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Investigating Interdisciplinary Collaboration: Case Studies in Art and Technology

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Abstract

In order to understand how collaboration between people from different disciplines takes place, research is being undertaken in the area of art and technology. The paper describes two studies of collaboration between artists and technologists drawn from the COSTART (COmputer SupporT for ARTists) project, an artist-in-residency programme that provided a platform for studying the creative process. The paper describes how the research was carried out and, in particular, how the data analysis was conducted using a coding scheme developed specifically for this context. Finally, the preliminary findings are discussed and future work is proposed.

INTRODUCTION

The paper describes an approach to investigating art and technology collaboration based upon case study data. It begins with a brief account of the art and technology context with specific reference to the COSTART project where the data collection took place. It goes on to describe the coding scheme for analysing the data and gives examples of how the analysis was undertaken. In the last section of this paper, preliminary findings are discussed which reveal certain aspects of art-technology collaboration in particular, how the relationship between shared language, individual backgrounds and interests affect each other and how computers affect communication between artists and technologists.

Study of Art-technology Collaboration

When C.P Snow first introduced the concept of "the two cultures" in the 1950s, the idea that there would one day be widespread interdisciplinary work that attempted to bridge the gap between art and science would have seemed fanciful. Today, there are programs funded by governments, private foundations and companies that explicitly encourage the transfer of ideas between differing disciplines and it continues to be an emerging area for research, such as residency program PAIR at XeroxPARC (Harris 1999), residency program SCIART funded by Wellcome (Wellcome 1997-) and residency program SYNAPSE funded by Australian Research Council (Synapse 2006). One of the common goals of these programs is to have a strategy in place that encourages creativity across the whole spectrum of collaboration. Hargrove (1998) argued that: "The different views and perspectives in collaboration are essential to help people better understand each other and light the park of creativity. ... Creativity occurs when people are able to connect different frames of reference in ways that result in creating or discovering something new... Think about how much greater the possibility for creative, high-leverage, catalytic ideas exists when many minds, or an extraordinary combination of people are brought together through the shared context of a dialogue around a common goal or problem.". In respect of the research described in this paper, the 'many minds' and 'shared context' were explored in the context of creative collaboration in art and technology.

John-Steiner (2000) claimed that despite our tendency to think of creative work as being the pursuit of the solitary individual, new ideas are more often than not generated through a process of shared struggle with others. Moreover, Fischer (2000) found that the power of the unaided individual mind is highly overrated (Fischer 2000). Thus it is very important to study collaborative creativity as a social process and to understand how group creativity takes place. In art practice that exploits and extends the use of technological media, collaboration between people of different disciplines is lively and growing and the opportunities for understanding the process expanding. COSTART (COmputer SySTems for Creative Work: An Investigation of ARt and Technology

Collaboration) (COSTART 2002) was a significant initiative in this area (Edmonds et al. 2005). The main purpose of the COSTART project was to carry out research into creativity between artists and technologists, bringing experts together in Human Computer Interaction, Creative Media and Digital Art Practice in order to study the nature of collaboration in creative work (Candy & Edmonds 2002a).

In the research from which this paper arises, we are investigating examples of art-technology collaboration from COSTART in which projects defined by artists were carried out with the support of technologists. The aim is to understand better what could affect the collaboration between artists and technologists. The analysis methods that have been applied to the data include descriptors of the collaboration context and features of communication and collaborative behaviours. In the following section, two case studies in interdisciplinary collaboration are described.

TWO CASE STUDIES

Two case studies have been selected from the COSTART cases. Each case involved three kinds of participants: artists who submitted a residency proposal, technologists who have the expertise artists need and observers who collect data during the residency by direct observation over a period of five days. Preparatory work was begun in advance of the actual period in residence in order to identify required tools and expertise necessary to support each project.

Case A

In the first case, the proposal by the artist A_1 was made to develop a 3D computer model based upon an existing physical model. During the residency, the goal was to model a physical object by using a software- application called 3D Studio Max. The artist A_1 had considerable expertise in the use of computer technology, particularly in relation to the design and production of web sites but she was not familiar with the 3D Studio Max software. The technologist T_1 had advanced expertise in the 3D Studio Max software but he had very limited knowledge about art. The observer O_1 was himself an experienced digital artist who had worked in art and science collaborations before. The data collected for each case includes field notes by the observer, residency diaries by the participants and selected sound tracks of conversation among participants across in the residency. The combination of information can provide the context to the detailed protocol analysis work. The following table 1 shows the details of selected recorded sessions by time, location and subject content. The data used for this analysis comprises selections from the detailed transcriptions representing a sequence of conversations that took place over three days. Other data such as field diaries and interviews were also included into the analysing data sets to validate interpretations. Those data listed in table 1 were used for the data analysis discussed in the following sections.

	Day 1			Day 3		Day 5
Tack	1A	1A	1A/B	2A/B	2B	2B
Time	10:00-10:20	11.55-12.15	15.05-16.30	11:45-12:19	16:45-17:25	10:50-11:05
Location	T1 office	Studio	Studio	Studio	Studio	Studio
Content	Initial meeting	Work with model	Lighting	making new models	morphing plus	exploring animation

Table 1: details of the recorded conversation during the residency in case A

Case B

In case B, the artist A_2's objective was to create a composition of percussion and orchestral samples which could be executed in real-time by several participants across the Internet. A_2 came from a music background and he also had some knowledge about computers and software. But compared with the artist A_1 in case A, A_2 did not have much experience in practice. The technologist T_2 in this case was a fully-trained computer technologist and had also worked as a designer for years. The observer O_2 was an experienced field researcher, who had done many studies in creative art research and design. In this case, the data collected from COSTART project were field notes by the observer O_2, selected conversation recording data among participants, residency diaries by participants, and interviews of participants. The following table 2 shows the detail of recorded sessions by time, location, subject content. The data used for this analysis comprises selections from the detailed transcriptions representing a sequence of conversations that took place over three days. Other data such as field diaries and interviews were also included into the analysing data sets to validate interpretations. Those data listed in table 2 are used for the data analysis, discussed in the following sections.

	Day 1		Day 2	Day 3	
Track	Track 1	Track 2	Track 3	track 5	Track 7
Time	10:00-10:20	11.55-12.15	15.45- 16.20	11:45-12:19	16:45-17:25
Location	T2 office	Coffee Room	O_2's office	O_2's office	Sensor Lab
Content	Initial planning meeting	Overview Technical Options	Review	Review	Major Turning point

Table 2: details of the recorded conversation during the residency in case B

In the rest of the paper, we will discuss how the code scheme was developed, how we analysed these data and what kinds of findings arose from the analysis.

CODING THE DATA

The analysis presented in this paper was applied to data samples from case A and B, the details of which are shown in Tables 1 and 2 above. In order to organize, clarify and map the large amount of qualitative data, we used Nvivo, which is a Computer Assisted Qualitative Data Analysis Package (CAQDAP) developed by QSR international (Bazeley & Richards 2000). Nvivo dramatically improves the efficiency and accuracy of qualitative analysis compared with the traditional manual approach. It provides functions to support the coding and retrieval of text and also it provides functions for researchers to write down their research memos during the analysis process (Gibbs 2002).

For this research, the code scheme was developed in two ways using different sources. The first way was to use selections of existing data and to record the phenomena disclosed by the data: for example, *Skill-A* node contains the data segments about how artists talked about their skills. The second way was to include some of the existing literature about collaboration such as Fourmentraux (2006) and Candy (2002a): for example, the *Leadership* node contains data which is related to who led the collaboration. The following figure represents how the code scheme was developed and how the preliminary results arose from this analysis.

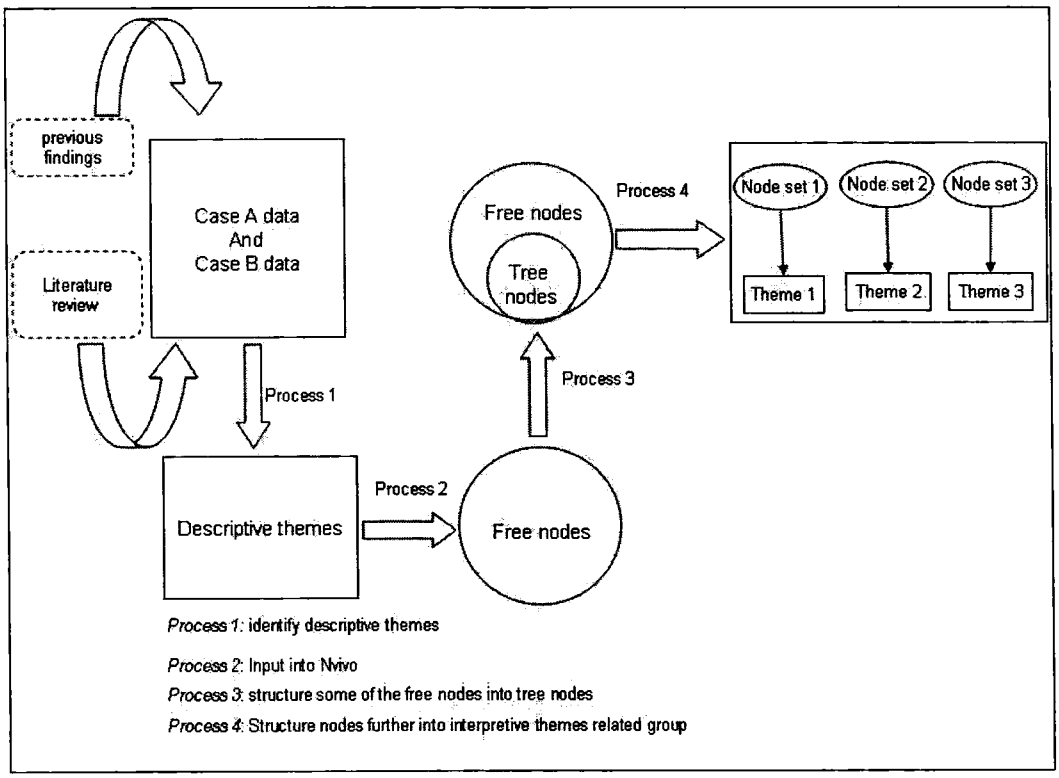

Figure 1: The flowchart of the data analysis process in this research

The flowchart in Figure 1 displays the process of developing the code scheme and how the preliminary results arose from the analysis. In process 1, descriptive themes which are summaries of what informants have said or

done (Gibbs 2002) are identified from the data of case A and case B. In process 2, those descriptive themes are input to Nvivo as free nodes, which represent an unstructured collection of nodes (Bazeley & Richards 2000). In process 3, free nodes are categorized and refined into tree nodes, which are organized into hierarchies, moving from a general category at the top to more specific categories down the bottom (Bazeley & Richards 2000). The examples of the nodes can be found in the following section 'The Code Scheme'. In process 4, some of the free nodes and tree nodes are regrouped further into node sets where nodes are related with each other to formulate interpretive themes. The difference between interpretive themes and those descriptive themes in process 1 is that descriptive themes are used to record the original phenomena directly come from the data and interpretive themes are used to find patterns among descriptive themes. In Nvivo, interpretive themes can be presented by node sets, where a group of nodes are used to construct a certain interpretive theme. There are two node sets formulated in this research, the discussion for each node set will be presented in one of the following sections 'Preliminary Findings'.

Refining the Code Scheme

During the four analysis processes mentioned above, the code scheme was refined in two ways. One was to change names or addresses of nodes. For example, during the process 3 in the figure 1 (see above), some of the free nodes were grouped into tree nodes. Those changed nodes do not affect the previous analysis because Nvivo nodes contain the links to the coded segment instead of real data and changing the name does not affect these links. The other way of refining the coding scheme was to create new codes when it was applied with more data. For example, in process 1, when the code scheme in case A was applied to case B data, some new nodes were made to record new facts emerged from the case B. When a new node was made, a check back to the coded data was conducted to make sure not to omit some data related to the new node. This checking is very necessary to make sure of the reliability and consistency of the data analysis (Bazeley & Richards 2000). In the remainder of this paper, the refined code scheme applied to the data in case A and B will be presented in detail and the preliminary findings which emerged from the process 4 in figure 1 will be discussed.

THE CODE SCHEME

As it has been mentioned above, there are two kinds of nodes in this code scheme: free nodes and tree nodes. As most of the free nodes were developed into a hierarchical tree structure in the process 2 of figure 1, the code scheme presented in this paper is mainly about the tree nodes. The following figure 2 shows the top three levels in the hierarchy of the code scheme, which is composed of three branches: *Context*, *Communication* and *Behaviour*. These branches represent three different approaches to categorizing the data. For example, *Context* branch is for analysing the context in each case, such as the participants' profile and the project profiles etc. *Communication* branch is for analysing the recorded conversation between participants during the collaboration. *Behaviour* branch is for analysing the collaborative styles of participants and the styles of the collaboration. In the rest of this section, a selected group of nodes in each branch will be illustrated with descriptions and brief examples.

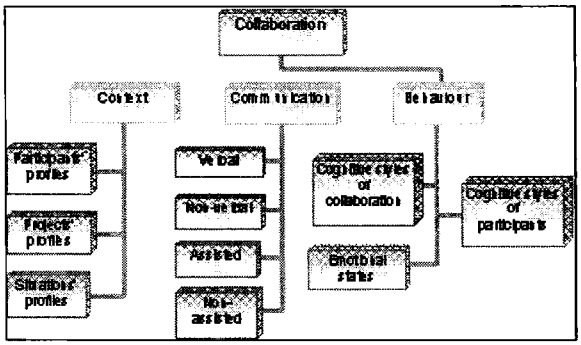

Figure 2: The top three levels of the code scheme

Context

In the *Context* branch, the nodes are summarized into three subcategories: *Participants' profiles*, *Projects' profiles*, and *Situations' profiles* (see also Figure 3) according to different kinds of context information. For example, *Participants' profiles* category contains each participant's expertise background. *Projects' profiles* category contains information of the project proposal and documents about final projects. *Situation' profile* category records information about how the technical environment was set up for participants, where the physical working environment was, whether they had collaborated with each other before and whether there was

some contact after the residency amongst the participants. More detail with examples can be followed in Table 3 below.

Category	Node	Description	Examples
Participants' profiles	Expertise-T	Technologists' expertise	Max (3D software)
	Expertise-A	Artists' expertise	Architecture and web design
	Expertise-O	Observers' Expertise	Field Research
Projects' Profiles	Proposal	Artists' proposals	A 3D model
	Final work	Outcome descriptions (including pictures or video shots of artefacts and word documents)	Pictures of the 3D model
Situation's profiles	Physical environment	The residency's physical location	Studio, Lab, etc.
	Technical environment	The types of software and hardware they used in the residency	G5, glove, Max MSP
	Collaboration history	Whether they collaborated with each other before	Yes/No
	After residency	Whether they contacted each other after residency	Yes/No

Table 3: Nodes in the *Context* branch

Communication

In the *Communication* branch, the nodes are summarized into two pairs: *verbal* and *non-verbal, assisted* and *non-assisted* (see also figure 3). In the first pair, the *verbal* category records some verbal communication components, such as *Interruption* node, *Talking conflict* node, *Common language* node. The *Non-verbal* category records *Silent* node, *Laugh* node and *Eye Contact* node. The *Assisted* category shows what kind of mediation in communication, which can be computer, white board and paper etc. The *Non-assisted* category records the conversation transcriptions without any mediation, for example, face to face talk. The more detail with examples can be followed in table 4.

Category	Node	Description	Examples
Verbal	Talking conflicts	includes misunderstanding, clarification, disagreement etc.	"A_1: But... T_1: yes, but...A_1: but..." "I mean again that I just want to try it out."
	Interruption	Interruption during the conversation	"A_1: I mean...T_1: lighter?"
	Common language	The language, as demonstrated by terminology used, was shared or restricted to one or other individual[1]	
Non-verbal	Silent	Break between the conversation	
	Laugh	Laugh during the conversation	
	Eye Contact	See each other by eye contact	
Assisted	Computer –assisted	Conversation when participants use computer as media, such as talked in front of computer	"A_1: I want this line a little bit lighter. T_1: which one? A_1: this one."
	Whiteboard-assisted	Conversation when participants draw something on the white board	"How about we use the white board to make it clearer?"
	Paper-assisted	Conversation when participants draw something on the paper	"This is the scratch about what I want to show in 3D."
Non-assisted	Face to face	Face to face communication without any media, such as computer, paper etc.	"...I'm working with technology that I've not previously used I started to use the 3D modelling about a year..."

[1] The more detail about this definition could be found in the conference paper "modeling co-creativity in art and technology" (Candy & Edmonds 2002b)

Table 4: Nodes in the *Communication* branch

Behaviour

In the Behaviour branch, the nodes are summarized into three categories: Cognitive styles of collaboration, Cognitive style of participants and Emotional states (see also figure 3). The Cognitive style of Collaboration category contains a group of nodes categorizing the collaborative features in each case. For example, the evidence about who led the collaboration will be recorded in the Leadership node and the evidence about learning process in the collaboration will be recorded in the Learning node etc. Under the Cognitive style of participants category, there is a group of nodes that categorize participants' behaviours in collaboration. For example, the evidence about participants' exploratory attitude is recorded in the Exploratory node or if participants talked about specific goals, these conversations is recorded in the Goal-driven node etc. The last category 'Emotional states' in the behaviour branch records participants' statements about evaluating the collaboration, emotional feelings, such as happy, frustrated etc. More details with examples can be followed in Table 5 below.

Category	Node	Description	Examples
Cognitive styles of collaboration	Leadership	Whether artists or technologists dominated the collaboration or they have an equal role	"I would like to you to change the light...", "I want this to be done like..."
	Learning	Learning process was described	"I've learnt ...", "I am very interested in this software and I want to learn it"
Cognitive styles of participants	Goal Driven	Talking involved with specific goals	"First we had to implement..., then we'll do the morph and then we'll test the animation"
	Exploratory	Talking involved non-specific goals	"I just want to try it out, it doesn't matter...", "How about we do this way and see..."
	Flexibility	Artists show strong interests in the technical parts or technologists' show strong interests in the artistic parts.	A $_1$: "I know that on-line video software can do..."
Emotional states	Evaluation	Participants' comments about collaboration	"We have achieved most of the parts compared with the original plan."
	Positive Emotion	e.g. happy, satisfied etc.	"Woh, I am so impressed that this could be done..." , "I am very happy with the outcome of the residency"
	Negative Emotion	e.g. frustration, worry, fear etc.	"I feel a little bit frustrated..."

Table 5: Nodes in the *Behaviour* branch

In the next section, the preliminary results will be presented and discussed by grouping some of these tree nodes across different branches into node sets.

PRELIMINARY FINDINGS

As we have mentioned in the earlier section 'Coding the Data', the analysis was summarized into four steps. The first process is to identify descriptive themes from the data and the second step is to input these themes into Nvivo as nodes. The third step is to refine these nodes and group some of them into hierarchy structure as a code scheme, which was explained in detail in the previous section 'the Code Scheme'. The last step in the data analysis is to formulate some node sets, where a group of nodes from different tree branches are bound together to reveal some interesting insights of the data. During this process, in each node set, the data categorized into different categories in the previous steps are revisited and re-analysed within the group. With the coded information each node contains from these two cases and the correlative comparison between nodes, some preliminary findings have emerged in each node set. In this section, we will talk about two node sets: 'relationship' and 'mediation'. The first node set 'relationship' explores aspects of relationship between interests, common language and background of artists and technologists in case A and B. The second set 'mediation' explores aspects of the forms of the mediations artists and technologists used to communicate with each other.

The Node Set 'relationship'

The first node set contains five nodes selected across the *Context* branch, *Communication* branch, and the *Behaviour* branch of the code scheme. The node selected from *Context* branch is the *expertise-A* node and the *expertise-T* node. The node selected from *Communication* branch is the *Common language* node. The nodes selected from *Behaviour* branch are *'Evaluation'* and *'Flexibility'*. There are three steps in the analysis process carried out in this node set: firstly summarize the data coded by each node (see table 6), secondly according to those summaries drawn in the first step, analyse some selected examples from the coded data in detail to get deeper understanding of the data. Thirdly, identify some theme based on the summaries from the first step and the specific analysis from the second step. Thus, in this section, we will present the summary of the coded data in this node set and then move to the specifically analysis of a selected coded data and in the end of the section a theme will be presented and discussed.

Branch	Category	Node	Case A	Case B
Context	Participants' profiles	Expertise-A	Art and general computing	Music and general computing
		Expertise-T	Computing	Computing and design
Communication	Verbal	Common language	Distinct	Shared
Behaviour	Emotional states	Evaluation	Successful	Failed
	Cognitive style of participants	Flexibility	A1 was strongly interested the technical issues, but T1 didn't show that much interest about the aesthetical issue.	The participants showed equally strong interest in one other's domain.

Table 6: the node set 'relationship'

From the analysis of the *Context* branch, we found that participants shared different of expertise background between each other in case A and case B. In case A, A_1 and T_1 shared limited common background between each other. While, in case B, A_2 and T_2 shared reasonable large amount of the common background between each other. Furthermore, from the coded data in *Flexibility* under *Behaviour* branch we had found that the participants in case A were less flexible with each other's field than in case B. In case A, A_1 showed some strong interests about the technical issues, but T_1 didn't show that much interest about the aesthetical issue. Compared with that, in case B, the participants showed equally strong interest in other's domain, such as A_2 and T_2 had a lot discussion about some shared topics, such as the technical requirements, the artefact's features and so on. Here is an example selected from case A, where A_1 showed her strong intention to know the technical parts of the project:

> "A_1: I'd like to do some of the modelling because I'd like to get some advice as well about how to...I'd like to learn about 3D modelling. I'd like to get some advice about how to approach these sorts of shapes.
>
> T_1: OK, so what I'll do is I'll just draw a few things. " (Track 1A, 10:05-10:25, day 1, Case A)

But the technologist T_1 did not show much interest in the aesthetic issues of the project. When the process came to the aesthetic parts, such as what kind of light effects were required by A_1, T_1 usually accepted A_1's ideas and tried to implement those ideas in the software as far as he could understand them.

However, compared with the case B, A_2 and T_2 showed evidence of more' bonding' with each other. A_2 was very interested in the technical issues, such as what kind of music upload protocol was used and T_2 was interested in the aesthetic issues, such as some specific requests about music editing. Moreover, from the *'Common language'* category of the *Communication* branch, we can see that in case study A and B had different level of common language. In case A, the artist and the technologist did not exhibit much common language that could be shared. Here are two examples from case A, which demonstrate their differentiated talking styles.

> "T_1: So in the beginning she drops the ink and then starts dissolving.
>
> A_1: It works really well, almost like a layer...seaweed..." (Tack 1A, 11:55-12:15, day 1, case A)

> "T1: Because I remember when you said you touched it rippled.
>
> A1: yeah, but if you touched it, it wouldn't be so much of a ripple it would be more of a - if you put your finger into a balloon it would be more of an indent really." (Tack 1A/B, 3:05:-3:30, day 1, case A)

The context of the first example is that they were discussion a colour effect in the physical object. The context of the second example is that they were talking about a ripple effect in the 3D model that they were developing. In these two examples, the artist used very descriptive terms to explain what kind of effects she wanted to make in the 3D model; by contrast, the technologist used simple terms to present the similar content. The analysis showed that there were differentiated terms that indicated a small degree of shared language. This result correlated with the degree of interest in each other's domain. In other words, case A demonstrated that there was not much shared-language between the participants and, at the same time, the participants did not show much interest in each other's domain.

In comparison, in case study B, the artist and the technologist had a reasonable shared common language and they also showed a high level of interest in each other's work. Here are two examples of the common language between participants in case study B:

> "A2: ...it is stream down. What I am thinking was, if you have a computer and run on the Macintosh, receive the information, and then, it seems like a right way to do it, but you can send the sound files back to the computer with producer.
>
> T2: right, then the real producer will send it, because we've got a quick server, I suppose that we could find out it would work with that.
>
> A2: Hum, yes. " (Tack 1, 10:00-10:20, day 1, case B)

> "T2: we are kind of modifying the commands, create music commands
>
> A2: yeah. It's.., I think that is specifically, like a music engine part of it. So, that is modulation is changing the actual instruments...
>
> T2: well. We should definitely do that and see what else you can control what you are saying." (Track 3, 15:45-16:20, day 3, case B)

The context of the first example is that they were talking about the way to send sound streams from one computer to another. The context of the second example is that they were discussing how to create a new sound. Compared with the two previous examples from case A, these two examples indicate that the artist and the technologist in case B used more shared terminology and exhibited more shared understanding within the context.

Therefore, from the comparison results in case A and case B in the node set 'relationship', we found that there exists a link between the level of shared background, the level of shared interests with each other's domain and the level of common language they shared with one another (see also the following figure 3). From this we may conclude that the more common ground participants shared with each other, the more interest they showed in each other's domain and the more shared language they had.

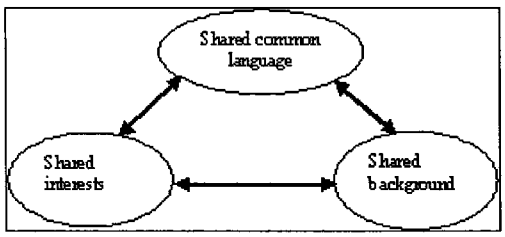

Figure 3: the relationship among shared common language, shared background and shared interests

The Node Set 'Mediation'

The second node set 'Mediation' contains six nodes across the *Communication* branch and the *Behaviour* branch of the code scheme. The nodes selected from the *Communication* branch are the *Talking conflicts* node, the *Interruptions* node, the *Common language* node, the *Computer-assisted* node and the *Face to face* node under three different categories: *verbal, assisted, non-assisted.* The node selected from the Behaviour branch is the *Evaluation* node under the *Emotional States* category (See the following table 7). The analysis process in this node set is slightly different from the first node set 'relationship'. In this node set, we firstly describe the general circumstances with specific examples about when and why artists and technologists communicated with each other with computers. Secondly, we present an in-depth analysis table, showing the differences in

communication between artists and technologists with and without computers. In the end, we draw a conclusion based on the first two steps.

Branch	Category	Node
Communication	Verbal	Talking conflicts
		Interruptions
		Common language
	Assisted	Computers-assisted
	Non-assisted	Face to face
Behaviour	Emotional	Evaluation
	States	

Table 7: the node set 'Mediation'

In case A, it was observed that when the artist and the technologist had computer assisted communication, they were working on a 3D model in 3D Max Studio software and they mainly discussed the specific feature of the model, such as the light effect, animation, the colour etc. Here is an example of when they talked about a light effect in the model:

> "T1: You want this to be brighter now?
>
> A1: You see there at the moment the second object is sitting like that, if that could be like there...So not that it's getting wider but it's getting narrower rather than...there. Because there's already one big one isn't there.
>
> T1: When you say narrower
>
> A1: More of a spotlight." (15:55-16:30, Track 1A/B, Day1, Case A)

In this computer-assisted communication example, we can see that T1 asked A1 about what kind of lights A1 needed exactly by referring to some specific components from the computer screen. Furthermore, from the last row 'Talking Conflicts' of the table, we can see that talking conflicts occurred less often in CAC than in NAC. This shows that the use of computers in communication may improve the level of understanding among participants, which could be one of the reasons that case A succeeded, even when they did not generate much shared language as we have discussed in the previous sub-section. In case B, A2 and T2 had a slightly different intention with computer assisted communication. T2 used the computer to make demos for A2 in order to explain what the software could and could not do for the project. Here is a computer-assisted communication segment in case B where the technologist showed a demonstration from the software Director to the artist:

> "T2: So, this is Director.... It seems like if you like some songs, then you play some samples
>
> A2: err.... yeah. It is like MP3 player.
>
> T2: so you could log in... you are looking at whole of other people doing stuffs. And first of all, it downloads of a lot of samples." (10:00-10:20, Track 1, day 1, Case B)

From this example, we can see that A_2 and T_2 talked much more generally in computer assisted communication than A_1 and T_1 in computer assisted communication. One of the reasons was that they had not yet achieved a very specific goal in the project.

From the above two examples of each case, we can tell that the circumstances of using a computer as a mediation tool in the communication are different between case A and case B. In case A, they were using computers as a tool to achieve the project. In case B, they were using computers as a tool to demonstrate the potential possibilities of current technology. In order to discover more about the differences of communication between participants talking with a computer and without, we selected three similar-length data segments of coded data in case A and case B from the *computer assisted* node and three similar-length data segments of coded data from the *face to face* node. The following table (Table 8) shows the statistical comparisons between case A and case B across nodes in this node set.

Nodes	Case A						Case B					
CAC	S_{C1}	S_{C2}	S_{C3}				S_{C1}	S_{C2}	S_{C3}			
FTF				S_{N1}	S_{N2}	S_{N3}				S_{N1}	S_{N2}	S_{N3}
Total interruption	19	4	12	9	4	2	6	4	5	19	25	6
A interrupted T	6	2	3	7	3	2	5	5	3	3	6	0
T interrupted A	13	2	9	2	3	1	4	3	3	16	19	6
Talking conflicts	8	2	1	0	1	0	0	1	0	1	0	1

Table 8: the statistical comparisons across nodes in node set 'mediation'

In this table, CAC stands for Computer Assisted Communication and FTF stands for Face to Face Communication. S_{C1}, S_{C2} and S_{C3} stand for three selected data segments which were coded by the *computer-assisted* node. S_{N1}, S_{N2} and S_{N3} stand for three selected data segments which were coded by the *face-to-face* node. The numbers in the rows of *'Total Interruption'*, *'A interrupted T'*, *'T interrupted A'* and *'Talking Conflicts'* present how many times these things happened during each computer assisted communication data segment or each face to face communication data segment. From this table, we can clearly see that in case A during the computer-assisted communication, the frequency of interruptions and talking conflicts was lower than in face-to-face communication. In case B, although there were no significant differences between CAC and FTF, we can still see that the presence of a computer decreased the level of talking conflicts. Thus, from this table, we can see that computers improved the level of communication between participants by decreasing the frequency of interruptions and talking conflicts. In other words, participants were talking more smoothly with computers as a mediation tool than without.

As we discussed in the first node set, the language is less shared in case A than in case B according to the *Common language* node under the *Communication* branch. However, from the *Evaluation* node under the *Behaviour* branch, case A achieved more than case B. Thus, a lack of shared language did not necessarily mean that there was a corresponding lack of success in the projects. From the data showed in table 8 as we mentioned before, the involvement of computers during the communication could decrease the level of miscommunication and improve the understanding between participants. Therefore, we suggest that one of the ways which may be used to overcome a lack of shared common language between artists and technologists is to use computers as a mediating tool during the communication.

CONCLUSIONS AND FUTURE WORK

The approach described in this paper is directed towards two main contributions to qualitative research. One contribution is the code scheme itself, which can be a reference for others to analyse similar situations in interdisciplinary collaboration, particularly those which involve the creative process. The other contribution is the initial findings. The first finding implicates that there exists a relationship between shared interests, shared background and shared common language. While the second theme implies that during the art-technology collaboration, shared language is not a necessity for a successful collaboration and computers facilitate participants to create a better understanding between each other. Both of findings reveal a very interesting phenomenon, which is that the mediation of computers may help artists and technologists overcome the difficulties of lacking of shared common language. This assumption will be investigated further when more cases from COSTART project are applied with this analysis framework. Moreover, new data about collaborative work in art and technology will be collected and analysed under similar conditions.

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