教育部人文教育革新中綱計畫

人文數位教學計畫

互動式多媒體設計

期 末 報 告

補助單位：教育部

指導單位：人文數位教學計畫辦公室

執行單位：國立臺北藝術大學科技藝術研究所

計畫主持人：許素朱

執行期程：98/2/1~98/7/31

2009 年 7 月 30 日

目次

一、 課程內容

1. 核心理念

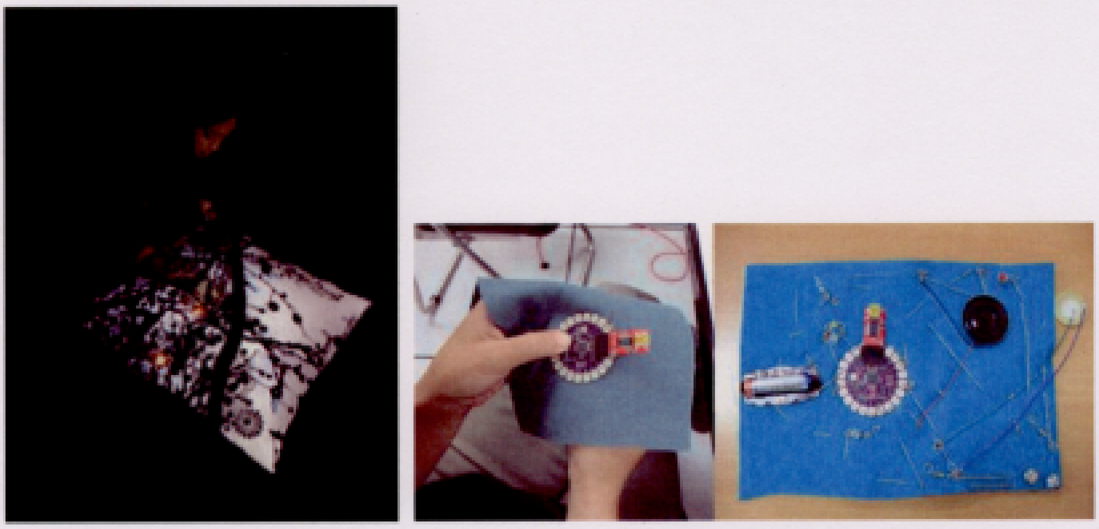
互動式數位藝術已是二十一世紀數位藝術創作的主要型式，各種互動式多媒體運用更是不勝枚舉。「互動式多媒體設計」課程，是門介紹互動式多媒體理論、實務兼具的課程，而且以數位典藏為創意內容之基礎讓學生修習與參與執行「互動式數位典藏數位創作」。

本人過去在台灣致力提倡「未來博物館(Future Museum)」概念，即把互動式數位藝術融入數位文化內容，使典藏內容能有活化的展示方式。此可提高博物館的競爭性，更可刺激文化創意產業的產生。許教授執行了兩年的「DIGIart @eTaiwan --文化內容數位媒體藝術創意加值」計畫，製作了多件頗受歡迎的互動式數位藝術作品， 2006 年 10 月於台北藝術大學關渡藝術美術館「2006 台北科技藝術展」展出，成果已受國內外注意，也獲得許多媒體報導。過去兩年也把計畫成果結合本課程，作人才培育工作。

從「線上虛擬互動多媒體設計」到結合空間「互動式情境感知多媒體設計」是本課程教導學生學習的重點。台灣甚至國際上，都鮮少有相關教材供教師使用。本人過去曾執行多項國家型數位典藏與數位創作計畫，包括數位藝術、互動式表演藝術、知識管理、數位典藏、數位創意學習、智慧型生活創意空間、...等。本人特別把過去執行計畫所累積之成果與經驗，特別花許多時間親自編寫教材，透過課程培育更多數位創作與數位典藏加值應用製作的人才，而設計「互動式多媒體設計」課程。

本學年度茲因配合台北藝術大學科技藝術研究所課程調整，「互動式多媒體設計」課程更名為「互動藝術基本概念與設計」。為維持原先申請補助之目標，課程內容特別規劃有：(1) 課程除加強互動設計基本概念，乃強調如何運用科技與藝術來探索人與人、人與藝術、人與科技、人與社會、人與自然、...等間的一種未來派的「智慧」創意互動關係；(2)本課程尚結合國科會計畫「ZEN - 〝輕安一心〞 創意禪修空間研究」，將法鼓佛教學院之典藏做「互動式情境感知多媒體設計」，讓同學能參與數位典藏創意應用。

圖：「ZEN - 〝輕安一心〞創意禪修空間研究」計畫中的禪修室、禪修道之規劃



圖：以<u>文化創意產業</u>爲出發點，之「穿戴式互動多媒體設計」規劃

2. 課程目標

「互動式多媒體設計」課程，是門介紹互動式多媒體理論、實務兼具的課程，而且以數位典藏爲創意內容之基礎讓學生修習與參與執行「互動式數位典藏數位創作」。

課程目標：

a. 培養學生具有互動式數位藝術基本概念之認知。

b. 培養學生具備國際互動數位藝術賞析能力。

c. 培養學生學習互動介面技術之操作，進而參與專題計畫把數位典藏內容設計成互動式數位藝術作品或互動式創意學習。

d. 課程亦重視學生在數位藝術之理論學養，透過小組討論學生必須閱讀與探討互動式藝術與科技之相關議題，並作小組報告。

e. 鼓勵學生把學習成果作學術發表或公開展覽。

3. 內容摘要

A. 開設課程摘要表

課程名稱	授課老師數		修課學生數		教學助理人數	
	男	女	男	女	男	女
互動式多媒體設 Interactive Multimedia Design	0	1	10 (2位旁聽)	4 (2位旁聽)	2	1

B. 舉辦之學術活動

活動名稱	參與人次
1.許素朱教授獲邀參加經濟部舉辦之「展示科技研究開發先期計畫」座談會，分享討論國內外互動展示科技之未來趨勢	座談會約有 30 人參與。(2009.3.10)
2. 許素朱教授獲邀參加研考會「願景 2020 世界咖啡館 Vision 2020 World Caf」，針對互動藝術在創意產業應用作經驗交流與分享	圓桌會議約有 360 人參與。(2009.4.12)
3. 許素朱老師與學生作品發表於「2009 年資訊科技國際研討會(2009 AIT)」	〈iFurniture:無線感測網路在群體交流互動傢俱應用〉論文發表，約有 180 人參與。(2009.04.24)
4. 許素朱教授獲邀至台大智慧生活科技整合與創新中心演講「ZEN - 〝輕安一心〞創意禪修空間研究」之互動科技藝術之創意規劃，以及如何配合本課程作實務執行	座談會約有 40 人參與。(2009.4.30)

二、 執行成果摘要

1. 開設課程

課程名稱：互動式多媒體設計 (Interactive Multimedia Design)

學分數：3 學分

上課時間：週四 9:30AM~12:30PM

課程網址：http://techart.tnua.eud.tw/~suchu/media

2. 每週主題概要

研究所 上課時間與課程內容		
日期	概念與作品介紹	製作與設計學習 / Group Discussion
02/26	課程介紹	
03/05	互動數位藝術基本概念 - 數位藝術三大要素、四個基本特色	ARS + SIGGRAPH + ISEA 介紹
03/12	資訊互動設計、典範觀者、創意動機	Flash 互動設計基本介紹 - Graphics, Symbol,Instance, Dynamic text
03/19	無形(Invisibility)未來 & Ambient Intelligence	Flash 互動設計基本介紹 - Timeline, Animation
03/26	作品介紹：數位藝術經典作品	Flash Basic Action Script-基礎概念
04/02	◎ 數位文化典藏計畫研究 （傳統文化週）	
04/09	◎ 「ZEN - 〝輕安一心〞創意禪修空間研究」計畫 （禪修室、禪修道）	Flash Basic Action Script （物件偵測) - 鍵盤控制、讀取檔案
04/16	作品介紹：SIGGRAPH 互動式作品 (2001~2007)	介面介紹：外接式ＵＳＢ數字鍵盤、滑鼠運用 RFID、觸控螢幕技術運用
04/23	◎ Homework-01 數位典藏互動式創意內容設計：敦煌壁畫互動走道學習牆設計	
04/30	作品介紹：ARS、ISEA 互動式作品	互動概念發源地 (Exploratorium)介紹
05/07	◎ Homework-02 (自然互動情境實驗操作)	
05/14	**Ambient Intelligence**、互動藝術無形智慧裝置等介紹	操作：介紹 **LiliPad Arduino** 基本操作
05/21	作品解析： DIGIart@eTaiwan、 eLife 計畫、作品裝置經驗談 -- 十猿圖、放大鏡看文物、清明上河圖、eBar、iBoard、慾望化身、...	
05/28	※ 端午節	
06/04	操作：**LED**，喇叭，水銀開關與帽子或衣服結合範例實做	
06/11	操作：光敏電阻，紅外線，蜂鳴片與帽子或衣服結合範例實做	

06/18	◎ 報告：互動藝術文獻報告
06/25	◎ Homework-03：穿戴式互動多媒體設計

3. 參考書目或指定閱讀

- Digital Art, Christiane Paul, Thames & Hudson world of art.
- Art of the Electronic Age, F Popper, New York: Thames and Hudson, 1993.
- New Media in Late 20th-Century Art, M Rush, New York: Thames & Hudson, 1999.
- ART@SCIENCE by Christa Sommerer & Laurent Mignonneau (Springer Wien NewYork)
- Manovich, L. (2000). The Language of New Media. Cambridge, MA: MIT Press.
- Hansen, Mark B.N. (2004). New Philosophy for New Media. Cambridge, MA: MIT Press.

4. 修課人數

- 科技藝術研究所一年級(10 人) 修課：

  石政哲、丁建中、程信傑、林紘立、張淑雅、周士斌、陳惟瑜、王世邦、莊景富、吳其育

- 科技藝術研究所二年級(2 人)旁聽：

  許聖珈、陳信佑

- 藝術與科技中心助理(2 人)旁聽：

  林雅芳、黃裕雄

5. 成績評量方式

※作業主要分成兩種：

(1) 小組討論與報告 Group Discussion：2 人一組學期中針對過去修課同學所做作品做「承先啓後」之解析討論報告；另外尚須閱讀國際「互動藝術」相關文獻做「國際視野」之解析討論報告。

每組同學需自行分工，討論的角色需含有 Facilitator、Summarizer、Keyword、background、connector 等內容之報告。

・Facilitator：主持人負責小組討論的進行、氣氛營運、提問

・Summarizer ：負責 study 的文章或作品之結論報告

・Keyword：負責 study 的文章或作品之關鍵字定義、重要性說明

・Background Investigator：負責 study 的文章或作品的背景探索說明(含作者背景、作品背後動機與影響）

・Connector：負責 study 的文章或作品的作品延伸影響議題探討、相關類似作品介紹、影響力、…

(2) 實作(設計)：

a. 結合國科會計畫「ZEN - 〝輕安一心〞創意禪修空間研究」，以法鼓佛教學院「敦煌連環故事壁畫」數位典藏內容，讓所有同學分工一起參與執行「敦煌壁畫互動走道學習牆」系統專題製作。

b. 2 人一組，需提案報告並實際設計出兩項作業：自然互動情境實驗、穿戴式互動多媒體設計。

項次	研究所作業名稱	百分比
1	Homework (1)(小組)：數位典藏互動式創意內容設計	30%
2	Homework (2)(小組)：自然互動情境實驗	15%
3	報告(小組)： (1)作品評析報告 (2)文獻閱讀報告	25%
4	Homework(3)(小組)：穿戴式互動多媒體設計	30%

6. 人員與相關活動

助理羅雅嵐：協助本課程受補助經費之核銷，以及相關事務工作。

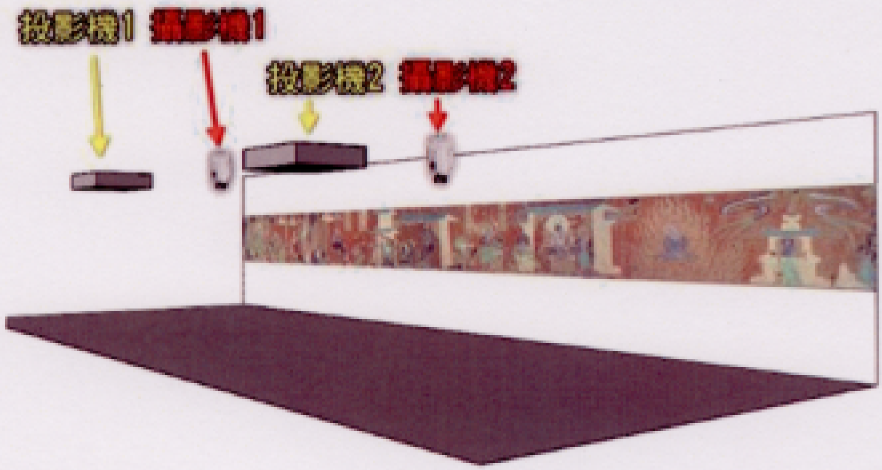
助理陳家文：協助本課程「穿戴式互動多媒體」單元之資料蒐集與「LilyPad 感測器」講義編撰。

助理劉士達：協助本課程「LilyPad 感測器」單晶片授課。

7. 設備使用

本學期受補助購買設備，有投影機、互動設計電子零件＆互動設計耗材：

(1) 投影機：本學期購買一部之投影機結合過去的投影機共兩部，運用在「敦煌壁畫互動走道學習牆」系統專題製作。



(2) 互動設計電子零件＆互動設計耗材：主要應用在「穿戴式互動多媒體」設計作業上，包含 LilyPad Arduino 板、LilyPad 3 軸加速、LilyPad 按鈕、LilyPad 水銀電池模組、LilyPad usb 傳輸模組、Xbee 模組 1.0、Arduino xbee 外掛板、Xbee 模組 Serial 板、Funnel Xbee 控制板、…等。

8. 總體成效

(1) 課程完成預定之授課單元與執行理想。課程完成：

a. 未來博物館範例解析（數位典藏結合互動式數位藝術之創意展示）。

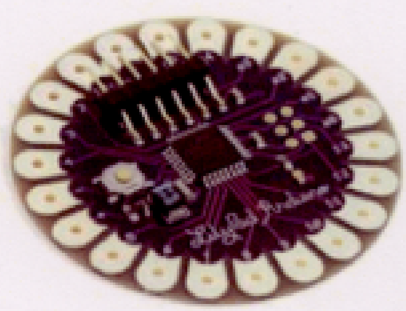
b. 互動式數位藝術基本概念介紹：數位藝術創作三大要素、互動多媒體設計六大要素、資訊互動設計、典範觀者、無形未來與環境智能 Ambient Intelligence 等概念介紹。

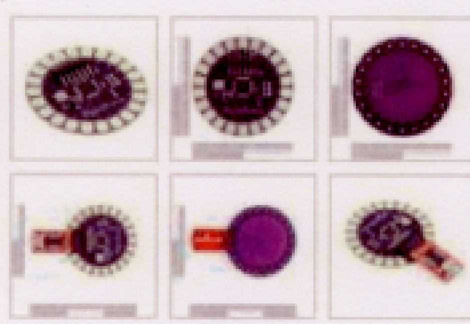
c. 國際互動藝術發展趨勢介紹、國際互動數位藝術賞析：ACM Siggraph Emerging Technology / Art Gallery、ARS、ISEA 等國際研討會與展覽互動藝術作品介紹。

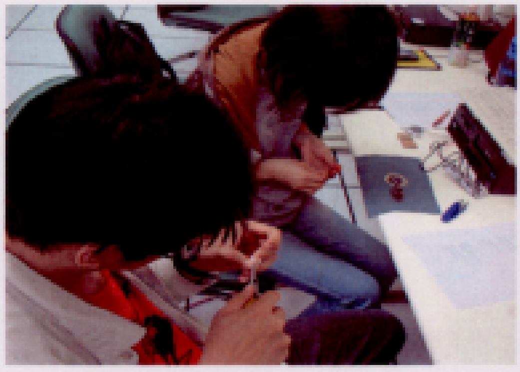
d. 互動介面技術種類介紹：觸控互動介面、RFID 互動介面、影子互動介面、感知互動介面、AR/VR 互動介面、WSN 無線感測網路介面、綜合 Hybrid 互動介面等。

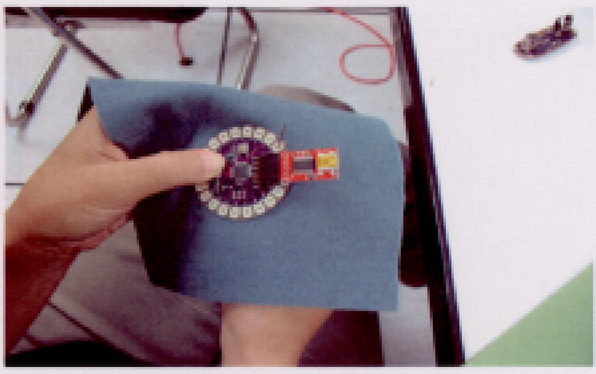
e. 週邊介面操作使用：鍵盤、滑鼠、紅外線數位攝影機、OpenCV、Flash Server 等。

f. 以文化創意產業爲出發點，讓學生運用 LilyPad 感測器+導電縫線執行「穿戴式互動多媒體」設計。









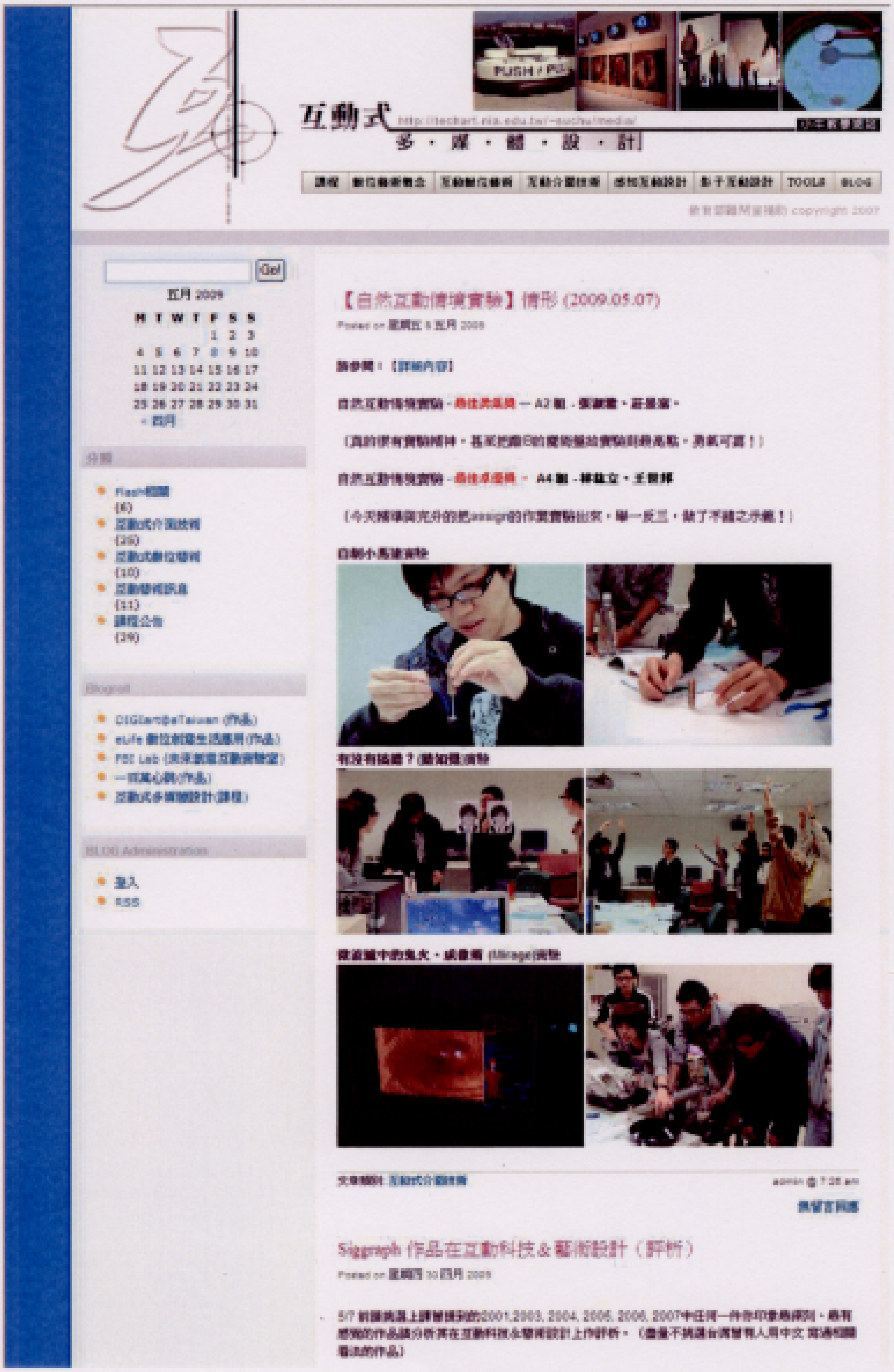
圖：學生課堂中學習 LilyPad 感測器與導電縫線之實際操作與設計

(2) 結合國科會「ZEN -〝輕安一心〞創意禪修空間研究」計畫，介紹敦煌的連環故事畫中的第 257 窟的「沙彌守戒自殺緣品」典藏內容，並執行「敦煌壁畫互動走道學習牆」系統專題製作。

圖：「ZEN -〝輕安一心〞創意禪修空間研究」計畫網站

(3) web 2.0 Blog 運用：課程除了線上教材外，尚採用 web 2.0 的 Blog 雙向交流方式，增加課程互動學習與討論之效。

http://techart.tnua.edu.tw/~suchu/media/blog/



(4) 過去專題計畫作品現場觀摩與解析：

圖：作品裝置分享：名畫大發現—清明上河圖

圖：講解運用三臺投影機接圖的構造與原理

圖：十猿圖在天花板不能釘的環境，如何善用工具架設投影機

圖：解說十猿圖設計上的細節，與互動時特別需注意的細節

圖：學生參觀"eBar-互動式吧檯"的裝置與互動設計

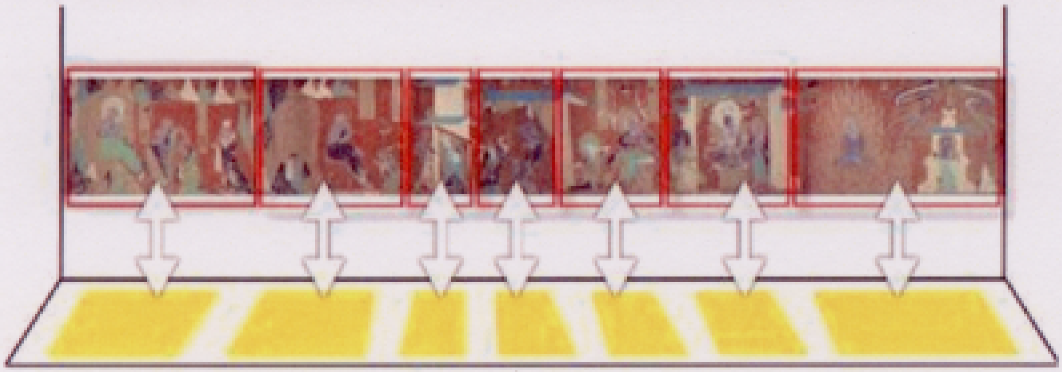
三、 課程成果介紹

1. Homework (1) - 專題製作成果：

關於數位典藏互動式創意內容設計，主要讓學生參與課程「法鼓山的 ZEN 計畫，數位內容選取敦煌的連環故事畫中的第 257 窟的「沙彌守戒自殺緣品」爲互動學習走道」專題製作。

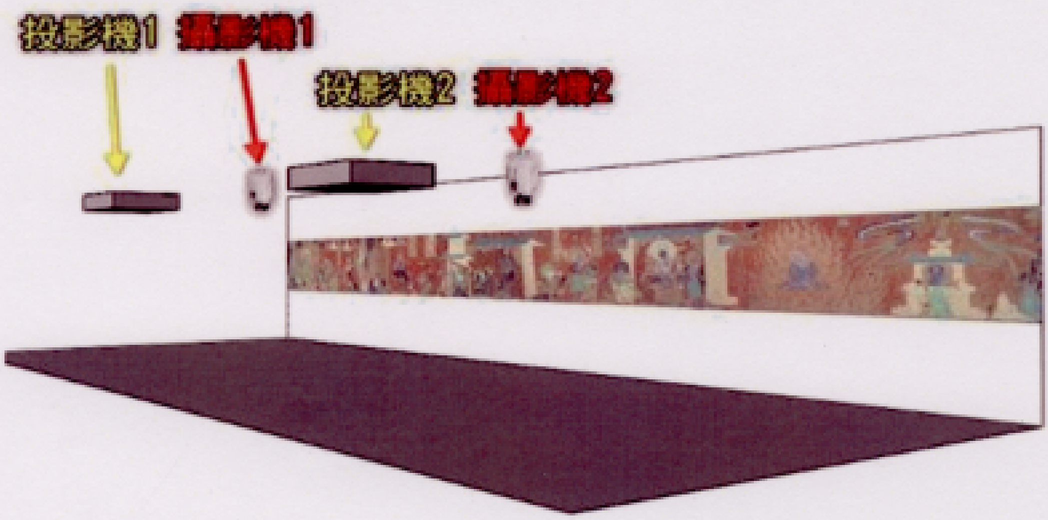
a. 本系統主要配合法鼓山「玄奘西域行數位博物館」計畫的典藏內容，我們選取敦煌的連環故事畫中的第 257 窟的「沙彌守戒自殺緣品」爲互動學習走道學習牆的創意內容，並開發姿勢辨識影像偵測互動介面，及設計互動創意學習腳本。配合計畫由學生作專題實作實習。

b.「沙彌守戒自殺緣品」含有七則連環故事，因此把壁畫切爲七個對應範圍。



c. 參與者在學習走道，需配合連環壁畫之方向性，需順向學習。定位後，連環壁畫將會有對應的解說。逆向學習，則會有方向學習錯誤之提醒。

d. 「敦煌壁畫互動走道學習牆」系統裝置示意圖，由兩部投影機作影像接圖，兩個紅外線攝影機作參與者位置偵測。



2. Homework (2) - 自然互動情境實驗：

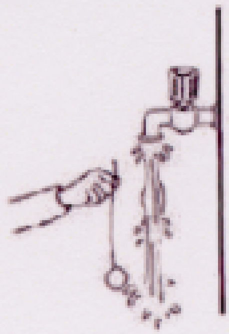
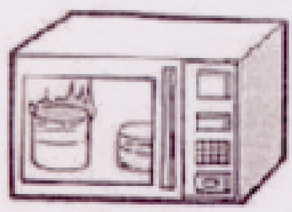
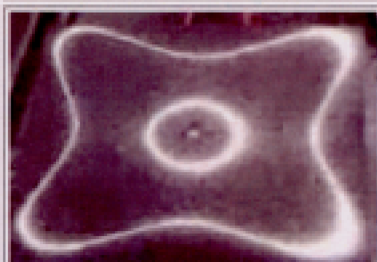
A1 組 - 丁建中、程信傑 - (1)Magic Bubble、(2)乒乓求爬瀑布

A2 組 - 張淑雅、莊景富 - (1)成像術 (Mirage)、(2)微波爐中的鬼火

A3 組 - 石政哲、吳其育 - (1)可見的聲音、(2)瞬間壓扁鋁罐

A4 組 - 林紘立、王世邦 - (1)有沒有搞錯？(錯知覺)、(2)自製小馬達

A5 組 - 陳惟瑜、周士斌 - (1)神奇的磁力、(2)鐵釘變銀釘

	項目	名稱	組別
01	 **Magic Bubble**	 乒乓求爬瀑布	A1 組 丁建中 程信傑
02	 **成像術 (Mirage)**	 微波爐中的鬼火	A2 組 張淑雅 莊景富
03	 **可見的聲音**	 瞬間壓扁鋁罐	A3 組 石政哲 吳其育

【自然互動情境實驗】(2009.05.07) 成果

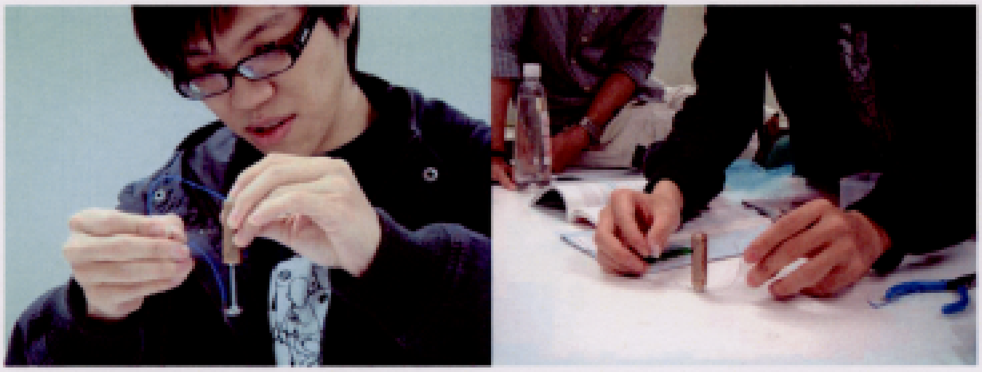
自然互動情境實驗 - 最佳勇氣獎 — A2 組 - 張淑雅、莊景富。

（真的很有實驗精神，甚至把酷 B 的魔術盤給實驗到最高點，勇氣可嘉！）

自然互動情境實驗 - 最佳卓優獎 － A4 組 - 林紘立、王世邦

（今天精準與充分的把 assign 的作業實驗出來，舉一反三，做了不錯之示範！）

自制小馬達實驗

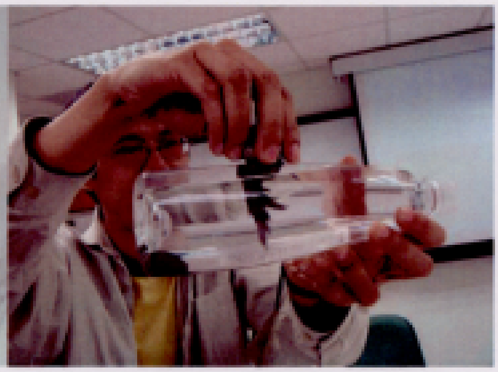


有沒有搞錯？(錯知覺)實驗

Magic Bubble、乒乓求爬瀑布 實驗

微波爐中的鬼火、成像術 (Mirage)實驗

神奇的磁力實驗



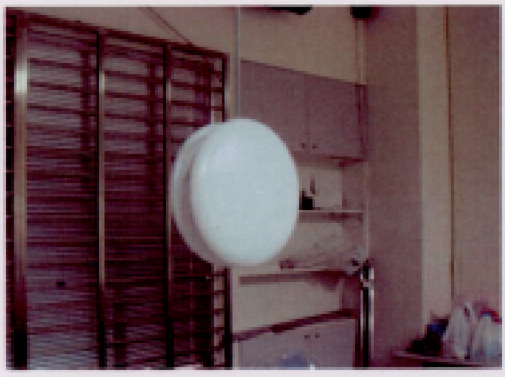
3. Homework(3 穿戴式互動多媒體設計：

我們主要以文化創意產業爲出發點，讓學生運用 LilyPad 感測器+導電縫線執行「穿戴式互動多媒體」的〝fashion & technology〞設計。學生分組完成作業成果：

(1) 向右轉・向左轉

可隨氣候、左右轉，而有不同 led 發光的「向右轉・向左轉」帽子！

(2) 盪盪盤

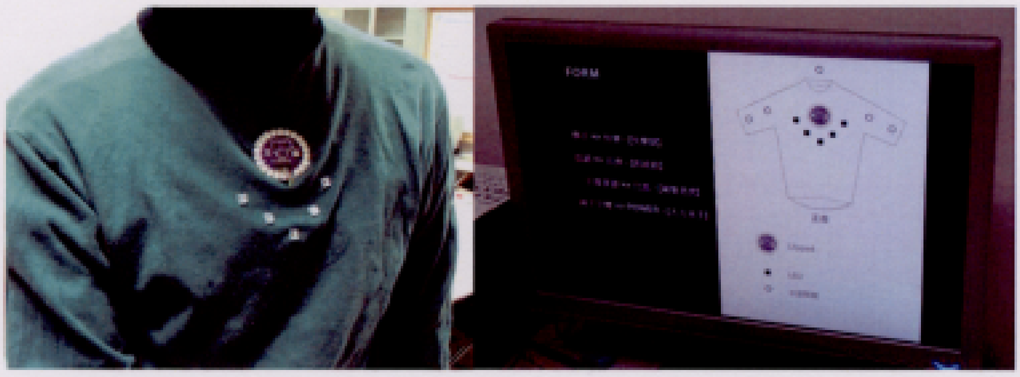


可隨擺盪、愉悅、聲音不同，而有不同發光之「盪盪盤」！

(3) 友誼智慧衣

可隨人體不同接觸而有不同音樂與發光之「友誼智慧衣」！

(4) 心音衣



可隨人的不同心情與動作而有不同發光圖案之「心音衣」！

4. **報告(小組)：**

學生報告均需準備 PPT 親自解說所解析或閱讀的作品與文獻之內容、背景、關鍵字、心得與啓發。

(1) 過去同學作品評析報告：藉由前屆學生作品<u>解析</u>，期達<u>承先啓後</u>之學習。

01. 張淑雅：劉瀚之< 睡眠者的牆>

02. 陳惟瑜：劉中興< 自彼方來>

03. 林紘立：吳宗翰< 墨池—使用水墨畫風格成像技術>

04. 丁建中：陳志建< 換日線>

05. 程信傑：王雅慧<影像中的時空滑移-另一種現實>

06. 吳其育：姚仲涵<竄流座標>

07. 王世邦：郭忠坤<用餐時刻>

08. 周士斌：劉士達<無線感測網路在互動群體交流之應用與研究>

09. 石政哲：張耿豪< 殺手藍調 >

10. 莊景富：黃子青<「考」之操縱者>

(2) 文獻閱讀報告：藉由<u>文獻閱讀探討報告</u>，期達<u>國際趨勢</u>與<u>視野</u>之學習。各小組自老師指定的文獻（含國際互動藝術作品）作解析報告。

A1 組 - A Network of Mobile and Stationary Computer_Systems

A2 組 － DeviceArt

A3 組 - Education for Interaction

A4 組 - Video Game that Uses Skin Contact as Controller Input

A5 組 - Bird Watching: An Introduction to Amateur Satellite Spotting

四、 經費運用情形

1. 學校配合款（自籌款）運用情形

本課程因應課程內容需要，購置資料還原卡、KVM 電腦切換器、滑鼠一批，本校自籌款補助金額爲：19,882 元。

由於教學課程中安裝各式互動控制軟體、感應裝置，爲維持課程學生使用之電腦系統穩定與安全，故補助購置資料還原卡，另外，補助購置 KVM 電腦切換器供學生實做測試以及作品呈現所需多螢幕互動多媒體影像控制，並且透過拆解滑鼠內部零件來製作 3D 旋轉控制器。

2. 經費運用情形一覽表

如附表一。

五、 課程目標達成情況

達成情形＆自我評估：

1. 培養學生具有互動式數位藝術基本概念之認知：已達成。但「數位藝術」仍是個進形式，隨時都還會有新理論、新評析、新作品，課程已帶領同學如何做新知探索。
2. 培養學生具備國際互動數位藝術賞析能力：課程已介紹國際在互動藝術與互動科技近五年之作品，且已介紹同學瞭解國際相關研究單位。
3. 數位典藏內容數位創意加值：課程已透過專題方式由教師規劃並帶領同學一起瞭解數位典藏之重要，以及如何運用互動式數位藝術與媒體技術，創意加值成「互動創意學習」之應用方式。
4. 培養學生學習互動介面技術之操作：以文化創意產業爲出發點，完成讓學生運用 LilyPad 感測器+導電縫線來執行「穿戴式互動多媒體」設計。
5. 課程重視學生在數位藝術之理論學養，透過小組討論學生必須閱讀與探討互動式藝術與科技之相關議題，目前已完成兩次小組報告。

六、 面臨問題與因應措施

1. 本課程著重在互動藝術之理論與概念介紹、國際作品解析、互動介面技術介紹以及實際操作設計，對授課教師而言蠻辛苦的。每週三小時的上課，幾乎得花了 10 倍時間準備。許多國際新知與技術需隨時注意，甚至本人需花時間與經費親自參加國外科技藝術相關研討會與藝術節活動並查詢相關文獻。不過，雖辛苦但收穫不小。

2. 對藝術背景學生而言，在互動技術上學習仍有門檻問題。本課程內容規劃頗多，學生要在一學期學習概念與介面技術之程式設計，實有點困難。未來將把可成內容拆成兩門課，讓同學能從基礎到進階學習。

3. 本課程是在下學期授課，常遭遇「教育部人文教育革新中綱計畫 - 人文數位教學計畫」之期末成果口頭報告執行上未臻完美，原因是北藝最後一週在六月底，但在六月中便需把期末報告之 PPT 送繳，許多學生期末作業無法放入。本課程第三年將不再申請教育部補助。

七、 後續課程構想

本課程未來仍會在台北藝術大學科技藝術研究所繼續開課，但未來將配合科技藝術研究所課程調整，「互動式多媒體設計」課程更名為「互動藝術基本概念與設計」，另外在科技藝術研究所將另開對應的進階課程。

八、 結論與建議

感謝過去兩年承蒙「教育部人文教育革新中綱計畫 - 人文數位教學計畫」補助得以順利進行課程之理想規劃與教學，課程成果未來會繼續朝文化創意產業之相關研究與推廣努力，培養台灣更多相關人才。

九、附錄（務必含教學參考資料、教學意見調查、數位化成果產出清單等。）

1. 教學意見表

國立臺北藝術大學97學年度第2學期課程評鑑個別科目統計表

開課單位： 科藝所　　課程代號： 27517　　科目名稱： 互動藝術概論與設計

授課老師： 許素朱　　修課人數： 10 人　受測人數： 10 人　回收率： 100.00 %

一、學生學習情況

題號	題目	選項1	選項2	選項3	選項4	選項5	1	%	2	%	3	%	4	%	5	%
01	我修讀這門課的性質	必修	選修	旁聽			8	80	2	20	0	0	0	0	0	0
02	我課餘每週花費於這門課的時間	6小時以上	4-6小時	2-4小時	2小時以下	沒有準備	2	20	2	20	3	30	3	30	0	0
03	我上這門課的情形	從不遲到或缺課	偶爾缺課	偶爾遲到	常常缺課	常常遲到	4	40	3	30	2	20	0	0	1	10
04	我上這門課的態度	很認真	還算認真	普通	不太認真	不認真	4	40	4	40	2	20	0	0	0	0
05	我對自我學習上的要求	很高	盡力而為	普通	不高	隨隨便便	3	30	5	50	2	20	0	0	0	0

二、教學意見　選項代號：(A)非常同意(B)同意(C)尚可同意(D)不同意(E)很不同意
※標準差可看出該題學生意見的分散情形，越大代表意見越不一致。

題號	題目	A	%	B	%	C	%	D	%	E	%	平均數	標準差
01	老師教學認真，不無故遲到早退或缺席	7	70	3	30	0	0	0	0	0	0	4.7	0.46
02	我覺得老師對本課程有充分的準備	7	70	3	30	0	0	0	0	0	0	4.7	0.46
03	老師授課或示範講解的表達與說明清楚有條理	5	50	5	50	0	0	0	0	0	0	4.5	0.5
04	老師鼓勵學生發問，並樂於傾聽或樂於與學生討論	5	50	3	30	2	20	0	0	0	0	4.3	0.78
05	我覺得老師能重視學生的反應而調整他的教學方式或進度	5	50	4	40	1	10	0	0	0	0	4.4	0.66
06	老師對課程內容有完整規畫並於開學時即將課程大綱、教材內容發放或上網	7	70	2	20	1	10	0	0	0	0	4.6	0.66
07	課程內容難易適中，各主題間有良好聯繫	6	60	3	30	1	10	0	0	0	0	4.5	0.67
08	本科採用的教材或講義恰當，有助於促成專業知識的完整學習應用	6	60	3	30	1	10	0	0	0	0	4.5	0.67
09	我覺得老師能適時指引，促進學生思考	6	60	2	20	2	20	0	0	0	0	4.4	0.8
10	我覺得老師能帶給我們啓蒙及成長的經驗	6	60	3	30	1	10	0	0	0	0	4.5	0.67
11	老師考評方式公平合理，能兼顧學生上課及課後的努力程度	7	70	2	20	1	10	0	0	0	0	4.6	0.66
12	我覺得作業份量或課後練習難易適中並配合教學內容有助於學習	7	70	1	10	2	20	0	0	0	0	4.5	0.81
13	我覺得本科目的老師是我上過的課程中教得較好的幾位之一	6	60	2	20	2	20	0	0	0	0	4.4	0.8
14	這是一門值得學習的課程，有機會我會推薦給學弟妹們	6	60	3	30	1	10	0	0	0	0	4.5	0.67
	1~14題教學意見平均數: 4.51												

三、其他意見

學生	意見

2. 互動藝術文獻（如附件）

- Bird Watching: An Introduction to Amateur Satellite Spotting
- Device Art
- Education for Interaction
- Video Game that Uses Skin Contact as Controller Input
- The Virtual Raft Project: A Network of Mobile and Stationary Computer Systems

ARTIST'S ARTICLE

Bird Watching: An Introduction to Amateur Satellite Spotting

Kathy Marmor

ABSTRACT

Space satellites are invisible instruments of globalization that influence governmental policies. This paper examines remote sensing satellites as optical devices capable of redefining human cognition. They represent accessibility and openness through the more agreeable paradigm of transparency. However, transparency, like surveillance, is based on the interconnection between power, knowledge and perceptual experience. Artists use a variety of tactical practices, including amateurism, to tease apart these connections. Amateurism dedicates itself to the politics of knowledge. The author concludes, based on examples of her work and that of others, that the potential for political intervention exists when knowledge is paired with action.

Space satellites are a potent symbol of the information age, and their versatility makes them a compelling technology. Yet satellites remain somewhat mysterious. Their invisibility puts them out of mind, but the data they collect and transmit in the form of images and communications greatly influence political, economic and social practices worldwide. Indeed, space satellites are often discussed as vital components of globalization. What is interesting about satellites, specifically remote sensing satellites, is the dialogue they initiate between the observer and the observed. This dialogue is often translated into a discourse on the manifestation of power in surveillance. Remote sensing satellites are also optical devices, and as optical devices they shape visual perception and cognition. Thus, the dialogue between an observer and the observed is complicated by the interconnection between visual experience and perceptual understanding.

Even though we have access to both the commercial and the noncommercial products of satellites, such as media broadcasting, weather maps or, more recently, their images via Internet applications such as Google Earth, we are no closer to understanding how satellites work or how their data is interpreted. Their scientific functions and sophisticated technology and their history of espionage keep satellites inaccessible to the layperson and perpetuate the idea that satellite images objectively document the earth and sky.

With these concerns in mind, I have created a multimedia installation called *Bird Watching* (Fig. 1) that represents remote sensing satellites as interactive homemade cardboard boxes. I use sound and interactivity in the installation as a means for determining location and representing the interconnection between local and global. *Bird Watching* engages an amateur version of remote sensing and satellite spotting to make the satellite's technology visible and their relations to us comprehensible. While researching satellites for my installation, I realized that the old equation of technology equals power and control has been supplanted by a rhetoric that extols the democratization of technology and global transparency.

THE POLITICS OF TRANSPARENCY

A combination of scientific and military aims has resulted in the production of over 2,000 space satellites in orbit, and the

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Fig. 1. Installation overview of *Bird Watching*, showing seven box satellites, computer projection, UHF/VHF radio antenna and tracking computer. (© Kathy Marmor. Photo © Michael Heeney.) FireHouse Center for the Visual Arts, Burlington, VT, 2007.

United States government funds more than half of them. Remote sensing satellites, which are the primary focus of this article, acquire information about the Earth through electro-optical sensors. The data is then transmitted to ground stations, where it is typically converted into a visual form for analysis. This process of synthetic imaging underscores the paradox of remote sensing: Satellite images are often perceived as indexes of the earth, and as such they substantiate reality; yet, in the words of Lisa Parks, "The satellite's image's aesthetics of remoteness and abstraction make its status as a document of truth very uncertain and unstable" [1].

The history of remote sensing satellites reinforces the construct that a satellite image *is* the data transmitted from the satellite's instruments. The conversion of electromagnetic radiation into a visual form fuels the idea that satellites depict what they independently "see." The fact that remote sensing satellites see what a human being cannot makes them appear as if they are capable of autonomous vision. The earth and its atmosphere seem transparent to us due to their unique perceptibility. This meaning of transparency: to be seen through clearly, could be applied to the spy satellites and their ability to reveal another country's secrets. In 1958 President Eisenhower ordered the CIA to replace U-2 spy-planes with reconnaissance satellites in response to the USSR's launch of Sputnik (Fig. 2). The Sputnik was the world's first orbiting satellite, and its success posed the possibility that the Soviets could also launch intercontinental ballistic missiles. Eisenhower's new satellites, the Discover series, code named Corona, were equipped with Keyhole cameras that took pictures of the USSR. The Corona project ended in 1972 and was replaced by Landsat, a series of earth-observing remote sensing satellites. The Corona images were declassified and made public in 1996.

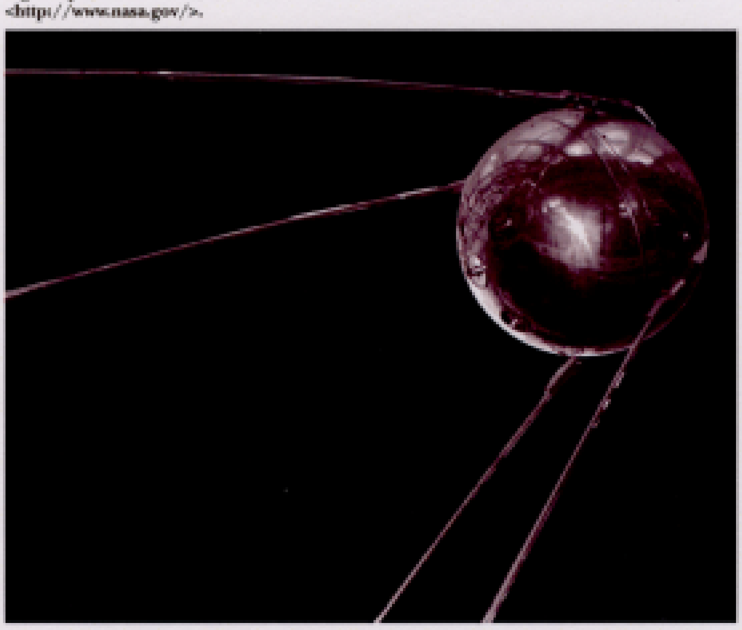
The rhetoric of transparency surrounding the use of remote sensing satellites has changed as satellite technology has advanced. Satellites, once highly specialized military and scientific apparatuses, are now thought of as universal tools promoting openness. The digitization of satellite data and the convergence of digital media have increased public and private access to satellite imagery. Today, Keyhole is the name of a company that provides a 3D digital model of the Earth created from satellite images that can be accessed via the Internet. Google purchased Keyhole in 2004. As Jonathan Rosenberg, Google's vice president of product management, said, "With Keyhole you can fly like a superhero from your computer at home to a street corner somewhere else in the world. Keyhole is a valuable addition to Google's effort to organize the world's information and make it universally accessible and useful" [2]. In fact, in 2007, the U.S. Holocaust Memorial Museum joined with Google to add a new layer called Crisis in Darfur over Google Earth's satellite images. This overlay allows users to see devastated villages and to quickly access information about the region. Crisis in Darfur is in a folder called Global Awareness, and these informative overlays provide the general public with concise information about the workings of governments, humanitarian organizations and corporations. This form of transparency offers the promise of shared power and responsibility. I suggest that today global satellite surveillance by governments, corporations or NGOs is just a matter of fact, in contrast to the late 1950s, when satellite surveillance was a closely guarded secret. Transparency does not connote power the same way that surveillance does. The term is benign, and its meanings and connotations facilitate the public's acceptance of an overt surveillance that is remote and global in scope.

Satellite images are virtual images. The complexity of the earth and its peoples is filtered through an assortment of sensors to produce a vast array of information. It is important to note that information is not the same as knowledge. As Nico Stehr states in *Knowledge Politics*, "knowledge is conduct" [3]. To have a complete understanding of a satellite image there must be both data and context. It is the filtering of data and the manipulation of the context that makes it easy to politicize the veracity of a satellite image. The allegations of the Cold War missile gap and Iraqi weapons of mass destruction (WMD) clearly demonstrate this. In 1957 and 1958 the U.S. was in the midst of an economic recession and President Eisenhower was planning to reduce defense spending. Senator John F. Kennedy claimed after the launch of the Soviet satellites that there was a growing arms disparity between the U.S. and the USSR. Kennedy emphasized the purported missile gap during his campaign, even though he had access to Corona satellite pictures of the USSR that indicated no such disparity [4]. The alleged gap tapped into a public fear and helped Kennedy defeat Vice President Nixon in the 1960 presidential election.

In 2003 Colin Powell, then U.S. Secretary of State, addressed the U.N. Security Council about Iraq. During his presentation he stated,

> Let me say a word about satellite images before I show a couple. The photos that I am about to show you are sometimes hard for the average person to interpret, hard for me. The painstaking work of photo analysis takes experts with years and years of experience, poring for hours and hours over light tables. But as I show

Fig. 2. Sputnik 1 satellite, launched 4 October 1957. It orbited the earth in 98 minutes, <http://www.nasa.gov/>.



> you these images, I will try to capture and explain what they mean, what they indicate to our imagery specialists [5].

He then proceeded to use the satellite photos as evidence that Saddam Hussein was moving banned materials from a number of Iraqi WMD facilities. These two examples show the opacity of satellite images and how their meanings are manipulated in the name of economics and national security.

The visual imagery from remote sensing satellites is similar to that of medical imaging. Both are based on the premise that to see through something is to uncover the truth—a truth provided through expert analysis. The idea that truth is a universal, fixed phenomenon is given more validity than the notion that the process of analysis and interpretation, measuring and categorization gives meaning to what is seen. The notion that transparency gives rise to a discernible object or fact, I argue, is a cognitive construct that instructs one *how* to see.

Optical Technologies and Visual Perception

Remote sensing satellites are technological devices that provide us with a radically different view of the earth and have altered our perceptions of the world. Satellites are thus optical devices that, like the telescope and the camera obscura, provide new models of cognition by redefining visual experience. The interconnection between optical technologies and vision can be traced as a trajectory from subjective vision to synthetic vision through the writings of the philosopher Descartes and theorists Jonathan Crary and Paul Virilio.

For Descartes, the telescope perfectly described the relationship between visual experience and cognition. The image perceived through the telescope was a sensory illusion created through light, mirrors and lenses that required the mind to make sense of it. Thus, vision could not be equated with knowledge. According to Descartes, vision was technical and knowledge was acquired through a consciousness of self and the certainty of God. This model emphasized the individual as a subject separate and distinct from the physical world. Descartes' view was reified by the camera obscura (Fig. 3) until new physiological studies indicated that the body was the site of visual production. Simultaneously, new optical apparatuses like the stereoscope, which required the viewer to wear special equipment, made the viewer part of the machine [6]. Incorporating the body as the site of visual perceptivity collapsed the distinctions between inner and outer worlds. This helped to establish vision as subjective and temporal and enabled the observer to partake in the processes of modernization.

According to Paul Virilio, vision is a variable of space and time that has been affected by what he describes as the phenomenon of acceleration. He claims that the telescoping lens of the optical device replaces the human body as the basis of vision. Thus, optical devices reconfigure vision by delocalizing it, and when vision is severed from the body it can be institutionalized within a machine. The computer's unification of the factual and the virtual is the foundation for synthetic vision and automated perception. Computer graphics represent a "paradoxical logic . . . when the real time image dominates over the thing represented, real time prevailing over real space, virtuality dominating actuality" [7]. This is particularly true of remote sensing satellites. Their real-time systems provide a continuous view of the present and the possibility of foreseeing the future. It is this ability to both prevent and predict that makes the satellite useful as a restraint.

Satellites are but one type of many digital and global communication technologies, privately and publicly owned, whose capacity for image production, reproduction and dissemination enables a constant stream of visual material to enter the public realm. However, public access to scientific representations does not make scientific knowledge more available. In fact, global technologies bring people "together long distance around standardized opinions and behaviors" [8]. Hence the very technologies that produce and distribute communications also provide a conduit for surveillance between peoples.

An overload of visual information also leads to a form of hyper-visuality that creates its own paradoxical logic, suggesting that the more we see, the less we see. For instance, today the picture of the earth taken from Apollo 17 and the DNA helix represent scientific ingenuity. Both of these images are divorced from their original context and meaning and instead function as ideological icons in popular culture. Representations such as these make science accessible only on a very superficial level. The icon of the helix represents to many people an impenetrable system of knowledge whose ramifications affect daily life.

A Creative Tactical Response: Amateurism

As producers of culture, contemporary artists grapple with the issue of visual saturation and homogenization of meaning in society. These artists, like the Dadaists and the Situationists before them, are responding to specific social, political and economic conditions. Art collectives such as the Institute for Applied Autonomy, Critical Art Ensemble and biotech hobbyists Natalie Jeremijenko and Eugene Thacker, and individual artists such as Marko Peljhan, Steven Holloway and myself implement a variety of tactics that expand upon the Situationists' *détourne* (appropriating and rearranging cultural signs to create new meaning) and *dérive* (a merging of psychology and geography—to drift without a goal) [9] or define new strategies such as "amateurism: a willingness to try anything" [10].

The amateur's approach—a shared interest, a willingness to try, and genuine curiosity—has influenced the content and methodology I employ in my artistic practice. My work stems from a desire to understand the scientific principles

Fig. 3. Camera obscura in Athanasius Kircher, *Ars Magna Lucis et Umbrae*, 1646.

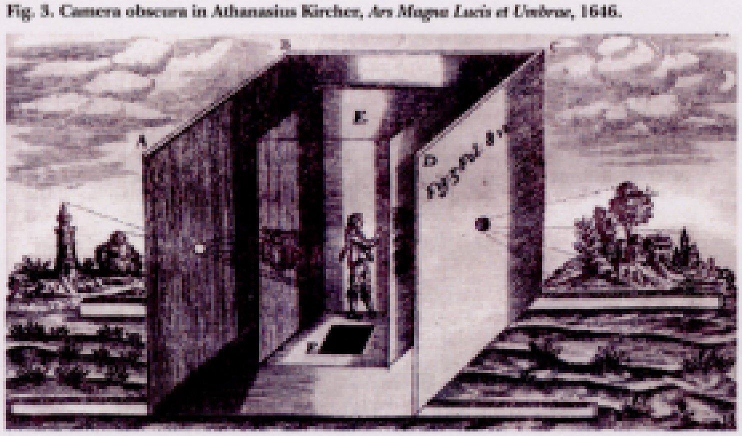


Fig. 4. Promotional image for *The DNA Cookbook*. (© Kathy Marmor. Photo © Lynn Imperatore.) Performed in Burlington, VT, and Baltimore, MD, 2003. This image shows the author with the key household ingredients for extracting DNA from raw wheat germ.

of specific instances of popularized scientific research. I am also interested in the culture of science and science as a cultural construct. Thus, my installations interpret complicated scientific knowledge by inviting interactive participation with humorous forms of "home-brewed" scientific technologies or techniques.

My installation *Bird Watching* consists of a flock of cardboard "boxes" whose elongated flaps resemble the wings of birds and the solar panels of space satellites. Each homemade satellite houses an audio speaker and inexpensive proximity sensors. My choice of materials reflects my belief that approaching science and technology with a do-it-yourself mentality interrupts passive consumerism and acquiescence to authority. The Radio Amateur Satellite Corporation (AMSAT) is representative of this approach. AMSAT is a national organization of amateur radio operators who make and launch sophisticated transmitting satellites from donated electronics. Their first satellite, Oscar 1, was launched as a secondary payload on *Discoverer XXXVI* in 1961. Today AMSAT has approximately 20 working satellites in orbit and a worldwide membership.

The usual definition of an amateur is a person who pursues an interest without pay. However, amateurism is not merely acquiring information or appropriating concepts and skills; it is what AMSAT represents: a diligent commitment to the "politics of knowledge": "knowledge is the capacity for action. Knowledge is conceptual doing" [11]. For the amateur, the acquisition of knowledge requires an investigative stance that results in an act of communal discovery. My use of interactivity to elicit participation in my installations is directly informed by these ideas. For example, in my installation and performance *The DNA Cookbook*, I assisted participants in extracting DNA from wheat germ using common household products and kitchen tools (Figs 4 and 5). The visible strands of DNA enthralled people. This simple activity was effective because the process was removed from the biology lab and set in the familiar surroundings of a kitchen. DNA was no longer a remote abstraction. Instead, I made it concrete and accessible through this communal performance. Later that evening, someone commented that the strands of thick viscous liquid did not look like DNA. For many people DNA is not a molecule found in every living organism; instead it is its representation—the double helix.

A space satellite, like DNA, is a powerful metaphor and symbol. The paradox of satellites is that (as with DNA) they have a palpable presence even though they are not seen. We see satellites because of what they produce. Perhaps it is this paradox of presence through absence that compels the amateur to look for them. I thought that if I could demystify satellites then I could unpack them as instruments of power. I had no idea how many different types of satellites there were and how varied their payloads were. This made it difficult to get an accurate historical overview, and as a nonscientist I found myself stymied by the obscure technical information and dry scientific writing. However, I found the web sites created by satellite aficionados, both amateur and professional, very useful and full of practical information including how to track satellites, communicate with them and decode their telemetry. I even discovered that I could hear data transmissions from satellites on a hand-held radio receiver.

The latter piece of information became an integral component of *Bird Watching*.

Fig. 5. DNA extraction performed at Burlington Art Hop, Burlington, VT, 2003. (© Kathy Marmor. Photo © Meg McDevitt.) The author performed twice during the evening, explaining what DNA is and answering participants' questions. Each performance took about an hour and a half.

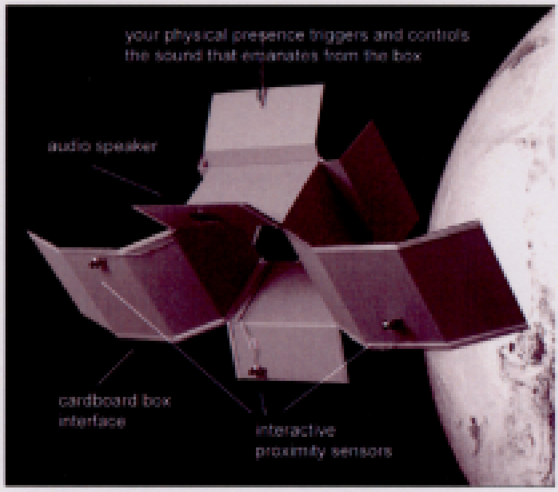


Fig. 6. Promotional image for *Bird Watching*, 2005–2006. (© Kathy Marmor) This image shows the components of each satellite box.

In the installation, hearing dominates over sight to communicate the interchange between the local and the global. The radio scanner emits a low continuous hum until it detects a satellite. The scanner then broadcasts the intercepted space satellite's telemetry through the audio speakers of my satellites. Thus, a distant foreign sound becomes local and personal. Sound also entices the viewer to physically interact with my cardboard satellites. Each bird (satellite) (Fig. 6) is embedded with proximity sensors that respond to the viewer's distance, and when a sensor is triggered the computer plays a recorded sound. If a person is close to the sensors, the sound is like that of a chirping bird, but the sound becomes more comprehensible as the viewer moves away from the sensor. At a certain distance the sound becomes distinctly human, thus referencing the local and immediate. The prerecorded sound of a woman crying or children laughing recalls the satellite's ability to sense human presence. The sound of the scanner's hum establishes a spatial reference point, and the sound from the sensors emphasizes the relationship between the body's geography and the installation space. When combined with the sound from a satellite passing overhead, this cacophony of sound creates an environment that situates the human body in a specific place.

Amateurism represents an opportunity to understand the principles that define a discipline whose knowledge is often under the providence of experts. I willingly immerse myself in these "closed" systems of knowledge to educate myself and use this education as a source of action. Amateurs must be willing to put their awareness into practice, and I suggest that such practice produces new forms of knowledge. For instance, I learned how satellite sensors worked, and this information became knowledge as I devised the installation's interactivity. My knowledge, or "conceptual doing," is passed to the viewer, who in turn reinterprets it as he or she engages with my satellites. It is my wish that participants interacting with the installation "set something in motion" for themselves.

Knowledge requires an active actor who "controls the circumstances of action." Thus, for knowledge to shape reality it needs the means for action. In 1597 Francis Bacon observed that "knowledge is power," and Karen Litfin states, "Imaging satellites function as symptom, expression and reinforcement of modernity's dream of knowledge as power" [12]. Nearly four centuries after Bacon, Foucault suggested "that power produces knowledge" [13]. Surveillance and the power it implies are masked by the supposed benefits of a transparency that denotes openness. The ideology of transparency constructs surveillance as a necessary function of satellites. In *Bird Watching*, satellites and the practice of observation are employed to explore the interconnection between power and knowledge. Power in my installation is perceived as complex overlapping networks that engage individuals, technology and culture as different but supporting mechanisms. Knowledge creates, sustains and transforms these mechanisms. Once viewers discover that my satellites are interactive, they become enthusiastic participants who soon control the sound (Color Plate E). Here, sound defines an exchange of power. However, participants soon realize that the satellites are also monitoring their interactions. The sensors embedded in the "birds" track the participants' movement, and this data is projected back in real time into the installation space (Fig. 7). This visual map makes participants more wary of their interactions with the boxes. The interplay of power between the boxes and participants mirrors the dynamics between actual space satellites and the installation itself. I use satellite tracking software that announces the times and orbits of satellites passing nearby. This automated voice and the ensuing live telemetry inverts the usual relationship of an invisible satellite watching us to one in which the audience is anticipating the satellite's presence. Anticipating the satellite echoes the watchfulness of an amateur satellite enthusiast. "To watch carries with it the connotation of a scrutiny. . . . To watch is to look for something that is not immediately apparent" [14]. Thus, *Bird Watching* asks the participant/viewer to be fully conscious of the power dynamic between the observer and the observed, and by acknowledging this power relationship my installation seeks to disrupt it. I suggest that it is a combination of watchfulness

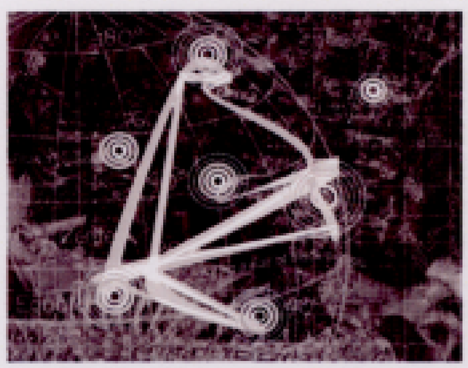


Fig. 7. Image of interactive map for *Bird Watching*, January 2006. (© Kathy Marmor and Jonathan Decker) Custom software created in collaboration with Jonathan Decker.

Fig. 8. Path using *iSee* software. (Photograph courtesy Institute for Applied Autonomy. © Institute for Applied Autonomy.)

and knowledge that politicizes transparency so that it is not a directive for uncovering truth. Instead, transparency is the act of implementing knowledge. Google Earth's layers of Global Awareness provide invaluable information, but it is the citizen who watches and acts on their knowledge that models reality; or, as Jeremijenko and Thacker note, democracies depend on transparency [15].

Art as Agency and Action: *iSee* and *One Pixel*

A dominating power maintains power by using surveillance as a method of control. *iSee* by the Institute of Applied Autonomy and *One Pixel* by Steven Holloway are two works of art that address surveillance by undermining the conventional power relationship. *iSee* and *One Pixel* offer a new form of knowledge, and this knowledge provides the impetus for self-agency and direct action. The Institute for Applied Autonomy is a collective of artists who produced a web-based application in 2001 called *iSee* that enables a user to determine a travel route that avoids surveillance cameras (Fig. 8). The application was specifically developed for Manhattan using data collected by the NYC Surveillance Camera Project. *iSee* demonstrates the pervasiveness of public surveillance by making it visible and provides the user with the power and the means by which to act. IAA argues that video surveillance is neither unbiased nor autonomous and in fact reflects state politics, corporate interests and cultural biases. By engaging CCTV technology, the Institute points out that surveillance supposedly equals deterrence, but in reality, when it is refined and linked to networked databases, surveillance establishes and verifies identity.

Steven Holloway's 2005 performance *One Pixel: An Act of Kindness* engages surveillance and satellite technology from a totally different perspective. In this work, he links the virtual: one pixel from a Landsat 7 satellite image—representing an area that is 30 meters by 30 meters—with the real: the physical place represented by the one pixel. For *One Pixel*, Holloway selected a pixel from a satellite image of Boston, Massachusetts, captured in April 2005. His performance consisted of defining the pixel's physical area through a variety of "non-destructive markings" [16]. He then invited the public to visit the pixel space and to record their observations of it (Fig. 9). As Holloway stated in a news release, "*One Pixel* demonstrates that the spirit of a living place cannot be appreciated without direct experience." Holloway's performance implies that knowledge is based on embodied subjectivity and that this form of knowledge is action.

Remote sensing satellites have historically been used as instruments of surveillance because of their ability to transmit data about the earth to ground stations at regular intervals in real time. A variety of interests, corporate and state, invest in satellite technology for the global transparency they provide. Today, the sky does not belong to one supreme observer; instead, satellite imagery makes the earth available to all. Political treaties such as the Convention on the Registration of Space Objects Launched into Outer Space (1976) or the Open Skies treaty for aerial observation (2002), plus worldwide advances in telecommunications, offer greater transparency. Here, the term *transparency* implies openness but also describes a way of looking. Satellite images are thought of as objective docu-

Fig. 9. (a) Markings describing 1-pixel area in Boston Commons for Steven Holloway's *One Pixel*; (b) participant recording observations, 2005. (© Steven R. Holloway)

ments that reveal truth. Transparency, on the other hand, also implies accountability, and accountability is impossible without knowledge. Knowing something does not necessarily lead to the ability to affect a situation, even though knowledge and power are often perceived as interrelated. If knowledge is the capacity for action, then there must also exist power—"the control over some of the circumstances of action" [17]. When these two conditions are met, then there exists the possibility of agency.

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Kathy Marmor has exhibited widely in the United States. Her work has been shown at Ciber@rts Bilbao, Spain, and New Forms festival in Vancouver, Canada. She has been an artist in residence at the Visual Studies workshop in Rochester, New York, and Light Works in Syracuse, New York. She has discussed her work at ISEA and at the 9th Workshop and Symposium on Space and the Arts.

Device Art: A New Form of Media Art from a Japanese Perspective

Machiko Kusahara

Device Art is a concept for re-examining art-science-technology relationships both from a contemporary and historical perspective in order to foreground a new aspect of media art. The term "Device Art" may sound obscure, or even self-contradictory, but it is a conscious choice. The concept is a logical extension of a change in the notion of art that already started in the early 20th century with art movements such as Dada and Surrealism. More recently, interactive art has redefined forms of art and the role of artists. What we call device art is a form of media art that integrates art and technology as well as design, entertainment, and popular culture. Instead of regarding technology as a mere tool serving the art, as it is commonly seen, we propose a model in which technology is at the core of artworks. As I will discuss later, the concept took shape on the basis of an analysis of works by contemporary Japanese media artists. Features surfacing in many of these projects include interaction, a positive attitude towards technology, and playfulness. The influence of Japanese cultural tradition can be clearly traced in these haracteristics. Another aspect of this work is the artists' involvement in fields such as design, entertainment, and commercial production, which becomes evident in the approach of internationally recognized artists such as Toshio Iwai, Nobumichi Tosa (Maywa Denki), and Kazuhiko Hachiya. This approach, which is often considered suspect from a Western point of view, is actually a natural part of Japanese art. A long history of visual culture that developed independently from Western paradigms of art plays an important role in the Japanese art scene, offering artists wider possibilities for bringing their concepts outside of the context of museums and galleries.

While theoretical analysis is an important part of the Device Art project, producing artworks according to its concept is the key element. The project launched in the fall of 2004 and has been pursued by nine artists and researchers, with a five-year grant from the Japan Science and Technology Agency, since the fall of 2005.[1] The aim of the project is not only to create "device art" but also to develop a working model for producing, exhibiting, and distributing these works, and theoretically frame them. Making these artworks accessible to a wider audience and users outside of the museums and galleries is part of our agenda. Development of hardware and software modules to support the art practice is also planned.

Background of the Project

Japanese works have been highly visible at international competitions in the field where art and technology meet, and often involve original interface design based on proprietary hardware. Toshio Iwai, the internationally recognized media artist whose collaborative work with Ryuichi Sakamoto won the Golden Nica at Ars Electronica in 1998, is an example of an artist creating this type of work. At SIGGRAPH 2005, *TENORI-ON*, a prototype he developed with Yamaha, attracted much attention for its unique features and refined design. The piece consists of a matrix of illuminated touch-activated buttons that serve as both input and output mechanism. Nothing else is needed: the interface / display itself is an innovative musical / visual instrument. After having explored a similar idea for years on different platforms, including portable game machines and cell phones, the artist considers this the ultimate version. The work is a device that enables anyone to play sound and enjoy images without any learning process; it is simple, beautiful, and self-contained, with open interaction for users. As the piece is made of transparent acrylic to make the light patterns visible from any direction, its function also becomes transparent. The choice of materials is thus crucial in realizing the artist's concept.

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Interest in hardware-based artwork with original design also is a key element in the activities of Maywa Denki, an "art unit" led by Nobumichi Tosa. [Fig. 1] Mixing low-tech and high-tech, he designs and manufactures strange looking robotic instruments that are performed by him or in collaboration with his "employees," or pre-programmed, or sold to enthusiastic Maywa Denki fans.[2] Although they often look odd and incorporate crazy ideas, the instruments function perfectly well. They are constructed on the basis of his knowledge and understanding of technology and material, as well as the practical skills required in cutting and molding metal parts, and working with programming chips and computers. While the instruments look strange, their mechanism is clearly visible to the audience, and Nobumichi Tosa even explains how they work during the performances. The fact that the robotic instruments occasionally do not immediately function properly also becomes part of the performance. It is important to the artist to keep the technology transparent and visible, including the possibility of its malfunctioning. Criticism of an industry that hides the "IT" behind a "wall" is an important part of his concept. With his funny robots and devices, Tosa insists that technology should not become a black box.

Figure 1. Nobumichi Tosa (Maywa Denki) with his sculptures.

The creation of entertaining works with original, physical interface design is a field not limited to professional artists. For the past few years, SIGGRAPH's Emerging Technologies (E-Tech) and Art Gallery have been filled with Japanese art works and research projects, including numerous ones by students.[3] With approaches ranging from Hi-tech to low-tech, they have come up with original and playful ideas involving unexpected uses of technologies. At SIGGRAPH 05, visitors could push around a tea can on a table and simultaneously see on a screen how little virtual creatures, *Kobitos*, performed the visitors' action [Fig. 2]; or suck different kinds of virtual food and drink through a plastic straw, while the actual pressure, vibration, and sound produced by drinking would be simulated by the system.[4] [Fig. 3] At SIGGRAPH06, participants could touch a soap bubble, with images projected on its surface, which would produce sound when it broke upon touch.[5] [Fig. 4] Or they could chase the shadows of invisible goblins, suck them up with a vacuum cleaner, and feel their weight.[6] As these examples show, a combination of interaction, application of physical material and custom-made devices, as well as playfulness characterizes many of these works from Japan, be they meant as art or research. An affirmative attitude towards technology is another crucial feature of these projects. Technology is not treated as something that should remain hidden behind an artistic concept, or something that instigates fear; rather, it is an important part of these works to make visible to the audience / participants what technology has to offer. However, this does not mean that the technologies used are idealized. Even the risks accompanying technology can be represented in a playful manner, as in the case of Maywa Denki's performances and custom-made electronic instruments. The bare circuits occasionally emit sparks when the instruments are played by the artist, who comments, "Hundred volts – very dangerous!"

However, works that are highly appreciated in Japan are often criticized by the Western art community for their lack of seriousness. These criticisms are often related to the entertainment factor in the works and their affirmative attitude towards technology, which are both typical of Japanese works, as indicated earlier. However, being critical does not necessarily require being serious or negative towards technology. This issue is deeply rooted in each of the societies' histories, particularly the effects of the industrial revolution.

In Europe and in the United States, the industrial revolution and automation are remembered as extremely negative and inhuman experiences for average people. Films such as Fritz Lang's *Metropolis* and Charlie Chaplin's *Modern Times* both illustrate this attitude. The experience certainly was different in Japan, where the industrial revolution took place much later in a short period of time in which the country was trying to catch up after more than two hundred years of isolation.[7] This also connects to the tradition of using science and technology for entertainment purposes rather than practical applications. Japan had a long period of peace until the mid-18th century when it opened its borders and the latest technologies and scientific instruments were imported and utilized for entertainment instead of "practical" purposes such as the manufacturing of weapons. Technology was something to be enjoyed rather than something to be feared.

The close relationship between art, entertainment, and design, as in the case of artists creating artworks on game platforms, games themselves, or commercially available products, may also seem problematic from a Western perspective,. Toshio Iwai's *TENORI-ON*, which I referred to earlier, has been developed in collaboration with Yamaha. His *ELECTROPLANKTON* is an artwork to be played on the Nintendo DS game machine. As in the case of *TENORI-ON*, the software invites users to

Figure 2. *Kobito: Virtual Brownies.*

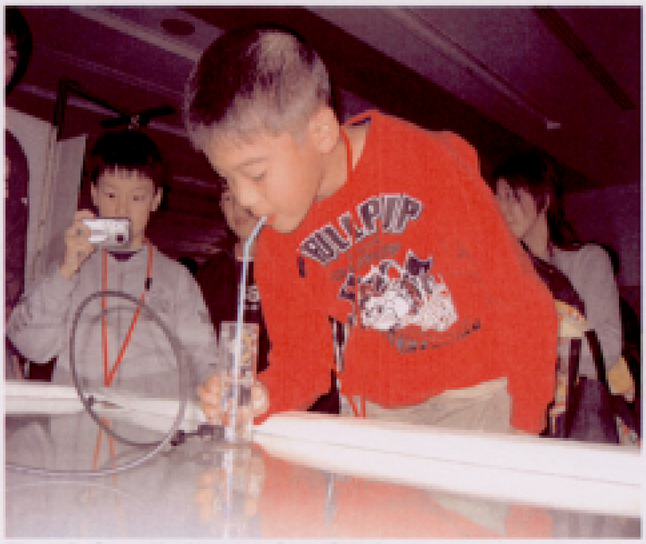

Figure 3. *Straw-like User Interface (SUI).*

Figure 4. *Bubble Cosmos.*

enjoy the audiovisual experiences they create.

Games, toys, and gadgets created by artists are not very common, but they are not a rare phenomenon in Japan and are widely accepted as a part of popular culture. *Bitman*, for example, is "high-quality jewelry" anyone can enjoy, as its creators Maywa Denki and Ryota Kuwakubo claim.[8]

The 7cm x 7cm white plastic frame with an 8x8 matrix of red LEDs displays the pixeled image of a man, a figure familiar from early games. [Fig. 5] Hung with a chain around one's neck, the bitmap image shows a real time animation of *Bitman* trying to keep his balance in the swinging world. By shaking the "jewelry" one can make *Bitman* dance.ix The movement of the digital bitmap character is created in real time as the embedded sensors detect acceleration and tilting of the panel. The product is commercially available along with other goods developed by the artists. The distributor of the piece is Yoshimoto Kogyo Inc., the king of Japan's entertainment business, which hires most of the standup comedians appearing on Japanese TV. Nobumichi Tosa himself (who leads Maywa Denki as its "CEO") is officially an employee of Yoshimoto, although he recently separated some of his activities from the company.

While Tosa, with his strong commitment to consciously crossing the border between art and entertainment, is a special case, the boundaries between art and related fields are not as rigid as in the West, because the notion of art itself is different, as is widely known. Some of the best paintings in Japanese art can be found on sliding doors and folding screens. Famous artists, such as Hokusai or Hiroshige, made woodblock prints for the public. Distinctions between notions such as fine art and applied art, or high art and low art, do not exist. These distinctions appeared and became standards in Western art history. In Japan, with its different social and cultural background, these classifications were not made. Although the Japanese art system has been westernized over the past one hundred years, there still exists a cultural tradition that encourages artists and the audience to share artistic experiences outside art venues.

Could artists publish their work as software running on a popular gaming platform and still claim it to be an artwork? They probably could. To put it another way, could digital "content" that is commercially available and runs on a game platform be seen as an artwork? How about a gadget, or a machine?

Art in the Age of Digital Reproduction Technologies

There have been long discussions on how better relationships between art and technology could be established. However, traditional art paradigms are still powerful enough to make art curators and even artists hesitate when it comes to exploring what media technology may mean to art. In order to recognize the boundaries we have taken for granted, we could ask ourselves the following questions:


Figure 5. Maywa Denki and Ryota Kuwakubo, *Bitman*

Could artists publish their work as software running on a popular gaming platform and still claim it to be an artwork? They probably could. To put it another way, could digital "content" that is commercially available and runs on a game platform be seen as an artwork? How about a gadget, or a machine?

Many might hesitate to answer yes. However, we have already seen examples of these projects by artists who make their works, running on game platforms, commercially available. Could we claim that they do not qualify as artworks because they exist outside of galleries and museums? (They often have been exhibited in art venues as well.) Or are they not art because they are not sold on the art market? How do we define art?
We live in a postmodern society of mass-produced objects, simulated realities, and simulacra. The aura of the original, which has been valued by the art world for so long, becomes questionable for artists coping with the reality of our society today. The situation has become even more complex since an essential feature of digital technology is to enable the production of multiple, completely identical copies.

In the beginning of the 20th century, Marcel Duchamp already turned the idea of "originality" upside down with his *Fountain* piece, two years after he had moved to the United States where the effects of a mass-production-based consumer society were clearly visible.

In the 1960s, Nam June Paik created video sculptures by combining TV monitors and video images that were either appropriated from regular TV programs or commissioned from younger video artists. Commercially produced TV sets and news programs became original once they had been reconfigured according to his concept and "signed" by the artist. What, then, could be the position of an artist in the age of digital reproduction technology with regard to the notion of originality, the role of an artist, or the "sublime" experience that a great piece of art is supposed to bring to its viewers?

There could be multiple answers to this question, and different approaches to recognizing projects as artworks. One possible answer would be that what qualifies a project as art has nothing to do with the uniqueness of the physical component. A work that exists in multiples, even if they are not numbered as in the case of many lithographs or "original" photographs, becomes a piece of art if it brings artistic experiences to its viewer. That brings us back to a question we had asked earlier: what is the difference between a piece of art and a commercial product, or a designed object?
These questions have not been fully answered, but cannot be avoided. Device Art is a movement aimed at openly raising these questions and proposing possible answers that make sense in the age of digital technologies.

So What Is Device Art?

The term "device" usually means an instrument that serves to achieve a certain effect as part of a process. In the case of art, the goal has traditionally been an effect that the final work has on its viewers. A device used in realizing the work is not necessarily an essential part of its content – it only plays an instrumental role in the process of production. In other words, the goal and the device used for achieving it belong to different hierarchical levels. The device serves the goal.

This has been true for most traditional art. Oil paint or brushes are not considered essential in the process of presenting and appreciating a painting, except as the tools or medium utilized for its creation.

The role that media art plays in art history has not been thoroughly explored, and questions raised by people such as Walter Benjamin, Jean Baudrillard, Marcel Duchamp and Nam June Paik have not been fully answered in a media art context.

However, this no longer remains true when it comes to art forms such as interactive installations. The choice of technology has a significant impact on the theme and concept of media art for several reasons. Artists might use media technology in order to express their thoughts on the social / political / cultural ramifications of the technology. The experience provided by an artwork also depends on the technology used. In the case of interactive art, visitors / users touch and manipulate the artwork instead of contemplating a static painting on the wall. Devices are often involved in the experience of an artwork.

As a concept, Device Art is rooted in the analysis of the key role that devices play in certain types of art, that is, artworks involving hardware (a device) specifically designed to realize the artistic concept. The device itself can become the content. Technology is not hidden, its function is visible and easy to understand, while it still brings about a sense of wonder. Well designed interfaces made of the right materials facilitate interaction for users, often in a playful manner.

To summarize, a device could be the "body" of an artwork that offers an artistic experience to its users / participants. In other words, the "resulting" experience cannot be separated from the device specifically designed or chosen to enable this experience. Producing multiple copies of such work and distributing it as a commercial product makes it accessible to a wider audience, provided the piece is designed in such a manner that anyone could use and enjoy it. An artist's concept could become a part of people's lives, rather than being kept in museums and galleries. Why not share art with more people?

Interestingly enough, these ideas sound familiar to the Japanese. Cultural traditions such as the tea ceremony, flower arrangements etc. are based on this understanding. It is obvious that the goal of a tea ceremony is not to just enjoy a cup of tea. The importance lies in the whole experience, including the process and the devices used, such as teaspoons and bowls. These tools are functional and made of appropriate materials, and yet there is something more to them than just usefulness. We know that refined tools can make one's life easier. They also serve as a medium in communicating with others. In a tea ceremony, correctly chosen devices change the whole experience.

This could also be applied to art. It is problematic to separate devices from experiences if the experience is only possible through the use of devices consciously chosen for their purpose. This obviously does not only hold true for Japanese media art, but the underlying idea is already part of Japanese culture.

Conclusion

The role that media art plays in art history has not been thoroughly explored, and questions raised by people such as Walter Benjamin, Jean Baudrillard, Marcel Duchamp and Nam June Paik have not been fully answered in a media art context. Fluxus and Neo-dada artists used Xerox machines to investigate what multiple copies might mean to art, but we have not yet found a coherent art paradigm for capturing the impact of the age of digital reproduction technologies.

Device Art is a concept that pushes the boundaries of media art and inherits the legacy of the experiments artists have been conducting with media technologies. By raising questions regarding possible relationships between art and technology, the role of hardware-based devices, and the borders between art and its related fields, and creating a common ground for artists and engineers to work together as equals, we might find some answers with regard to future directions rather than the past.

We are hoping that Device Art could bring an alternative point of view to art history. We use Japanese art history and visual culture for reference in order toilluminate our approach and how the above-mentioned questions relate to each other. However, what we find in the end might be a global model. Japanese art history just happened to provide a background that allowed artists to think differently.

Media art is a more recent development in art. Device art tries to push media even further. By doing so, it might help to gain a better understanding of the meaning and role of art in a media society.

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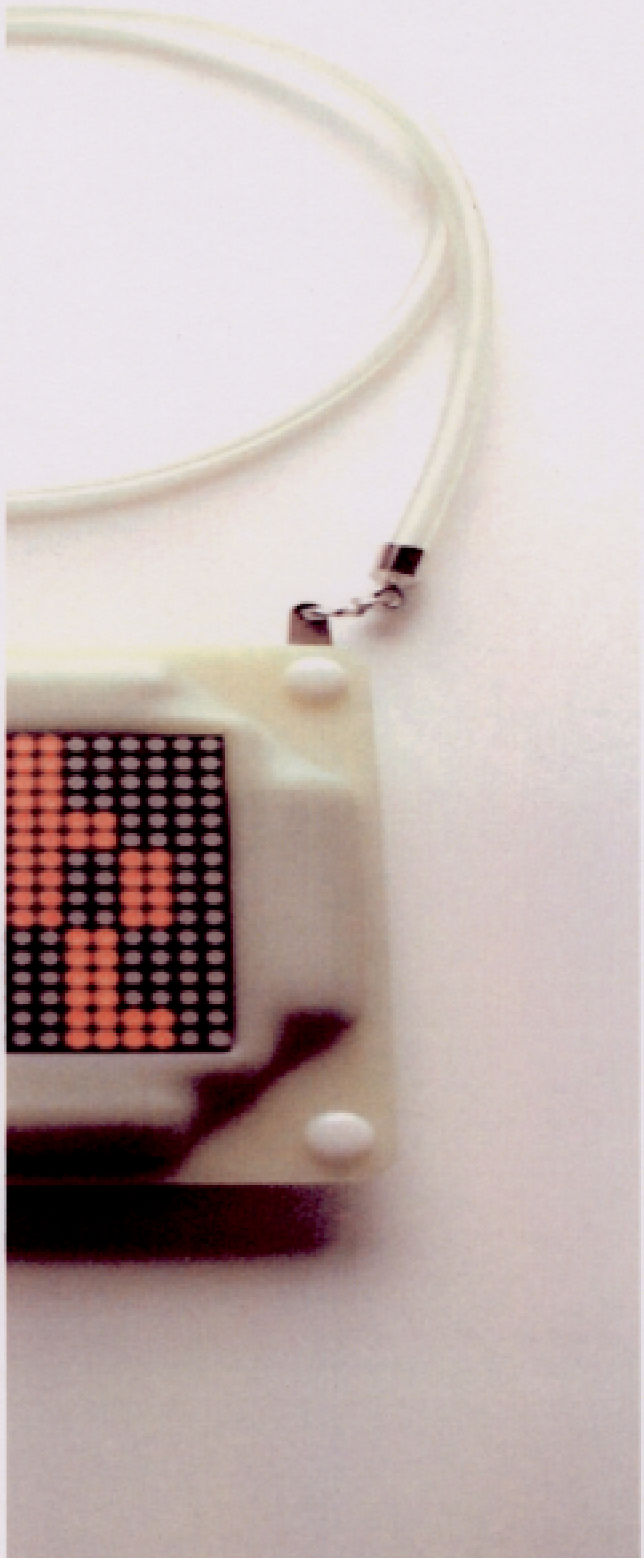
[1] The project members are Hiroo Iwata (Tsukuba University, researcher in engineering), Kazuhiko Hachiya (artist), Masahiko Inami (University of Electro-Communication, researcher in engineering), Sachiko Kodama (University of Electro-Communication, artist), Ryota Kuwakubo (artist), Taro Maeda (NTT Research Laboratories, researcher in engineering), Nobunichi Tosa (Maywa Denki, artist), Hiroaki Yano (Tsukuba University, researcher in engineering), Machiko Kusahara (Waseda University, media art researcher). All the members have exhibited their works either at SIGGRAPH or Ars Electronica, or both. More information is available at http://www.deviceart.org.
[2] Maywa Denki literally means Maywa Electric Company. The unit adopts the organizational structure of a typical small-scale company that produces electric devices. The artist plays the role of the CEO while student interns and collaborating artists are called "employees." They all wear uniforms and sing the "corporate song" as a part of their performance. The robotic instruments and other works are referred to as "products". Some of them are in fact commercially available. The corporate structure chosen by the artist functions as commentary on Japanese society.
[3] *TENORI-ON* was exhibited at SIGGRAPH 2005, and Iwai's *MORPHOVISION*, developed with the NHK Research Laboratory, was selected for SIGGRAPH 2006.
[4] *Kobito: Virtual Brownies* (http://rogiken.org/vr/english.html), *Straw-like User Interface* (SUI) (http://magno.hi.mce.uec.ac.jp/~inamilab/en/projects/SUI/index.html)
[5] *Bubble Cosmos* (http://in5.jp/bc/english/index.html)
[6] *INVISIBLE - The Shadow Chaser* (http://chihara.aist-nara.ac.jp/ivrc2005/en/invisible.html) These are works that had been submitted to the Inter-College Virtual Reality Contest (IVRC), a student competition organized by the Virtual Reality Society of Japan (VRSJ) since 1993. Besides serving as a major venue for educating the next generation of artists and engineers, it has become an important meeting place for art and engineering students.
[7] It was not a complete isolation, since restricted trade was maintained with China and Holland during the time.
[8] Kuwakubo collaborated with Maywa Denki on the development of new "products." Both Tosa and Kuwakubo have exhibited internationally at venues such as NTT/ICC (InterCommunication Center) or Ars Electronica. Kuwakubo's works have been shown at SIGGRAPH as well. Tosa's performance in Paris in 2003 was a great success.
[9] http://www.maywadenki.com/mshop_english.html



EDUCATING FOR INTERACTION

By Dan Collins

A first version of this paper was given at the Performative Sites conference at Penn State in October 2000.
A published version appeared in New Art Examiner in February 2001.

What is interaction? How can we begin to make sense of the avalanche of educational toys, computer programs, and artworks that claim to be "interactive?" What would a new pedagogy structured around the rules of interactivity look like?

Some theorists have argued that all "art is interactive," effectively shutting the door on the discrete contributions of new digital/computer-based interactivity. Conversely, other theorists such as Simon Penny have insisted that traditional artworks such as painting and sculpture are simply "instances of representation" and as such should not be defined as truly "interactive systems." For Penny, interactive artworks are "virtual machines which...produce instances of representation based on real time inputs." (Penny 1996) Still other theorists distinguish between the relationship of system *interactivity* (the enabling hardware and software) and the nature of the *interaction* (the actual exchange--be it aesthetic, educational, political, etc.) (Hillman et al, 1994). For our purposes here, a high level of interaction equals "mutual reciprocity"--a state of dialectical exchange between two or more entities. Ideally, interactive systems--whether a high tech computer game or a Socratic dialogue--can be tools for learning providing intelligent feedback that refines and amplifies user input.

While the demand for "interactivity" is a relatively recent phenomenon in the arts, the culture at large has long been obsessed with the idea of machines that learn. The evidence is mounting. From media spectacles such as Big Blue's defeat of World Chess Champion Garry Kasporov in May of 1997 to quieter revolutions in teaching autistic children, computers that master the behaviors of their users are beginning to find a place in the culture. There is more than a hint of narcissism in our desire to be personally reflected in the machines we make. We don't want simply "dumb" tools, we want "intelligent" machines that respond and learn by interacting with their owners. Even our cooking appliances and car radios are "programmable" to reflect individual tastes.

Few art schools provide courses for producing let alone interpreting or critiquing "interactive artworks." Though the borderline between the fine arts and other cultural practices (such as science, technology, and entertainment) is becoming increasingly blurred, it is clear that the development of "interactive art" is largely dependent on "non-art" traditions. From a technical and theoretical perspective, such strange bedfellows as computer gaming, combat simulation, and medical diagnostics have more in common with much recent digital and interactive art practice than main stream art history or criticism. Theorizing this territory is less a matter of mining, say, the Art Index, and more a matter of conducting systematic research into areas such as communications theory, human computer interaction, educational technology, and cognitive science. With this in mind, it may be helpful to briefly review how other disciplines are looking at the issues surrounding interaction.

THEORIES OF INTERACTION

"Interaction" is a useful construct in helping to understand the complex relationships occurring in a computerized learning environment. Educational technologist Ellen Wagner defines interaction as "... reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another." (Wagner, 1994)

Wagner points to historical examples of communication theory to illustrate the move from "one-way" systems of communication to "multi-directional" systems. C.E. Shannon's mathematical theory of communication (Shannon, 1948), for example, was a highly linear engineering model of information transfer involving the one-way transmission of information from a source to a destination using a transmitter, a signal, and a receiver. Later theorists built upon Shannon's model to include the concepts of interactivity and feedback. It is only recently that truly interactive systems that support both synchronous and a-synchronous exchanges among multiple users have been available. Common examples of synchronous exchange include live satellite uplinks, telephones, and chat rooms on the Net. E-mail is the prototypical example of an "asynchronous" exchange system.

Other trends supporting the development of interactive systems come from research in artificial intelligence and cognitive science. If "mutual influence" and reciprocity are criteria for true interactivity, then the system needs to be capable of delivering more than pre-existing data on demand. Interactive systems need to be able to generate "custom" responses to input and queries. In short, the system needs to be smart enough to produce output that is not already part of the system. Interactivity must be more than following predetermined prompts to preprogrammed conclusions like in a video game

While most natural and living systems are "productive" in the sense of creating new "information," human-made machines that can respond with anything more than simple binary "yes/no" responses are a relatively recent phenomenon. To paraphrase media artist Jim Campbell, most machines are simply "reactive," not interactive. "Intelligent" machines, being developed with the aid of "neural networks" and "artificial intelligence," can interact by learning new behaviors and changing their responses based upon user input and environmental cues. Over time, certain properties begin to "emerge" such as self-replication or patterns of self-organization and control. These so-called "emergent properties" represent the antithesis of the idea that the world is simply a collection of facts waiting for adequate representation. The ideal system is a generative engine that is simultaneously a producer and a product.

"INTERACTIVE" ARTWORKS

Creating an experience for a participant in an interactive artwork must take into account that interactions are, by definition, not "one-way" propositions. Interaction depends on feedback loops that include not just the messages that preceded them, but also the manner in which previous messages were reactive. When a fully interactive level is reached, communication roles are interchangeable, and information flows across and through intersecting fields of experience that are mutually reciprocal. The level of success at attaining mutual reciprocity could offer a standard by which to critique interactive artwork.

Many artists have developed unique attempts at true interaction, addressing problems of visual display, user control processes, navigation actions, and system responses. Different works have varying levels of audience participation, different ratios of local to remote interaction, and either the presence or absence of emergent behaviors. Moreover, different artistic attempts at interactivity suggest different approaches to interaction could be used for diverse kinds of learners in a variety of educational settings. Understanding experiments with interaction in an art context may help us to better understand interaction in pedagogical settings.

Carol Flax: Journeys: 1900/2000

Detail showing a viewer turning a page of the book and triggering a video projection.
Photo credit: Patricia Clark.

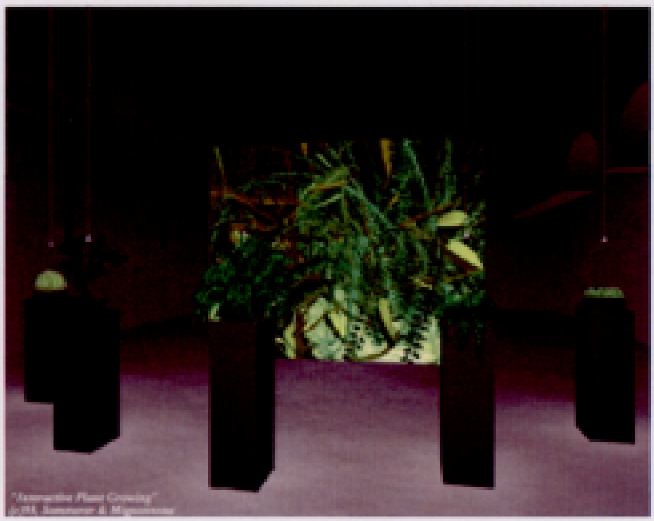
Arizona artist Carol Flax has created an "interactive book" entitled, *Journeys: 1900/2000* at the Institute for Studies in the Arts at Arizona State University, where I am the Interim Director. At the heart of the project is a reproduction of a 19th century travel album that trades in fragments of memory, pieces of voyages, and bits of history. It uses single images from various existing albums, reproducing and recontextualizing them to create a completely original "voyage." Movement sensing technology (computerized tracking devices) sense the presence of a viewer. "Bend sensors" embedded in the pages cause an electrical signal to be sent to a computer when a page is turned. Video and audio clips are in turn triggered that support, amplify, or contest the veracity of the photographic prints of idealized ancient settings through the simple juxtaposition of contemporary imagery and sound with historical photographs. For example, a black and white image of a Middle Eastern market--a classic example of the "exotic" and the "picturesque"--is overlaid with a video closeup in color of an orange being passed from the hand of one person to another in an Arizona back yard. Text is used throughout both descriptively and ironically to throw into question the truth value of what we are seeing. The message is deliberately multi-leveled and ambiguous, but one thing is clear: we are creating a journey in which we are complicit, not simply voyeurs.

The work enables a unique method of navigating the content and scores high in providing a seamless encounter between the user and the subject matter. While the artwork is described as being an interaction between a single user and a variable content, the entire set of options remains fixed in the computer's database. The work does not claim any degree of "reciprocity" between the object and the user. It does not "learn" the reader's habits. Therefore, it is not, strictly speaking, interactive. This does not diminish the project's ability inspire repeated visits and reward the user with unexpected discoveries. Given its non-linear organization and randomized sequences of multiple video clips, each user's experience of the book is actively engaging and unique.

As a model for a different "textbook" perhaps, the project points toward a new class of books that are constructed with the individual user in mind and that respond with some intelligence to reader's choices. The fact that Flax insists on preserving the essential kinesthetic aspects of reading--the feel of the paper, the turning of the pages--implies that certain direct forms of knowing just cannot be improved upon. However, the use of moving images, scrolling text, and audio clips that spill beyond the boundaries of the book have more in common with immersive experiences such as VR than reading. This is neither a conventional book nor an over-scaled e-book, but rather a hybrid of traditional forms and "reactive" hi tech processes.

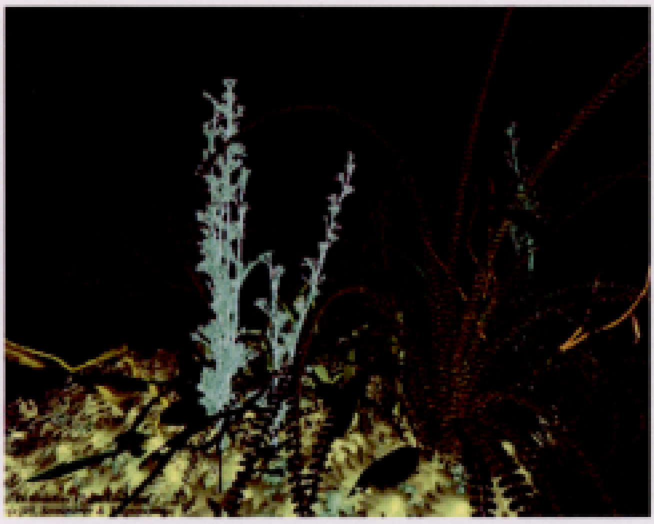
Christa Sommerer and Laurent Mignonneau: Interactive Plant Growing (1993)

Austrian-born Christa Sommerer and French-born Laurent Mignonneau teamed up in 1992, and now work at the ATR Media Integration and Communications Research Laboratories in Kyoto, Japan. In nearly a decade of collaborative work, Sommerer and Mignonneau have built a number of unique virtual ecosystems, many with custom viewer/machine interfaces. Their projects allow audiences to create new plants or creatures and influence their behavior by drawing on touch screens, sending e-mail, moving through an installation space, or by touching real plants wired to a computer.



Artist's rendering of the installation showing the five pedestals with plants and the video screen.

Interactive Plant Growing is an example of one such project. The installation connects actual living plants, which can be touched or approached by human viewers, to virtual plants that are grown in real-time in the computer. In a darkened installation space, five different living plants are placed on 5 wooden columns in front of a high-resolution video projection screen. The plants themselves are the interface. They are in turn connected to a computer that sends video signals from its processor to a high resolution video data projection system. Because the plants are essentially antennae hard wired into the system, they are capable of responding to differences in the electrical potential of a viewer's body. Touching the plants or moving your hands around them alters the signals sent through the system. Viewers can influence and control the virtual growth of more than two dozen computer-based plants.



Screen shot of the video projection during one interactive session.

Viewer participation is crucial to the life of the piece. Through their individual and collective involvement with the plants, visitors decide how the interactions unfold and how their interactions are translated to the screen. Viewers can control the size of the virtual plants, rotate them, modify their appearance, change their colors, and control new positions for the same type of plant. Interactions between a viewer's body and the living plants determine how the virtual three-dimensional plants will develop. Five or more people can interact at the same time with the five real plants in the installation space. All events depend exclusively on the interactions between viewers and plants.

The artificial growing of computer-based plants is, according to the artists, an expression of their desire to better understand the transformations and morphogenesis of certain organisms (Sommerer et al, 1998).

What are the implications of such works for education? How can we learn from this artistic experimentation to use technological systems to be better teachers? Educators have long recognized the importance of two-way or multi-directional communication. Nevertheless, many educators perpetuate the mindset of the one-way "broadcast"--a concept that harks back to broadcast media such as radio and echoes the structure of the standard lecture where teacher as "source" transmits information to passive "receivers." The notion of a "one-to-many" model that reinforces a traditional hierarchical top-down approach to teaching is at odds with truly democratic exchange. In Interactive Plant Growing, Sommerer and Mignonneau invert this one to many model by providing a system for multiple users to collaborate on the creation of a digital wall projection in real time. The system in effect enables a real time collaboration that takes many diverse inputs and directs them to a common goal. And this is exactly what good teaching is. This conceptualization of critical pedagogy has been developed in many different situations, but here is combined with technology that mirrors its structure.

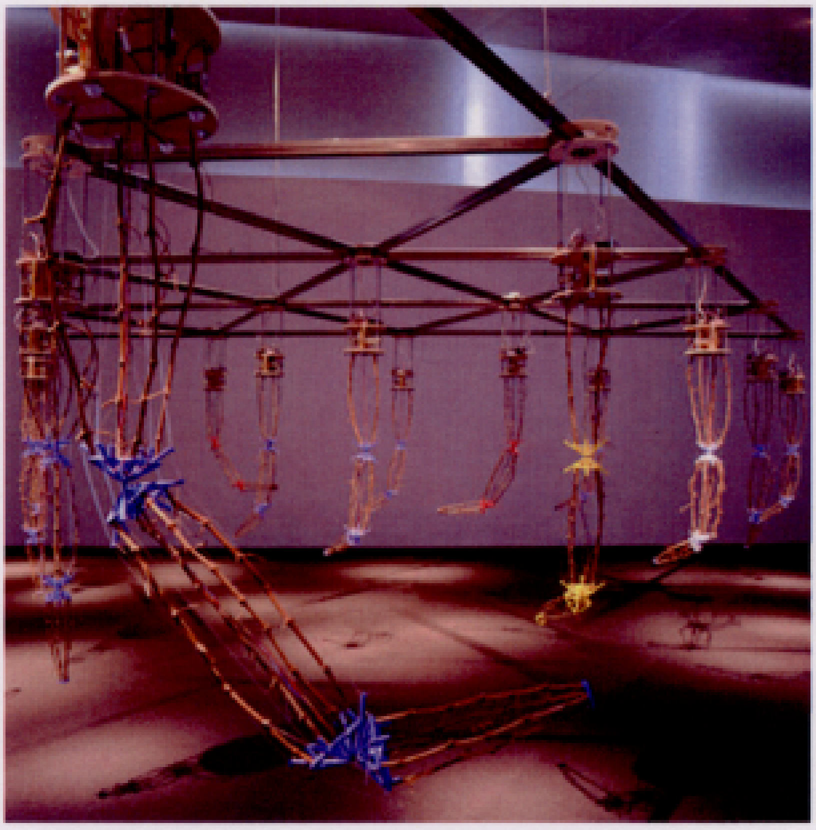
Sommerer and Mignonneau: *Verbarium* (1999)

In a more recent project the artists have created an interactive "text-to-form" editor available on the Internet. At their Verbarium web site, on-line users are invited to type text messages into a small pop up window. Each of these messages functions as a genetic code for creating a visual three-dimensional form. An algorithm translates the genetic encoding of text characters (i.e., letters) into design functions. The system provides a steady flow of new images that are not pre-defined but develop in real-time through the interaction of the user with the system. Each different message creates a different organic form. Depending on the composition of the text, the forms can either be simple or complex. Taken together, all text images are used to build a collective and complex three-dimensional image. This image is a virtual herbarium, comprised of plant forms based on the text messages of the participants. On-line users help to not only create and develop this virtual herbarium, but also have the option of clicking on any part of the collective image to de-code earlier messages sent by other users.

Screen shot of the Verbarium web page showing the collaborative image created by visitors to the site.
The text to form algorithm translated "purple people eater" into the image at the upper left.
This image was subsequently collaged into the collective "virtual herbarium."

In both the localized computer installations and web-based projects realized by Sommerer and Mignonneau, the interaction between multiple participants operating through a common interface represents a reversal of the topology of information dissemination. The pieces are enabled and realized through the collaboration of many participants remotely connected by a computer network. In an educational setting, this heightened sense of interaction needs to be understood as crucial. Students and instructors alike become capable of both sending and receiving messages. Everyone is a transmitter and a receiver, a publisher and a consumer. In the new information ecology, traditional roles may become reversed--or abandoned. Audience members become active agents in the creation of new artwork. Teachers spend more time facilitating and "receiving" information than lecturing. Students exchange information with their peers and become adept at disseminating knowledge.

Ken Rinaldo: *Autopoiesis* (2000)



Overview of all fifteen robotic arms of the Autopoiesis installation.
Photo credit: Yehia Eweis.

A work by American artist Ken Rinaldo was recently exhibited in Finland as part of "Outoaly, the Alien Intelligence Exhibition 2000," curated by media theorist Erkki Huhtamo. Rinaldo, who has a background in both computer science and art, is pursuing projects influenced by current theories on living systems and artificial life. He is seeking what he calls an "integration of organic and electro-mechanical elements" that point to a "co-evolution between living and evolving technological material."

Rinaldo's contribution to the Finnish exhibition was an installation entitled *Autopoiesis*, which translates literally as "self making." The work is a computer-based installation consisting of fifteen robotic sound sculptures that interact with the public and modify their behaviors over time. These behaviors change based on feedback from infrared sensors which determine the presence of the participant/viewers in the exhibition, and the communication between each separate sculpture.

The series of robotic sculptures--mechanical arms that are suspended from an overhead grid--"talk" with each other (exchange audio messages) through a computer network and audible telephone tones. The interactivity engages the participants who in turn effect the system's evolution and emergence. This interaction, according to the artist, creates a system evolution as well as an overall group sculptural aesthetic. The project presents an interactive environment which is immersive, detailed, and able to evolve in real time by utilizing feedback and interaction from audience members.

What are the pedagogical implications for systems such as *Autopoiesis* that exhibit "emergent properties?" Participant/learners interacting with such systems are challenged to understand that cognition is less a matter of absorbing ready made "truths" and more a matter of finding meaning through iterative cycles of inquiry and interaction. Ironically, this may be what good teaching has always done. So would we be justified in building a "machine for learning" that does essentially the same thing that good teachers do? One argument is that by designing such systems we are forced to look critically at the current manner in which information is generated, shared, and evaluated. Further, important questions are surfaced such as "who can participate"; "who has access to the information;" and "what kinds of interactions are enabled?" The traditional "machine for learning" (the classroom) with its single privileged source of authority (the teacher) is hardly a perfect model. Most of the time, it is not a system that rewards boundary breaking, the broad sharing of information, or the generation of new ideas. It IS a system that, in general, reinforces the status quo. Intelligent machines such as Rinaldo's *Autopoiesis* can help us to draw connections between multiple forms of inquiry, enable new kinds of interactions between disparate users, and increase a sense of personal agency and self-worth. While intelligent machines will surely be no smarter than their programmers, pedagogical models can be more easily shared and replicated. Curricula (programs for interactions) can be modified or expanded to meet the special demands of particular disciplines or contexts. Most importantly, users are free to interact through the system in ways that are suited to particular learning styles, personal choices, or physical needs.

IMPLICATIONS FOR ART AND EDUCATION

Interactive artworks of the future will enable interactions that are at once personal and universal. These interactions will be characterized by a subtle reciprocity between the body and the natural environment, and an expanded potential for self-knowledg and learning. Truly interactive experiences are already empowering individuals (consider the "disabled" community or autistic learners, for example).

Returning to various theories of interaction (particularly those of Ellen Wagner), several recommendations for artists emerge that begin to trace a trajectory for the education of the interactive artist. They include training on and empowerment with various technologies; understanding media-structured feedback loops (1) and methods for enhancing "mutual recriprocity"; rethinking where meaning is constituted (cognitive theory is now suggesting that "meaning" is seen as something that happens between rather than inside individuals); and redefinition of the roles of educators and learners. Rapid evolution in the art profession as a whole is creating changes in the definitions and roles played by art teachers and prospective artists.

There is no question that the uses of technology outlined here need to be held against the darker realities of life in a hi-tech society. The insidious nature of surveillance and control, the assault on personal space and privacy, the commodification of aesthetic experience, and the ever-widening "digital divide" between the technological haves and have nots are constant reminders that technology is a double edged sword.

But there is at least an equal chance that a clearer understanding of the concept of interaction--specifically interaction enabled by technology--will yield a broader palette of choices from which human beings can come together to create meaning. In watching these processes unfold, educators will surely find new models for learning.

Notes

(1) "The feedback loop is perhaps the simplest representation of the relationships between elements in a system, and these relationships are the way in which the system changes. One element or agent (the 'regulator' or control) sends information into the system, other agents act based upon their reception/perception of this information, and the results of these actions go back to the first agent. It then modifies its subsequent information output based on this response, to promote more of this action (positive feedback), or less or different action (negative feedback). System components (agents or subsystems) are usually both regulators and regulated, and feedback loops are often multiple and intersecting (Clayton, 1996, Batra, 1990)." (Morgan, 1999)

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return to Dan Collins's bibliography

Video Game that Uses Skin Contact as Controller Input

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Figure 1: Snapshot of playing Freqtric Game.

Abstract

In this paper, we present the first stage of our video game prototype which treats skin contact as controller input. Skin contact is communication which has special emotion. Video game also has elements of communication, for instance, Family Computer [Nintendo 1983] has two controllers in order that family or friends can play the game together. We use these two features and propose the interaction that players can enjoy video games with skin contact. We implemented the game controller and two video games. The controller has the mechanism which enables to detect skin contact. One of games of our prototype is a shoot-em-up game. Another is a rhythm action game. Our goal of this research is to show the increase of enjoyment and intimacy at the game with using skin contact.

CR Categories: H.5.2 [Information Interfaces and Presentation]: Input devices and strategies—Prototyping;

Keywords: interaction design, game controller, skin contact, video game, communication, interpersonal communication

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1 INTRODUCTION

Today the telecommunication penetrates our daily life, like telephone, e-mail, chat on Internet, etc. Certainly it is convenient and necessary to use these electronic way of communication, which offers certain proximity in distance. However, face-to-face, moreover, body-to-body communication is also necessary for human life to recover its inherent sensitivity. Especially, skin contact have its original power of communication. This kind of primordial communication is characterized by its corporal presence of each other and an interaction of bodies through skin contact, which are absent from a virtual space communication. In close personal relationships, such as family and friends, touch is particularly important as a communicator of affection. we play the game with our friends or family at multi player game mode. This has an interesting opportunity to experience communication in both virtual and real space.

From the view of game devices, recent game controllers have not only key buttons but also various sensors in it. These efforts to improve game controller encourage to create new type of games. For instance, by Wii controller[Nintendo 2006], we came to be able to enjoy a new type of games that was not before. It is important to make unprecedented controller in order to create a new type of games.

We presented implementation and performance of a musical instrument "Freqtric Drums" which treats a human skin contact as a musical interface [Baba and Tomimatsu 2006]. In this paper we applied this technique to video games. By adding the mechanism of skin contact detection to a game, A player comes to be able to communicate with another player in the real and virtual (game) space (Figure 1). Our goal of this research is to show increase of the degree of enjoyment in the game which has skin contact input. We present the game controller device and two video games which treat skin contact as controller input. We call our prototype of this video game system "Freqtric Game". Freqtric Game is a 2-player game system which has the mechanism of skin contact detection.

2 RELATED WORK

There are many types of a game device, such as Joysticks, gloves, foot controller, Wii controller and so on.

In the case of applying part of human body to game control input, Shou et al. proposed a face-tracking as game controller input[Wang et al. 2006]. And J.David et al. proposed the eye-tracking for video game control[Smith and Graham 2006]. Their devices are unique and intuitive one, but also are high cost and big one to install. Our sensing module is so small and easy to implement to other game devices at low cost.

Scott et al. and BJ Fogg et al. proposed a haptic device as interpersonal communication and entertainment[Brave and Dahley 1997][Fogg et al. 1998]. They used haptic feedback technology in it. Their Concept is similar to us, but our approch differs in using human body as a interface from theirs.

3 SENSING TECHNIQUES

We propose a game system that is enable to treat human skin contact as controller input. In order to do so, we need the sensor device which can detect skin contact. Then, we investigated two method for sensing. One method is human body transmissions. Another is Electro Dermal Activity(EDA).

3.1 Human body transmission

Human body transmission uses a human body as a transmission medium allows wireless communication without using airborne radio waves. Zimmerman proposed human body transmission first[Zimmerman 1996] . There are some implementation for data communication[Hachisuka et al. 2003][Fukumoto and Tonomura 1997].

To apply this technique to our skin contact sensing, we have the following two restrictions: (1)taking several time to detect a skin contact, (2)can not detect the intensity of touching. When we do skin contact, there is not always enough time for data communication. And human body transmission could not detect a intensity of touching.

3.2 EDA

EDA(Electro Dermal Activity)is a term used to describe changes in the skin's ability to conduct electricity. Amount of electric current in the inside of the body is measured. EDA technique is used as polygraph and so on. Changes in the skin's ability to conduct electricity is mainly related to internal body resistance and skin resistance. Especialy human skin resistance(100-4000 Kohm)is enough larger than internal body resistance (25-120 Kohm) to ignore internal body resistance. Skin resistance is related to the degree of touch intensity and size of a touch surface. In order to sense the degree of touch intensity, we use human skin resistance and subtle direct current.

We implement the device that can detect not only skin contact but also the intensity of skin contact. It is important to detect the intensity of skin contact, because softer touching has different meanings from harder touching at touch communication. We use EDA for implementation in order to express players delicate nuance.

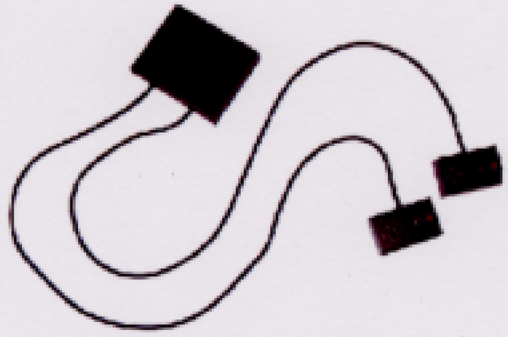

Figure 2: Freqtric Game controller device.

Figure 3: Using Controller (up: normal operation, down:skin contact input)

4 IMPLEMENTATION

4.1 Hardware

Our device called "Freqtric Game Controller Device (FG controller device)" looks like a regular game controller (Figure 2), but it contains our original sensor to detect skin contact. The looks of FG controller device shows that we can easily apply "Freqtric Game Sytem" to existing games. Handling FG controllers, two players can do skin contact input by touching each other. There is a stainless steel plate on the back of each controller. Players are connected to the sensor of FG Controller to handle their FG controller (figure 4). Figure 3 shows snapshots of skin contact input. In order to detect the degree of skin contact intensity, we use analog photocoupler (MI0202CL) as a part of the circuit. When we treat human

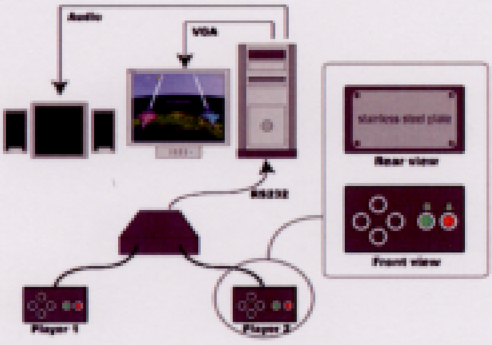

Figure 4: The overview of Freqtric Game system.

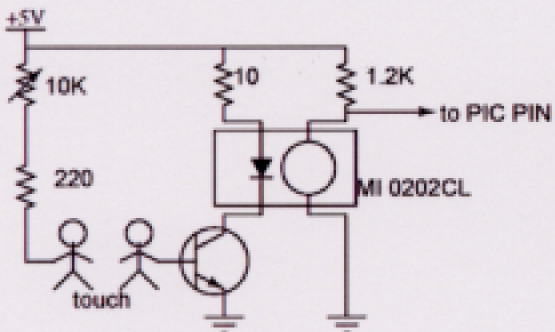

Figure 5: The circuit of FG controller sensor module.

bodies as a leading wire, we must take consideration of the noise from human ground. We can ignore the noise by using analog photocoupler, because analog photocoupler need some milli seconds to be turned on. Responce time of analog photocoupler is about 6-10 [ms]. [1] It is so small to find latency for players. Figure 6 shows sample data when players touch each other repeatedly. The value of voltage takes from 0.9 to 5.0[V]. If players are not touching each other, value of voltage indicates about 5[V]. The harder, the lower voltage become. The softer, the higher voltage become. 5 is the circuit of our sensor module.

FG controller device has Microchip[2] (PIC18F425) in it. FG controller device is connected to the computer through RS232 communication. Figure 4 shows the overview of our system.

4.2 Software

We made shoot-em-up game which is called "Freqtric Shooting", rhythm action game which is called "Freqtric Dance" and simple competitive fighting game called " Freqtric Robot Battle " to show examples of video games using FG controller.

Freqtric Shooting: shoot-em-up game

Figure 7 shows screenshots of Freqtric Shooting. Freqtric Shooting is a type of shoot-em-up games. A shoot-em-up is a computer and

[1] From MI0202CL data sheet.
[2] MICROCHIP: http://www.microchip.com/

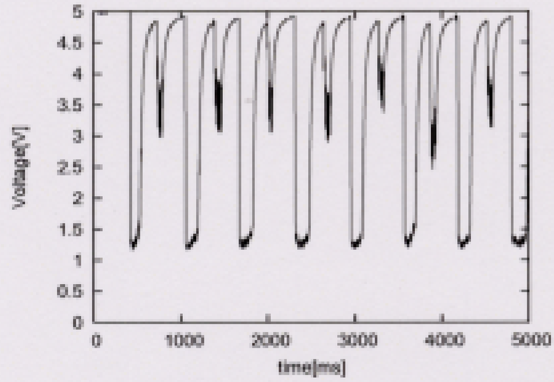

Figure 6: Sample data of our sensor. Repeatedly one player touches another hardely, then softly.

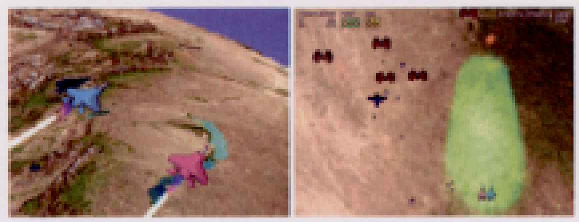

Figure 7: Screenshots of Freqtric Shooting

video game genre where the player has limited control of their character or machine (usually a jet fighter or spaceship) and the focus is almost entirely on annihilation of their enemies.

Normal operation

Players move own jet fighter to press arrow keys on the FG controller. They can shoot missiles from their fighters to press B button. A missile has four degrees of power and four types. Players can change a missile type to get a colored (red, green, blue, white: default) star object. Their fighters explode to collide with enemies or enemies' missile.

Special operation with skin contact input

By doing special operation, "skin contact with other player" in the real world comes to become corporation in the game world. We think that this encourages enjoyment or intimacy at corporative work between 1-player and 2-player.

Bomb: clearing enemies and enemies' missle on the screen
Pressing both A and B button, players can destroy all enemies and enemies' missile on the screen by touching another player. They can increase stocks of the bomb up to three by getting a yellow star object.

Unit: power up own fighter
Players' fighter is united by touching each other when a player is near by another on the screen. Players can shot "energy shot" and move fighters is the twice as quick as single fighter while fighters are united.(figure 7)

Revival of own jet fighter
Each player has only one life. After explosion of own jet fighter,

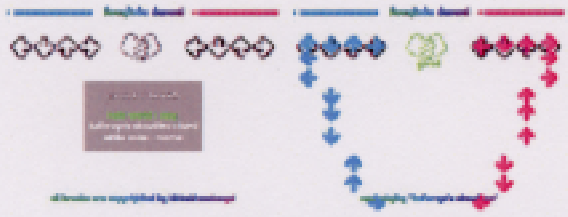

Figure 8: Screenshots of Freqtric Dance

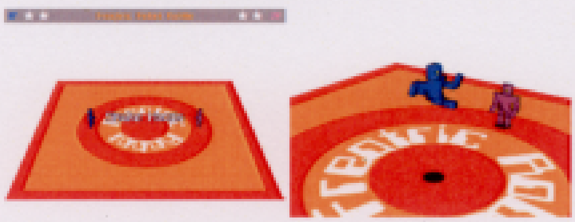

Figure 9: Screenshots of Freqtric Robot Battle

player can't rejoin to the game by himself. But if one player doesn't lose his/her life, another player can join to the game again by touching other player 100 times.

Freqtric Dance: rhythm action game

In a rhythm action game, the player must press specific buttons, or activate controls on a specialized game controller, in time with the game's music. We made this type of game called "Freqtric Dance". 8 shows screenshots of "Freqtric Dance".

The gametype features the following gameplay: as arrows and hand marks scroll upwards on the screen, they will meet with a stationary set of target arrows and hand mark. When they meet the targets, the player should press the proper arrow button or touch the other. The moving arrows and hand mark will meet the targets based on the beat of the song. The message (perfect, good, bad, miss) is displayed based upon how accurately players can trigger the arrows or hand marks in time to the beat of the song. Players' efforts are awarded by letter grades that tell him/her how well the player has done; A is the highest award and D is total failure.

Freqtric Robot Battle

Players can move own robot to press arrow keys on the controller. They can shoot missiles from their robots to press B button. A player is fallen from the stage first will be a loser. Players also can use skin contact input. Players can attack the other robot by slapping the other player. Players also can stick to the other robot by grabbing the other player. To start or end the game, player must do " shake hands " as the manner of sportsmanship. Figure 9 shows screenshots.

5 FUTURE WORK

We made two types of video game using FG controller device. Our goal of this research is to show the increase of the degree of enjoyment and intimacy at the video game with skin contact detection. In order to do that, we need three - four types of the video game. Now we are considering and making other type of video games, such as action, puzzle, sport game and so on.

As Shou et al. evaluated whether the interest or enjoyment of the game changes as a result of the type of input device, by the subjectivity evaluation method and the user observation method, etc[Wang et al. 2006]. After making a few more games, we shall experiment and investigate about enjoyment and intimacy at our game which treats a skin contact as controller input.

6 ACKNOWLEDGEMENT

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The Virtual Raft Project: A Network of Mobile and Stationary Computer Systems Inhabited by Communities of Interactive Animated Agents

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1 ISLANDS AND RAFTS

This project presents a novel interaction paradigm in which computer screens serve as islands of virtual space ("iLands"). Mobile "virtual rafts" let people move animated agents between iLands (see Figure 1). The project features innovations in heterogeneous computer graphics, tangible human-computer interaction, interactive animated characters, and mobile computing technology. It has applications in education, entertainment, and new media art.

2 ART AND SCIENCE

The Virtual Raft Project offers a unique physical and graphical interaction that can be used for learning and interactive storytelling, and as a "sand box" in which participants can experiment with interactions of animated agents. There are three main goals for this project:

- To develop an interactive platform that enables physical human interaction with virtual characters.
- To explore the implications of this kind of heterogeneous platform for animation of autonomous characters, as they break away from the constraints of a fixed desktop screen.
- To enable active learning by creating an engaging setting for exploring a range of content domains, starting here with color theory, but extending to more complex domains such as ecology and other system sciences.

3 INNOVATIONS

There are three main innovations for this project. First, this project offers an example of animated characters that are able to move seamlessly among heterogeneous graphical systems. If a character appears on only one screen, it does not seem to "exist" as an entity apart from that screen. If, on the other hand, a character can move between devices, then it appears to exist in a way that is not dependent on any given machine. Networked multiplayer games do this to a certain extent as well, but there the characters remain "in the box." The characters in the Virtual Raft Project appear to exist in real space, interacting physically with people, and are able to move between both stationary and mobile graphical screens. Through this dynamic cross-screen animation, the characters appear to be more believable than characters that only exist on fixed computer screens.

Second, through the virtual rafts, the work presents a novel tangible interaction between humans and virtual characters. Accelerometers in the tablet PCs allow characters on the rafts to respond in real time to the physical motion of the device; this visual feedback appears to enhance the realism of the characters and create an enjoyable experience for human interactors.

Finally, the work demonstrates an "island metaphor" for computational interactions, which helps to frame the relationship between real space and virtual space, and between the real creatures and virtual creatures that inhabit those spaces. As the autonomy of computer programs increases, the desktop metaphor is constraining the kinds of interactions that people might have with computers. A metaphor that lends itself to autonomous computational entities is needed. The island metaphor may provide an interesting way to think about human-computer interactions that is somewhat different from the traditional desktop metaphor. Considering computers in this way could open up new possibilities that might not be evident from other points of view.

4 FUTURE WORK

This example of a novel interaction paradigm enables autonomous animated characters to break free from the traditional desktop screen. Because it allows characters to jump between stationary and mobile computing platforms, the system increases the realism of the characters and helps to frame the way people should interact with autonomous agents. The "island metaphor" for computational devices points toward a new kind of interaction designed to accommodate and enhance the capabilities of autonomous systems. This interaction could be used as a platform for new kinds of educational exhibits, new genres of location-based entertainment, and new forms of interactive media art. In particular, the development team is currently collaborating with several science centers to develop a version of the project based on multi-species ecological interactions.

Figure 1: A participant carries a virtual raft up to an iLand.