned and limited time of observation.

In the closing symposium attendees stated that despite 'technical trepidation', they wished to access the affordable commercial apparatus used in the workshops. Reflecting this, concluding remarks suggested a funding strategy that would enable such purchases with accompanying staff training programmes alongside

funded collaborative partnerships between therapists and digital artists where shared knowledge could be productive. However, in a follow-up to the workshop a communication received from the local Roland representative informed that no institute has purchased a sensor unit. Also, the author's networks of local digital artists working with non-invasive sensors in Porto report no contact from institutes or therapists.

From a research perspective the workshops offered further opportunities to question and evolve the author's ongoing SoundScapes concept and strategy of creating situations that empower participants to non-invasively control 'responsive-multimedia by motion from within a virtual environment. The work to date has involved the creation of a concept that is responsible for patented technical apparatus and method. As a hybrid system it has evolved through 3rd party expert assessment of human responses to use. Refinements have thus been based upon investigating dynamic relationships between the technical and the human systems as well as through questioning the complex network of sub-systems that reside embedded within the situation. However, this has been limited and increased multi/interdisciplinary expert collaborations towards improved developments and understandings of the potentials of motion-sensitive environments are deemed needed.

In line with Eaglestone and Bamidis (2008), a future strategy is proposed as outlined above with a view to augment the field through the creation of a designated open research platform. Such a platform could opportunely address the complex issues involving commensurability in respect of corroborated validity and replicability in this multifarious field of alternative and adaptive interactive systems for idiosyncratic and collective special needs. Supplementing this proposal, is that a network of linked platform nodes could be employed to act as a bridge between the academic researchers, commercial developers, and healthcare professionals so that access to appropriate apparatus, training of use, and suitable systematic and meaningful evaluation methods become available alongside an active sharing of expert knowledge so as to directly support partnered stakeholders such as the future generation of therapists, caregivers and disabled people.

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[2] Bodypaint algorithm programming by R Trocca & G Volpe – www.daonline.info/archivio/7/pagine/ultimo_n_opinione_ambiente.php
[3] www.infomus.org/EywMain.html
[4] www.irfanview.com

## APPENDIX

*Data supplied on workshop attendees*

**Workshop 1**. *School*: E.B.2, 3 Matosinhos
Age: 8-16 years
1 with autism
13 with mental retardation
4 with mental retardation + motor disabilities

**Workshop 2**. *School*: E.B.2, 3 Santa Marinha
Age: 11-16 years old
20 students - hearing impaired

**Workshop 3**. *Institution* – CAID
Age: 22-41 years
2 with moderate mental disability
2 with Down Syndrome
2 with moderate mental + severe motor disability
1 with mild motor + moderate mental disability

**Workshop 4**. *School*: Internato Vítor Fontes
32 students
*School*: Externato Ana Sullivan
Age: 6-19 years
22 students

**Workshop 5**. *Hospital*: Psiquiátrico Conde Ferreira
Age: + 30 years
16 with psychiatric mental illness

**Workshop 6**. *School*: Externato Ana Sullivan
Age: 12 – 19 years
23 students

**Workshop 7**. *Institution:* Cercigaia
Age: + 14 years
2 with moderate mental retardation + motor disabilities
2 with severe mental retardation + autism
1 with moderate mental retardation
1 with severe mental retardation
9 with moderate mental retardation
1 with cognitive disabilities + hearing impaired
1 with Spina Bifida
1 with Treacher Collins Syndrome + Genetic cardio disease

*Institution*: Centro de Educação Especial de Penafiel
Age: 4-10 years
15 children hearing impaired

**Workshop 8**. *Institution*: APPACDM
Age: 19-51 years
7 with severe mental retardation
3 with moderate mental retardation