GoingPublik: Testing System Design Outside of the Ivory Tower

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1.0 ABSTRACT

While it is easy and has become quite common for computer scientists to solve their own, carefully and iteratively self-made problems within the often cited 'ivory tower', the vision of a creative artist typically provides computer scientists with problems falling outside of their own realm of thinking and which are often 'hard nuts to crack'. In addition, artists can successfully act as natural motivators, animators and integrators within a scientific research institute, making an interdepartmental team of collaborators pull together towards a single goal [1]. The goal, whether it be a performance or a presentation, not only provides the artist with an opportunity to create digitally enhanced art, but has also helped in turn to stimulate the institution's abilities to develop and solve new technological problems under pressure.

The main area of computer research which was being done at the host institute during the *GoingPublik* project was in the area of constructive research systems and multimedia and their implementation in the area of wearable computers - i.e. mobile multimedia. Although, the major role played by the artist in the development of the system and the software to run it, was one of challenging the research and technology, rather than directing or redirecting it, having the opportunity to test the system with a concrete task which goes beyond the self-made problems of the ivory tower, proved to be a silver line on the horizon. Thus, It can hardly be imagined doing constructive systems research in 'new media' without artist partners.[2]

1.1 Key Words

Mobile Multimedia, Wearable Devices, Digital Score, HCIs, Sound Art, System Research

1.2 ACM Classification Keywords

H.5.5 [Sound and Music Computing]: Systems, H.5.1 [Multimedia Information Systems]:Artificial, augmented, and virtual realities, D.4.9 [Systems Programs and Utilities]: Miscellaneous

2.0 INTRODUCTION

This paper wishes to convey in the large the experience of a mutual collaboration between science and art and in the small the fruits of that collaboration both technically and artistically. Technologies in the area of human interface design which reconsider and extend the desktop metaphor as a means of computer interaction in the light of the progress made in hard and software technology recently will be discussed. These included subsets stemming from the implementation of a new general purpose graphical user interface and multimedia framework, zoom-able and textual user interfaces and translucent free-form windows. [3]

Aesthetic issues rooted in the works of the artist and his formal influences will be briefly touched upon in order to show where the artist's interests lay in general. These include interests in the use of transparency for modularity and optical phenomena to bring about kinetic relationships. Finally, how these interests were then developed further into a sonic art work whose central element revolves around the digital enhancement possibilities of mobile-multimedia systems in specific.

2.1 Aesthetic Roots: Examples in History

Historical examples of works of art showing an interest in using transparency as a kinetic element visually or as a basis for modularity in the creation of art work can be found in the output of László Moholy-Nagy[4], Marcel Duchamp[5] and John Cage[6]. A few brief description of such will suffice:

• The viewer, while looking at Duchamp's *Large Glass* at the Philadelphia Art Museum which is positioned in front of a window so that one can look through the glass and out the window at a fountain in the courtyard, comes to realize that the real world and the art world mix here symbolically in pleasant agreement.

• When using the transparencies needed to realize *Variations 1-V,* performers come to realize that Cage has not provided them with a finished score, but with a creative tool for the construction of one and that there will never be a single definitive version of the work.

• Any artist today working with modern tools will see that Moholy-Nagy's *Light Modulator,* which is constructed out of plexiglas and which employs kinetic movement to interact

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optically with a light source, serves as an early metaphor for a digital art, which basically consists of illuminated color spaces on a monitor.

2.2 Art & Science: A Common Ground

Examining the above mentioned works closer would reveal their relationship to and dependence on science and how they might have served as forerunners to the project discussed here. It is also quite easy to imagine why a sound artist would be interested in using related ideas of kinetic art and light to create a digital tool with which sound art could be conveyed and realized in real time by a performer and how a group of computer scientists might use their abilities to assist the artist in the invention of such a tool. This tool, a *Realtime Scoring System* (RSS) was developed at the Eidgenössiche Technische Hochschule in Zurich (ETHZ) and used for the first time in a performance of *GoingPublik* in Monthey, Switzerland. In the hands of the performer, it became a creative tool with which the formation of the score and therefore the outcome from it in terms of sound could be controlled to a large extent directly by the performer's interaction with the system. Using the system also guaranteed that each performance of the work would differ from one another and in this way always providing a fresh and unique experience for the performers themselves.

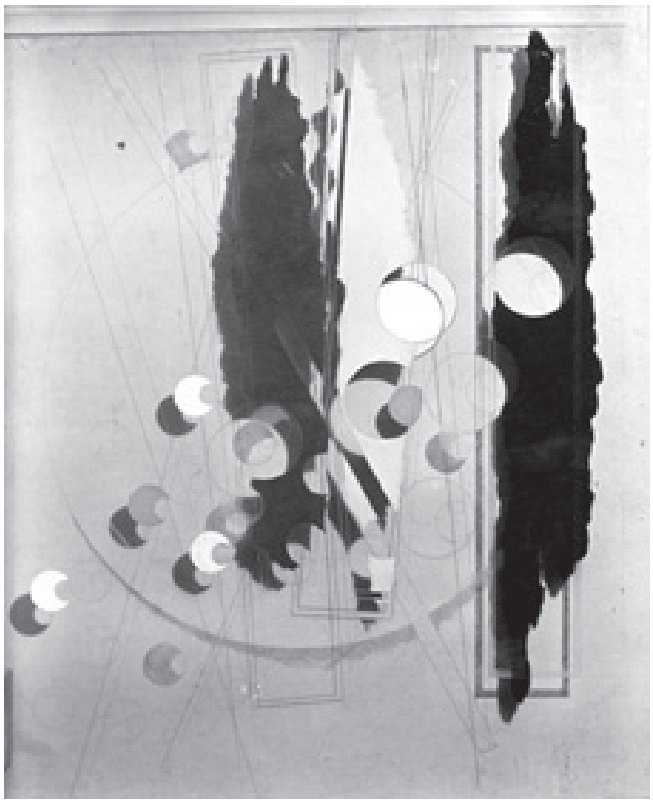

Figure 1. One of Moholy Nagy's Light Modulator studies from 1925. The final realization of the "Light-Space modulator", a Gesamtkunstwerk composed of color, light, and movement, was finally realized in 1930, after many years of preparation and with the help of an engineer and a technician. Constructed out of Plexiglas and employing kinetic movement to interact optically with a light source, any artist working today with modern tools will see that this work serves as an early metaphor for a monitor being illuminated via digital art.

2.3. A Defence Industry?

It has been said, that it is no longer possible for any professional computer scientist working behind the walls of the many institutions for computer science to avoid a direct association with technological developments related to the defence industry. Many artists today, because of their interests in the digital sciences, are compelled to take up relationships with such institutions, particularly if they should want to foster their interests in developing new creative works or tools in digital form.

The new digital artist is then placed in the same dependencies as those of the computer scientist. As the research for suitable sensor systems to be used in the *GoingPublik* slowly came to fruit, the artist gradually became aware of the reason for their development and how they are deployed in the world. Rather than covertly hide these facts, the decision was made to integrate them into the concept. Forced with the moral choice, it will interesting to watch whether the artistic community will come to the same conclusions in the future as scientists have come to in the past. Possible answers to posed questions related to technology, war and art will be presented at the end of the paper.

3. 0 CONCEPT: THE DISTRIBUTIVE ENSEMBLE

GoingPublik is a sound art project for a distributive ensemble of trombones. Sound art as opposed to music does not place emphasis on the psychological relationships between sounds, but on their independence from one another. As the American Composer, John Cage has often put it, Sound Art is an art form in which the sounds are let to come into being for themselves[7], thereby letting them be appreciated for their own qualities, whether they be pure harmonic sounds or dissonant noisy ones. Compositional quantities and qualities being then based on functions of time rather than harmonic ones, interest held by timbre and rhythmic contrasts rather than harmonic growth.

The core idea in the project is a strategy of mobility and this is accomplished employing a wearable computer system running a software based electronic scoring system as its central element. The program itself basically allows for what might be termed 'composed improvisation' which permits improvisational elements within a compositional structure. This is accomplished by electronically monitoring the performer's physical behaviour during performance. The program then responds by making suggestions to and even demands on the performer to various degrees and at various times.

Since each of the performers is equipped with the same elec-

Figure 2. A moment from the 'inside' performance of GoingPublik in Monthey, Switzerland which used a GPS simulator in software as a substitute for live satellite signals. Performers from left to right are Thierry Madiot (F), Günter Heinz (D) and Roland Dahinden (CH). The trombones were taken apart and spread across the performancee space to emphasize the effect of 'distribution', the 3d compass sensor responding to all movements that were used to assemble the instruments back together.

tronic scoring system and because the system revolves around universally shared inputs such as geographical positions obtained via satellites and sensors using the earth's magnetic field to obtain 3d compass readings, all systems have a common denominator and are thereby virtually linked. It is then possible, despite the physical distribution of the performers in space, to have a commonly shared compositional palette and, at moments of close proximity between performers, to obtain instantaneous synchronized sonic elements. Both needed for creating sonic structure within the work itself.

3.1 Electronic Scoring: A Mixed Reality Concept

The invention of a electronic score (RSS) and its implementation for the first time in the sonic art work 'GoingPublik' is the result of the artist's desire to develop a 'mixed reality' concept. The initial approach was to use images taken from the immediate environment using a live-camera and then to combine these live-images with vector based graphics via superimposition. Performers would then be able to interpret irrational, or non-musical elements such as images of natural and man-made elements like trees or street signs coming in through the camera by using the rational vector based tool of a matrix designed to force the live-image into the sonic domains of frequency and time. The tempo of reading through the matrix being dictated by a 'conduction-line' scrolling from left to right which changes tempo in relation to walking speed.

Figure 3. Albrecht Dürer's illustration of an artist using a grid system to obtain a more natural geometrical perspective. The grid system depicted here consists of a viewing device, a matrix and the object to be rendered. Notice while looking at the illustration that Dürer created it with one point perspective in order to perhaps place the viewer in a position similar to that of the artist sketching at the grid.

One is reminded here of the use of a matrix by artists in history such as the Renaissance Painter Albrecht Dürer[8] who used a framed wire grid to achieve a proper projection of what the eye was looking at from a fixed viewing point. By using such a tool, mastering geometrical perspective became a science and an exacter, more natural representation of the three-dimensional world on the two-dimensional surface was easily achieved.

In the final form of the RSS used in GoingPublik, a live image feed from a camera was no longer used, but was substituted by a limited collection of images of the surroundings stored in memory. Over these, two independently modulating vector systems were superimposed, thus providing a means to rationally interpret the irrational elements of the score. This technique proved to be easier to handle by cutting down computing time and allowed more control of what actual images could be used to yield a rich and complex collage-like score. At the same time, it became possible to pair the images between all of the performers on a common contextual basis.

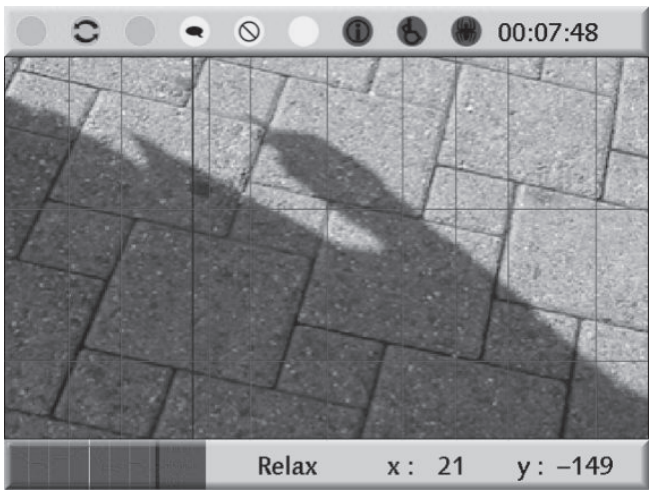

Figure 4. A screenshot of the MatrixWindow as seen by a performer in the viewing glasses. The red lines are the vertices of the matrix and are seen superimposed over the image used for west. The vertical lines are used for the time domain and the horizontal ones used for the pitch domain. The somewhat thicker blue conduction-line can be seen to the left as it moves through the matrix. Due to the tempo being 'RELAX', the line will transverse the space between any two read lines, regardless of the distance between them, at a speed of 1000 ms.

Further, the image over which the vectors form a matrix is drawn from a library of only four images, each one having been assigned to a direction and appearing in the score then in relation to the heading of the performer. Dependent on the positional reading stemming from the 3d compass sensor, the images may overlap and dependent on the reading for pitch and roll the image may appear distorted by a squewing process.

The vector systems themselves consist of lines moving on the horizontal plane and lines moving on the vertical plane, each system moving independently and both based on separate computer algorithms designed to generate and manipulate the lines in a particular way in realtime as the performers interact with the environment through body movement. So, although the mixed reality concept no longer takes place on the visual level between live-image and vector graphics, it does take place between the stored images, the vector graphics and the live-movement of the performer within the performance space. Again mixed reality: A realtime element being superimposed on and interacting with a stored element.

4.0 WHERE EFFICIENCY MATTERS

The abbreviation Q-bic[9] stands for 'belt integrated computer' system which is a compact low-power computer system designed by the Wearable Computer Lab at the ETH Zurich. The mainboard of the computer as well as it extension board are connected via flex cable and are housed in the buckle of a

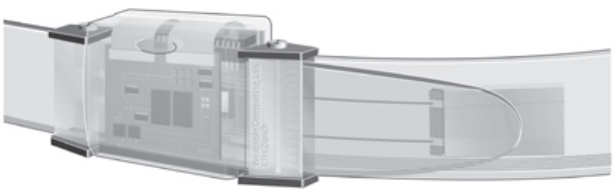

Figure 5. A transparent view of the Q-bic system. The main board (facing) consists of an X-Scale 400 MHz processor, 256 MB SDRAM, 32 MB flash Memory; the extension board, located behind the main board, consists of a bluetooth sender and receiver, 2 USB Host & Client Ports, GPIO Pins and an External Flash Slot. To the far right of the illustration, one can see the flat battery enclosed in the belt.

belt on a docking board from which all needed connection coming from the system are wired out into the belt to various points along the waist, providing a unique strategy for the connecting peripherals.

The GoingPublik Software runs on the open source system "Bluebottle"[10] that is being developed at the Institute for Computer Systems at ETH. The Bluebottle system is based on the Active Object System kernel (Aos)[11], a lean multi-processor kernel developed in the spirit of the ETH Oberon Project. It provides a runtime environment for the Active Oberon programming language[12], which directly supports active objects, objects that are tightly coupled to threads. Above the kernel a flexible collection of modules provide generic abstractions for devices and services, for example file systems, user interfaces or networking. The Aos kernel is currently implemented for Intel IA32 and StrongARM-based computers.

The simplicity of a lean system makes it an ideal platform for experimentation and development. Without unnecessarily complicated and obscure Application Program Interfaces (API), the programmer can immediately begin to productively implement the desired application programs and finish larger projects in a short and closed period of time. Type-safety and automatic memory management remove a big class of potential hard-to-find programming errors that are common in conventional systems. For the *GoingPublik* project, the Bluebottle system directly runs on the Q-bic hardware without any layers beneath. The small system size allows storing all the required images and data for the *GoingPublik* project in the system memory. The entire analysis of sensor data and the rendering of the matrix display are comfortably done with the available CPU power of the Q-bic system, thus creating an efficient and completely mobile solution.

5.0 GOOD BYE OFFICE, HELLO WORLD!

Removing the desktop from desktop computing leaves the system developer confronted with new and different problems of interfacing and the user with new skills to be mastered. The flat surface used to support traditionally interface peripherals such as a mouse and a keyboard has been removed and on account of this negation, the stationary computing paradigm has also been banished. Simply put, not only has the

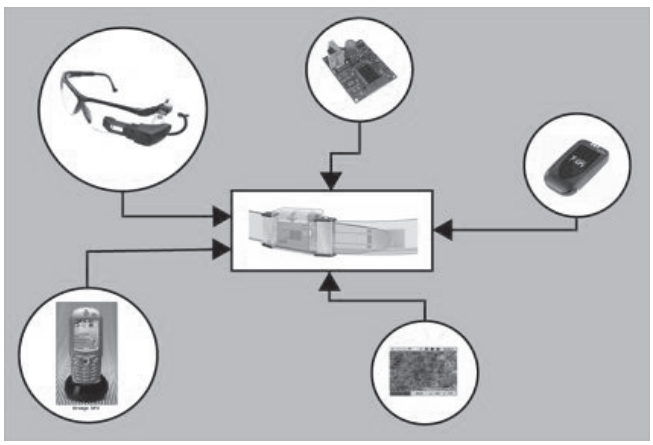

Figure 6. A diagram illustrating the hardware setup used in GoingPublik. The Q-bic system is depicted at the center. Starting from the top left and going clockwise are SV-6 display glasses from MicroOptical, the TCM-50 3d Compass Sensor from PNI Corporation, the GPS device from Socket (not used), a Screenshot of the main window of GP Software written by Thomas Frey (CH) and lastly the SPV E200 SmartPhone used for interfacing.

computer disappeared from sight through miniaturization, but the concept of 'office space' has been enlarged to include all inhabitable spaces. Due to such trends, the world is slowly becoming a 'networked living office space'.

Of course, this type of remobilization of the human being brings with it a necessary rethinking of the design and use of computer interfacing. Emphasis must automatically be placed on efficient system design, lean software, secure wireless technologies and networking and the ergonomics and ruggedness of wearability. By adding to the list, the use of conductive clothing and smart fashions in order to blend the extraordinary in to the ordinary of 'working street life', the system developer comes up with a vision (if only a glimpse) of technology for the computer user in the 21st century.

5.1 Radical methods of Approach

Having to provide a comfortable substitute for desktop space interaction has not been an easy task nor has it been completely successful. Working toward a viable system for the project *GoingPublik* has more than proved this. Although personal display systems have made much progress in providing the user with a low profile viewing system which can be used comfortably for a limited period of time in most any working environment, the user has had to adapt back to a small screen viewing area and this using only one viewing eye to do so.

The user here is being faced with a partial handicap; the system developer with what might be termed lightly as an interesting challenge. New interface designs which take these handicaps, or perhaps better put ergonomic limitations into considerations have been implemented for use in the *GoingPublik* project. They have helped the user in general to be adaptive and no longer see the situation as handicapped.

However, since wearable computing has discarded office space interfacing, the designer must begin by thinking differently and propose radical measures and not adaptive ones. The interface method in the *GoingPublik* project suggests such radical measures. Utilizing a SmartPhone equipped with a .net[13] API implemented to function as a more practical device in conjunction with wearable systems, allows the users to use the joystick of his cell phone (soon all cell phones will be smart) as a 2d mouse and the buttons as a control area sending program commands wirelessly. We are still confined to the telephone terminal design, but its use lies closer to a correct adoption of a given evil, rather than to an ergonomic abuse.

The SmartPhone's use coupled with the implementation of non text based Graphic User Interface (GUI) on the software side such as easily targeted, 'Pie-Menus[14]' and not the typical text menu buttons associated with desktop interface models, makes for much easier control of program parameters without eyestrain or cumbersome hand movements in a mobile and hectic situation such as that of the performers in *GoingPublik*. Thinking even further, an sms scripting function, that is really a 'short' one, might be implemented to control more complex settings demanded by the program running. Examples of such in *GoingPublik* would be settings used to interact with the image score library or when the coordinates of the performance space have to be designating by the performer.

6.0 MACHINE STRATEGIES FOR COMPOSITION

As stated above and repeated here for the sake of clarity, all of the performers involved in the performance of GoingPublik are equipped with a belt integrated wearable computer, a Global Point System (GPS) receiver connected to the serial port, a three dimensional digital compass communicating to the computer using wireless bluetooth[15] technology and one of two possible input devices - a SmartPhone or an airborne mouse. A high resolution head-mounted display with a small screen area of 640 x 480 pixels connects the viewer's eye to the activities of the software running on the computer.

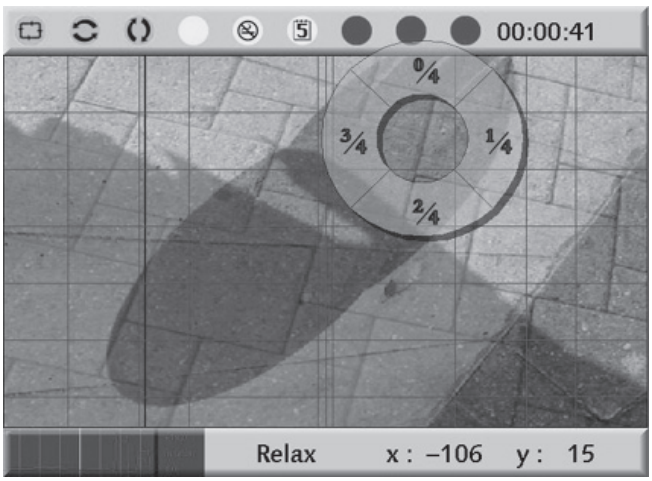

Figure 7.The 'pie-menu'. To activate the menu, the performer presses down the joystick of the Smartphone. Moving the Smartphone's joystick in any one of four directions selects one of the four options that can be chosen with the menu. Menu options can open new sub pie-menus to allow for more options. A selection sequence through a number of sub-menus results in a movement sequence that can be remembered as a gesture, making selection go easily and quickly. Note: The pie-menu depicted here is used for selecting a play position from the GPS simulator used for inside performances.

The wearable computer is the central point of the setup, because its function is to analyse the input from the sensors to calculate and render the realtime score that is presented in the head-mounted displays for interpretation by the musician. The input device is used to set the initial settings of the program and to make changes to the software during the performance if needed. For example in case of dead locking in which the performer might have to adjust the settings before joining the action again.

6.1 Sensor & Software Strategies: Lines & Images

The position of the performer determined by GPS values within the perimeter in which the performance takes place, influences the positions of the lines used to indicate the sonic domains of frequency and time. The compass heading of the musician measured in eight positions decides which of one of four images should be used for interpreting the score. Single images are rendered at the poles of the compass and the images overlap with one another outside of these positions.

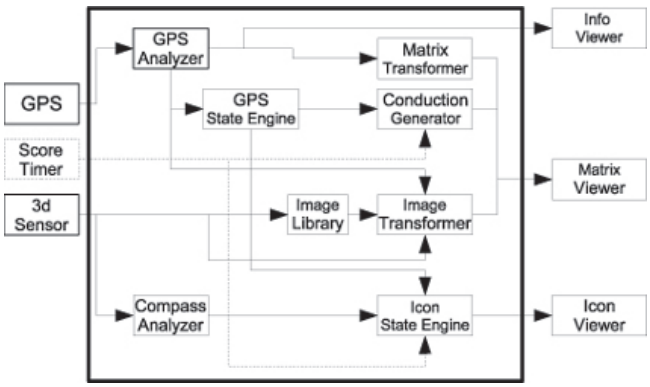

Figure 8. A schematic showing the relationships between the sensor systems and the component packages of the GP software. The elements depicted within the rectangle are the software components, the elements depicted to the left are the sensor systems and the elements depicted to the right are those drawn into screen areas of the display glasses.

Compass variables for pitch and roll determine the degree and direction of distortion of the image and the walking speed of the performer measured by GPS information resizes that image, either by enlarging it up to 200 % or reducing it back down to its original size of 100%. The image content forms the symbolic, notational base of the score. Through continuous, real time manipulation, whose degree of effect is directly controlled by the performer, new possibilities of interpretation of a consciously limited palette of compositional elements continuously emerge.

6.2 GPS Data Flow

The GPS data is first sent from the GPS sensor system to the 'GPS-Analyser' which then returns a set of normalized coordinates, an averaged speed-level and the time amount spent at that speed-level. The normalized coordinates are sent to the 'Info-Viewer' for display and to the 'Matrix-Transformer' which calculates the geometric structure of the score matrix and draws it into the 'Matrix-Viewer' for display, thus defining the rhythmic structure and the pitch range for the performer. The speed-level and time-spent values are sent to the 'GPS State-Engine' that controls a set of 'Stop-Icons' and a set of 'Go-Icons' to regulate the performer's speed and to change the tempo of the conduction-line. The speed-level is also sent to a the 'Image-Transformer' that resizes the image in relation to the speed-level.

6.3 Compass Data Flow

The compass data consists of values for heading, pitch and roll. The value for heading is first sent to the 'Image-Library' that selects an image out of a library of four. The translucent overlapping of images is also dependent on the heading value. The values for 'pitch' and 'roll' are sent to the 'Image-Transformer' that stretches the selected image in proportion to the

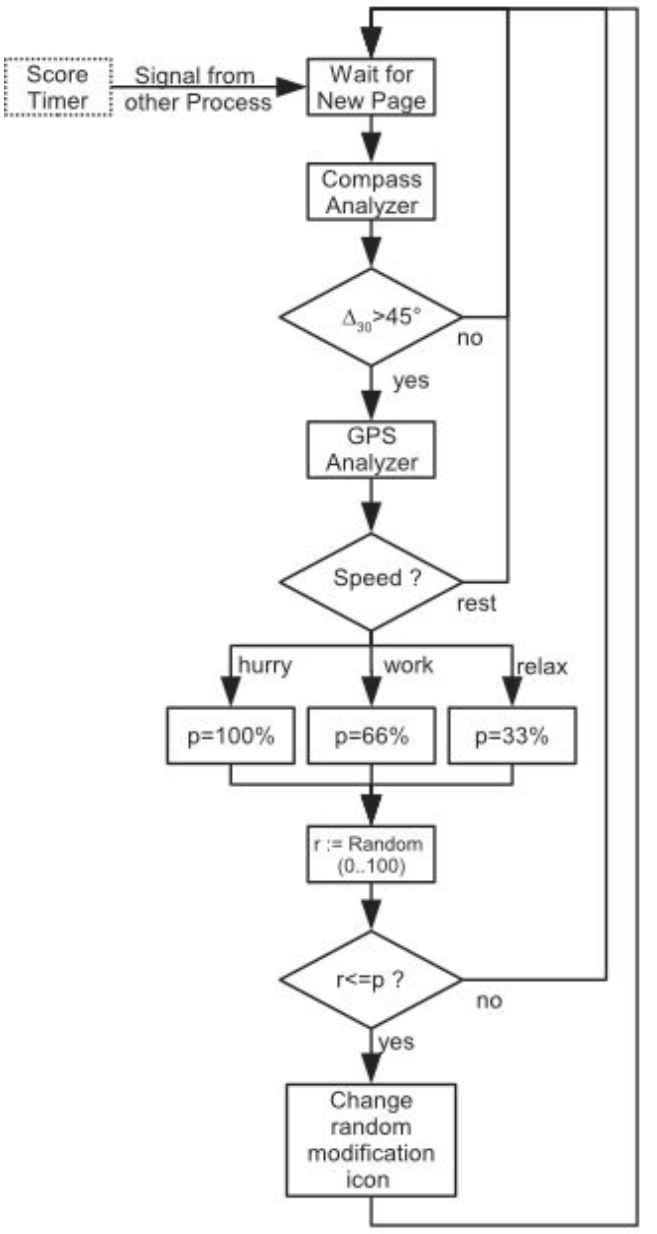

Figure 9. A flow chart showing the selection process for modification icons that takes place when the conduction line switches to a 'new page'. The 'stop' and 'go' icons are modified following more stringent rules involving the speed level within a 30 seconds sliding window, the time the speed level was held and a random component. By following the diagram from top to bottom, one can easily come to understand how a decision determined using simple probabilities.

intensity of these values. The selected image, appropriately stretched in accordance with the compass values and resized in accordance with the GPS values, finally makes its way into the 'Matrix-Viewer' for display to be interpreted by the performer in relation to the geometric structure of the superimposed matrix. The compass data is also sent to the 'Compass-Analyser' that notes heading changes over time. This information is sent as another parameter to the state engine that controls a set of 'ModIcons which determine how phrasing, or in what manner the performer should read through the score. The choice of Mod-Icons finally appears in the 'Icon-Viewer' for display. The GPS State-Engine will also determine how often or if the ModIcons will change.

6.4 Sensor & Software Strategies: Icons

Apart from the parameterization being carried out by the domain vertices of the matrix system, the RSS provides the performer with a second set of compositional elements by suggesting and even sometimes demanding certain actions of the musician. These 'hints' are in the form of three groups of icons located above the score area at the top of the screen. Depending on the musicians walking speed, the time spent doing so, and a weighted random component, two of the icon groups suggest and if ignored demand speed-ups or slow-downs and related actions to help realize these changes artistically in order to integrate the performer's environment sonically into the work.

Based on the rate of heading change, walking speed and a weighted random component, the system also suggests or demands in form of defined icons (ModIcons), how the score is to be read through by the performer. The relationship between speed to styles of interpretation has been determined in software by borrowing aesthetic concepts of laying stone paths found in Japanese gardens. By drawing such a parallel, it was possible to generate and control parameters for what might be termed 'style': These are PHRASE (the division of the material presented in the matrix into units), PATH (the form of the curve used by the performer to read through the material presented in the matrix) and PLAY (the degree of thickness in playing that the interpret should use while reading through the material presented in the matrix).

Here the movement of the eye over the image from left to right and through the matrix system is confined by the above series of phrasing rules which the performer must follow precisely. By doing so, contrapuntal differences between the performers are brought about, so that 'sonic windowing' is created through which unoccupied audio space can be guaranteed to all performers participating.

7.0 TECHNOLOGY, ART OR WAR?

Considering the origins of the sensor systems used in the GoingPublik project, one may conclude that most research and development programs bear fruit for the military and not for the museum. If the arts should play a role in the development of such technologies, such as GPS, 3d compass sensors, head up displays etc. - all of which are standard issue for today's high tech combat soldier- this role would only be to sweeten the image of the companies which produce such devices and such a role would only take the smallest percent in the finance plans of such companies.

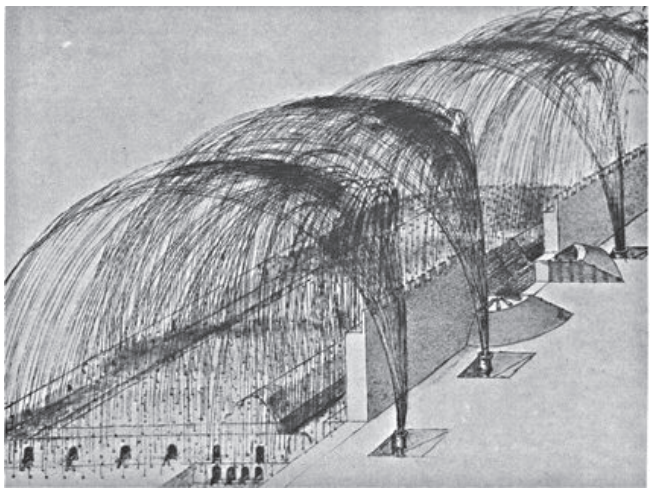

Figure 10. Many Renaissance artists such as Da Vinci and Michelangelo, whose interests extended into non-artistic matters, were not only active as painters and architects, but were often employed as engineers. Depicted in the illustration is one of Da Vinci's sketches of a project in which he applied his knowledge of mechanics to his duties as a military engineer. Judging from the illustration, Da Vinci was particularly interested in notating all possible projectile paths dependent on mortar angle. Today, we know this to be the basic idea behind modern turret guns.

Joseph Weizenbaum[16] , the famous computing pioneer and critic, believes that it is not possible to develop technology without having such development be an integral part of the defence industry. He was quite frustrated when he became aware of the "hidden agenda" at the MIT Media lab[17]. However, pragmatically seen, it doesn't really matter so much if technology is pushed with the primary intention of increasing military power and 'misused' for peaceful purposes, or when turned around, whether it was created with the primary intention of supporting civil applications and maliciously used for war. Certainly, quantum physics has not been invented with the goal of building atom bombs and no mobile phone has ever been produced with the intention of providing a killer with an instrument of detonation[18]. At last, the sheer existence of institutions like the Media lab amongst other such institutions is undoubtedly an asset to the world.

We may conclude here, that technology is an integral part of our modern society and as such, it unavoidably does have positive as well as negative consequences (or better put, consequences that we consider as positive and consequences that we consider as negative.) Technology is just one manifestation of the polarity of our earthly life and we better accept it as

a challenge. As Albert Einstein[19] predicted, warfare has reached a deadly zenith[20]. Modern wars are now fought as computer games and from an abstract distance making it easier to 'fire and forget'. GoingPublik is a work of art whose realization would not be possible without defense technologies. However, the project does pose the question to the viewer whether artistic output is just war in disguise or whether war might be art in different clothes.

8.0 CONCLUSION

GoingPublik is an example of a work employing digital and related media. At its base, digital art is no more and no less than the creative application using computers and at the heart of working with computers is teamwork. Critical points in the creative process between individuals involved occurred when any one of us crossed into another domain not their own, thus being forced to share and acquire knowledge to continue working. The project's realization stands therefore as a record of a collaborative partnership between practitioners from different backgrounds.

After we became established as a team, the focus of creativity was placed on the cognitive process of creating the tool to be used in the work itself. Once that which was intended as a goal had been reached and the tool was in use for a specific purpose, the experience of working with that tool was believed to be usurped into the collective knowledge of the performer using it. As a consequence, it was felt that any experience made using such a tool to develop creativity through cognitive processes could hardly be eradicated and that learned would manifest itself as part of the conceptual repertoire of the performer, which of course can and will be communicated further with or without the 'tool' to others through the creative act. The result thereby producing applicability in other creative domains.

The effectiveness of the tool itself was believed to stand in direct relationship to the results obtained by using it, because if new cognitive processes bring about changes in perception, then theses changes can then be measured in the degree in which the artist has discarded, at least in part, his or her general tendency in style, content or method. He or she being coaxed by the tool to bring about something new and outside of their own 'beaten path'.

After the team had accomplished the task of creating the tool and not until the performance of *GoingPublik* was on the gender, did it become apparent to the artist that the work was over. In simple terms, it was the path taken and not the goal reached which seemed the most important aspect of the work and is the single most aspect that was appreciated and will be remembered by all.

The shortest poem in the world stems from the boxer Mohammed Ali[21]. It reads "ME:WE". I believe that collaborative work between scientists in general is always has always been 'WE', regardless of who has taken the privilege to take credit for work done. With artists or with artists in collaboration with scientists, the artists always seems reluctant to begin with the 'ME', but as time goes on the artists realizes, either through a lack of knowledge, time or finances, that he or she can not accomplish the task as an isolated figure. The 'WE' of the project slowly becomes apparent and the 'MINE' of the artist becomes the 'OURS' of the world.

This part of the paper has served its purpose in documenting the accounts of the practices of those individuals as well as well letting the reader reflective over the collective practice of the collaboration.

From the technical point of view, the project showed again how the superiority of lean runtime systems stands over more complex heavy weight systems like Linux when it comes to adaptability and flexibility. It was possible to port the required kernel and IO functionality for the Bluebottle system onto the new wearable Q-bic computer within less than one programmer month of work (Bluebottle Portation). The same IO support level is still a 'work in progress' for the Linux system. The GUI framework of the Bluebottle system could be easily extended to support Pie-Menus as an interaction facility on the wearable computer.

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10. REFERENCES

[1] Clay, Art 2004: *Interview with Prof. Dr. Jürg Gutknecht,* in: Programmheft Tonkünstlerfest Musique et Environment STV Lausanne, Switzerland, Page 61.

[2] ibid.

[3] Frey, Thomas 2003: *Architectural Aspects of a Thread-Safe Graphical Component System Based on Aos*, Lecture Notes in Computer Science 2789, Springer

[4] Moholy-Nagy, László (1895-1946) Hungarian Painter Photographer and Film make. Moholy-Nagy believed that the reality of 20th century was the invention, construction and maintenance of machines and that machines were to replaced the transcendental spiritualism of past eras.. To be a user of machines is to be of the spirit of a technology based century.

[5] Duchamp, Marcel (1887-1968) French Painter, sculptor, and author. He was associated with Cubism, Dadaism and Surrealism, though he avoided any alliances. Duchamp's work is characterized by humour, a wide variety of media, and its incessant probing of the boundaries of art. His legacy includes the insight that art can be about ideas instead of worldly things, a revolutionary notion that would resonate with later generations of artists under the term Concept Art.

[6] John Cage (1912 - 1992) American composer and writer. Cage is best known for his notorious piece for piano solo entitled *4'33"* which consists of a period of silence observed by the performer in order to make the listeners aware of beauty of ambient sounds around them. He was an the first composer to adapt chance to composing music (aleatoric music), one of the first to extend traditional instruments via preparations and electronic music pioneer.

[7] Cage, John 1939: *Silence, Lectures and Writings* . Wesleyan University Press, Published by University Press of New England, Hannover, New Hampshire, Page 10.

[8] Albrecht Dürer (1471-1528) German painter, wood carver and engraver. He is best known for his woodcuts in series, including the *Apocalypse* (1498), two series on the crucifixion of Christ, the *Great Passion* (1498-1510) and the *Little Passion* (1510-11) as well as many of his individual prints, such as *Knight, Death, and the Devil* (1513) and *Melancholia I* (1514).

[9] O.Amft, M.Lauffer, S.Ossevoort, F.Macaluso, P.Lukowicz, G.Tröster 2004: *Design of the QBIC wearable computing platform,* Proceedings of the 15th IEEE International Conference on Application-specific Systems, Architectures and Processors. Galveston, Texas.

[10] Zeller, Emil 2004: *Bluebottle on Wearable Devices - QBIC Belt Integrated Computer*, Poster *session*, IOM04 International Oberon Meeting, Basel University, Basel, Switzerland.

[11] Muller, Pieter 2002: *The Active Object System - Design and Multiprocessor Implementation.*PhD thesis, Institut für Computersysteme, ETH Zürich, 2002.
Egger, Bernard 2001: *Development of an Aos Operating System for the DNARD Network Computer*, Diploma thesis, Department of Computer Science, ETH Zürich, Switzerland.

[12]Reali, Patrik 2003: *Using Oberon's Active Objects for Language Interoperability and Compilation*.PhD thesis, Institut fürComputersysteme, ETH Zürich, 2003.

[13] A high level programming language from MicroSoft Corporation used in many mobile devices.

[14] J.Callahan, D.Hopkins, M.Weiser, B.Shneiderman 1998: *An Empirical Comparison of Pie versus Linear Menus,* In Proceedings of ACM CHI'88 Conference on Human Factors in Computing Systems

[15] A secure wireless, low-power communications protocol.

[16] Joseph Weizenbaum (born 1923) Professor emeritus of computer science at MIT. In 1966 he wrote the program ELIZA which demonstrated natural language processing by engaging humans into a conversation resembling that with an empathic psychologist. He is also one of the leading critics on the implications of Artificial Intelligence. His influential 1976 book *Computer power and human reason* displays his ambivalence towards computer technology and lays out his case: while Artificial Intelligence may be possible, we should never allow computers to make important decisions because computers will always lack human qualities such as compassion and wisdom.

[17] Weizenbaum, Joseph 1976: Computer Power and Human Reason, San Francisco, CA: W. H. Freeman Page nn.

[18] The train bombing in Madrid by Terrorist in March, 2004 was carried out using remote detonation via handy.

[19] Einstein, Albert. (1879-1955) was a physicist and mathematician who proposed the theory of relativity. He also made major contributions to the development of quantum mechanics, statistical mechanics and cosmology, and is generally regarded as the most important physicist of the 20th century. He was awarded the 1921 Nobel Prize for Physics for his explanation of the photoelectric effect and "for his services to Theoretical Physics".

[20] Einstein, Albert. *Essays*. Page nn.

[21]Muhammad Ali (b. Cassius Marcellus Clay Jr., (born 1942) American boxer. Renowned the world over for his boxing and political activism, he quickly became famous for his unorthodox style, his spectacular results, and his tireless self-promotion. He made a name for himself as the "Louisville Lip" by composing poems predicting in which round he would knock his opponent out. In 1966, he refused to serve in the American army in the Vietnam War as a conscientious objector, famously saying that he "got nothing against no Viet Cong. No Vietnamese ever called me a nigger." He was stripped of his championship title and his license to box, and sentenced to five years in prison.