A Taxonomy of Communication from Design Perspective

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Abstract

Technologies help people communicate with each other in various ways. With so many advanced techniques these days, however, the design of communication services becomes even more difficult and confusing. This difficulty is more visible in designing Unified Communication systems where similar tools support overlapping communication needs. In this paper, however, we argue that all communications, despite specific techniques and related meanings, have only a limited number of basic patterns, and these patterns together form a structure which reveals the relations among them. These patterns represent methods of applying techniques to support communication between people. And this disregard of specific techniques and actual meanings in communication provides a universal perspective for designing communication services in a clearer way.

Keywords: *Communication, Design model(s), Design perspective, Taxonomy;*

1. Introduction

Since the advent of electronic technology, the way people communicate with each other has been rapidly changing. Even 10 years ago, services like Wikipedia, Facebook and Twitter do not exist, but each of them introduced a new style of communication. Together with smart phones and Internet, these systems make the design of communication services more difficult and confusing. This is because the complicated nature of people's needs to communicate, and techniques developed to support these needs. This complexity becomes more visible in the design of Unified Communication service (UC), where people try to apply similar but different techniques to meet overlapping yet not identical needs. However, it is relatively simple idea that technological changes help people cross physical, social and psychological boundaries (Sara Kiesler & Lee Sproull 1992). This means, despite of specific techniques and people's needs, every technique must cross a certain barrier to support communications between people. For example, telephone crosses space barrier, books cross space and time barrier, and Wikipedia allows the public to collaborate remotely and asynchronously. These barriers represent patterns of applying communication techniques, such as telephone supports the pattern of real-time, remote conversation between two people. In other words, these patterns are various ways in which we can use techniques to support communication between people. We believe these patterns between technology and people represent the unique perspective of design.

However, these communication barriers still remain unspecified. New types of communication are normally identified after a certain innovative technology or service emerged. Understanding patterns of these barriers, or in other words, patterns of applying communication techniques, is an important consideration for firms attempting to develop communication services. This issue can be addressed by creating a taxonomy that characterizes communication from design perspective, which is, patterns of applying techniques to support communications between people.

2. Communication mechanism

Theoretically, taxonomy of communication is more a choice of perspective than absolute truth, as shown in Figure 1 and Figure 2. The first taxonomy focuses on consideration of Computer-Supported Cooperative Work, while the second one chooses the view of project management. Distinct frameworks are then derived by focusing on different factors of communication. The selection of a communication mechanism also can influence the quality of information received (Steve D. Giffin, 2002). Thus, in order to create a taxonomy that addresses the patterns of applying communication techniques, an appropriate communication mechanism must be applied. We believe the mechanism which serves as the foundation of design perspective is the traditional communication model, as shown in Figure 3.

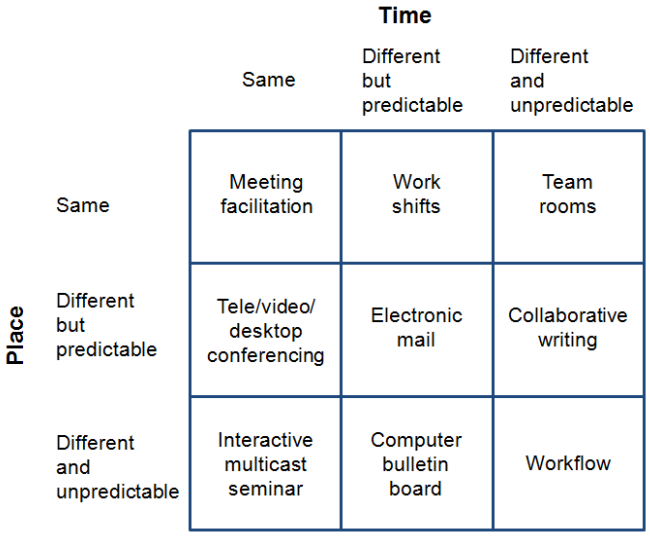

Figure 1. Taxonomy of communication from Jonathan Grudin's research (1994)

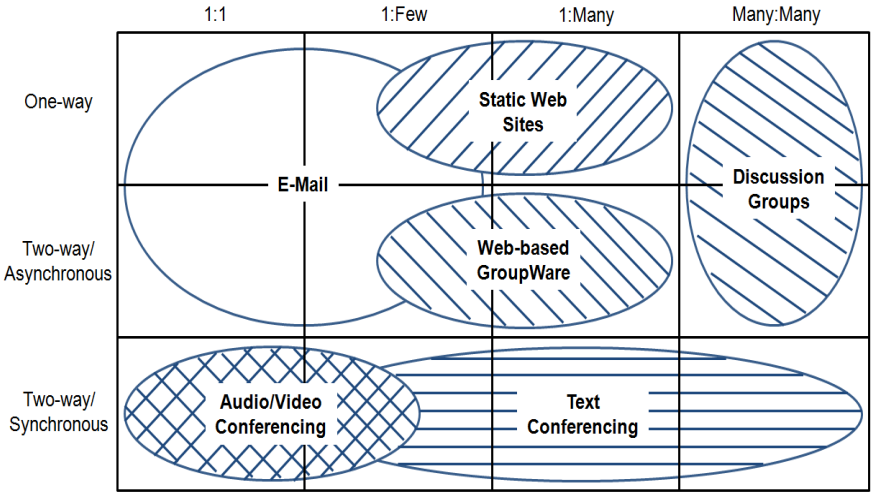

Figure 2. Steve D. Giffin's taxonomy of internet applications for project management (2002)

The reason for choosing this model is its consideration of only four simple but necessary elements. It simplified technical details into just basic Medium and Message, thus ignored the detailed techniques or tools that may be applied; It also simplified people into only basic Sender and Receiver, thus disregarded the specific meaning of messages, people's expectation, social roles and needs. However, further simplification of the model will disobey facts that how communication between people works. For example, if we simplified Medium and Message into only Information, we ignored the fact that information can only be transferred between people by using some physical mechanism which has no actual meaning at all. This communication model, although very simple and traditional, focuses on the relations between technology and people despite of specific techniques and actual meanings. Thus the rest part of this research is based on the hypothesis that this model represents the design perspective, which considers patterns of applying communication techniques.

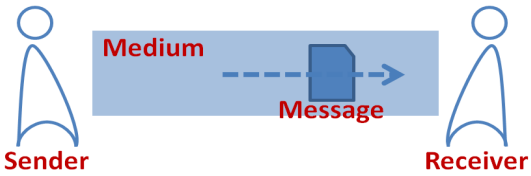

Figure 3. Traditional Communication Model

Table 1. Our definitions of four elements in communication model above

Sender	Someone who is trying to send a message to the receiver
Message	Any forms of information that is transmitted by the medium
Medium	Between sender and receiver, anything the message is transmitted on
Receiver	The target of the message, who can also access the medium

Although this four-element communication model is a very simple and traditional mechanism, definitions are still needed to be specified in order not to cause confusion, as shown in Table 1. These definitions seem natural, but in reality it is tricky to apply them. First, the Sender may not be the creator of the Message, like the mail carrier who sends a mail to me. Second, the Medium varies according to the Sender and Receiver under consideration. For example, if we consider the one who actually wrote the mail, thus the mail carrier becomes a part of the Medium. And there may be other Medium to transmit the same Message, such as e-mail system. Until a Message is perceived by the Receiver, the communication is not completed. Example can be I got the mail but forgot to actually read those written messages in it.

Based on Sara Kiesler and Lee Sproull's research (1992), it is very comprehensive to consider communication barriers from physical, social and psychological aspects. So in the rest part of this paper, based on the model in Figure 3, we discuss patterns of these barriers, or in other words, patterns of applying communication techniques in these three categories.

3. Communication barriers

3.1. Psychological aspect

Communication is about transferring meanings and ideas from one people to another. But according to David Wright (2001), "each living system is self-referential. It is self-referential because its behavior is determined by its structure" and "all systems boundaries are meaning-

boundaries". In other words, human cognition is more a self-referential process than a process that transfer "Meaning" from outside of the nervous system to in. Language and cultural differences are typical examples of the psychological barrier. And even if people speak the same language, say English, people's definitions about "justice", for example, may be different and even sometimes opposite. Because this strongly depends on people's personal experience, education and etc.

However sad we may feel, this means fundamentally, psychological communication barrier is by its nature impassable. Unless we invent techniques which precisely transfers one's cognitive data and process to another, this barrier will always be barrier. But that kind of technology will for a very long time stay in science fiction. The only attempt to cross this communication barrier is to communicate with each other more.

In communication, other psychological limitations like attention and memory are also immutable. Techniques cannot change but only "enhance" them to some extent by changing physical and social conditions. So in our research, we put aside this impassable psychological barrier of communication and focus on physical and social aspects, which are possible to be crossed by technological changes.

3.2. Physical aspect

Since the model in Figure 3 is highly simplified, details like video, audio and text are disregarded. Thus physical factors that can be derived from the model are only *space* and *time*.

A general categorization of *space* and *time* in communication is wildly used in many areas especially CSCW, as shown in Table 2 (Steve D. Giffin, 2002; V.M.R. Renichet, 2007). *Space* and *time* serve as two dimensions in this framework. As to the dimension of *space*, it is quite clear and comprehensive that there are only two types. The categorization of *space* in Figure 1 takes people's expectation into consideration, where it is no longer pure dimension of *space*. So in terms of *space*, we conclude two types of communication barriers: Co-located and Remote. It may be a little strange to consider Co-located communication as a barrier, but tools like blackboards in class and PC projectors are exactly techniques developed to better cross this barrier.

Table 2. Traditional Space/Time matrix of communication

	Same Time (Synchronous)	Different Time (Asynchronous)
Same Space (Co-located)	Face to Face Interaction, PC Projectors;	Team Rooms, Shift Work Groupware;
Different Space (Remote)	Telephone, Instant Messaging;	Voice Mail, e-mail;

However, as to the dimension of *time*, although it seems natural to have these two types, there are disagreements among scholars. Because according to this categorization, Telephone and Instant Messaging (IM) are the same in terms of *time*, yet researches tend to identify differences between them. Bonnie A. Narid, Steve Whittaker and Erin Bradner (2000) pointed out that "study participants contrasted the intermittent nature of these IM conversations with phone calls which were seen to be more circumscribed and lacking in IM's emergent, more discursive character." Susan E. McDaniel, Gary M. Olson and Joseph C. Magee (1996) in their analysis focused "on the temporal characteristics of the conversation, since these appear to be a key reason for the

appearance of parallel threads in CMC." While Aaron Zinman and Judith Donath (2009) suggested IM's "asynchronous nature leads authors to send short messages in bursty fragments, often interleaving parallel topics, to overcome immediacy issues in the medium." These arguments about IM are all related to the consideration of *time*, which clearly indicate the insufficiency of original categorization about *time* in communication. Thus based on our hypothesis, we try to categorize communication in the dimension of *time*. First we derived five factors related to time from the model in Figure 3, as shown in Table 3.

Table 3. Time-relevant factors derived from model in Figure 3

Co-Presence	At any one time, sender and receiver's presence to the medium
Time of sender (Ts)	Time that sender spend to put the message into the medium
Time of transmission (Tt)	Time for the message to transmit from sender to receiver
Time of maintenance (Tm)	Time that the message can be maintained in the medium
Time of receiver (Tr)	Time that receiver spend to perceive the given message

Tm is an important factor derived from model in Figure 3. The purpose of voice mail is exactly to maintain the Message in the phone long enough, so that Receiver can listen to the Message while Sender is not present. And in our definition, Co-Presence is an absolute concept despite of people's interaction. This is because when located together, people's presence is intuitive. While remotely, people's actual presence is difficult to assured. So in telecommunication, especially UC, virtual presence information is crucial and provided by the system, such as on-line status in IM. This virtual presence indicates people's availability to communicate, or in other words, that communicators are sharing the same time on a certain medium. However, Co-Presence in our definition corresponds to the actual presence of Sender and Receiver despite of on-line information provided by the system.

First we define synchrony based on these factors from our hypothesis, as shown in Table 4. "Co-Presence = 1" represents the situation where Sender and Receiver are present to a certain Medium at the same time, whereas "Co-Presence = 0" represents either or both of them are absent.

Table 4. Our definition of communication synchrony

	Co-Presence = 1	Co-Presence = 0
$Tt < \alpha$	Synchronous	Asynchronous
$Tt > \alpha$	Asynchronous	Asynchronous

α is a variable which varies according to specific contexts. For example, 20 seconds delay of messages is normal in IM but extremely inacceptable in video chat. If the delay of messages in IM is more than one hour, people would no longer consider it as synchronous communication. According to this definition of synchrony, IM and telephone are both synchronous. In order to explain previous arguments among researchers, we further utilize another factor derived from our hypothesis, as shown in Table 5. Similarly, β is a variable which varies according to specific contexts. "$Tm < \beta$" represents that a Message can NOT be maintained in a certain Medium, while "$Tm > \beta$" represents that a Message can be maintained.

Table 5. Types of communication barriers in terms of time

	$T_m < \beta$	$T_m > \beta$
Synchronous	Real-Time	Intermittent
Asynchronous	----	Shift-Time

This division of Tm is meaningful in terms of human cognition. As mentioned in the research from J. A. Deutsch and D. Deutsch (1963), "however alert or responsive we may be, there is a limit to the number of things to which we can attend at any one time. We cannot, for instance, listen effectively to the conversation of a friend on the telephone if someone else in the room is simultaneously giving us complex instructions as to what to say to him. And this difficulty in processing information from two different sources at the same time occurs even if no overt response is required". Thus if $Tm < \beta$, which means the Message can NOT be maintained in the Medium long enough, so Receiver's attention has to be paid to that very Message in order to perceive it. While if $Tm > \beta$, which means the Message can be maintained in the Medium long enough, so that Receiver's attention is not constrained to that Message but also be able to conduct other cognitive works. For example, when you are reading this sentence, someone may interrupt you. But since the messages are maintained in the medium, you can read the sentence later without losing any information. But if it's a spoken sentence in a meeting, the actually perceived information would be lost because of the interruption. As shown in Table 5, in asynchronous situation, if $Tm < \beta$, communication cannot be successfully conducted. So at this point, we have three types of communication barriers in terms of *time*: Real-Time, Intermittent and Shift-Time, and now we can construct a new Space/Time matrix of communication, as shown in Table 6.

Table 6. New Space/Time matrix of communication

	Real-Time	Intermittent	Shift-Time
Co-located	Face-to-Face Interaction	Blackboards in class	Post-in Note
Remote	Telephone, Video Chat	Instant Messaging	e-mail, Voice mail

As shown in the table, blackboards in classes support the type of Intermittent, Co-located communication, so that students' understanding of class contents can be dramatically enhanced. Other examples can also be found to fit into this new Space/Time matrix. Again, it may be strange to consider Co-located, Real-Time communication as a barrier, but speaking itself is the very first systematic technique that human developed to cross this barrier. As to deaf-mute people, other techniques like hand language are developed to cross this type of barrier. So at this point, we conclude that Table 6 is our categorization of communication barriers in terms of physical aspect.

3.3. Social aspect

Again, because the model in Figure 3 is highly simplified, social factors that can be derived are only the amount of communicators, and strategy of utilizing Medium and Message.

Based on the research from Ruesch and Bateson (1951), four levels of communication can be derived by only considering the amount of communicators, as shown in Table 7. Again, ɣ is a variable which varies according to specific contexts. The difference between the concept of Group and Public communication is the difference of magnitude, which varies according to different contexts.

Table 7. Types of communication based on amount of people

Amount of Communicators	1	2	3 ~ɣ	ɣ ~
Type of Communication	Intrapersonal	Dyadic	Group	Public

Besides the amount of people, the strategies of utilizing Medium and Message can also be described by model in Figure 3. First, the strategies of utilizing Medium can be considered as the direction of communication, as shown in Figure 4. Similar concept is also given by Brian Cugelman, Mike Thelwall and Phil Dawes (2009). However we focus on the role of being Sender or Receiver, and further defined two strategies of utilizing Medium, as shown in Table 8.

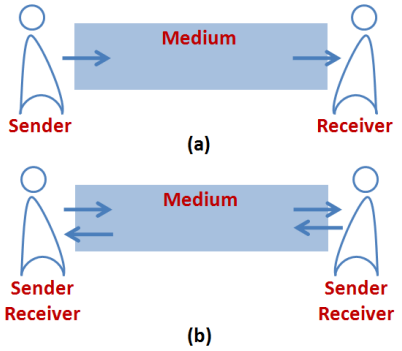

Figure 4. Strategies of utilizing Medium

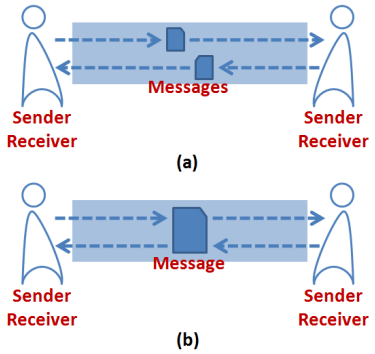

Figure 5. Strategies of utilizing Message

Table 8. Mode of communication based on strategies of using Medium

Uni-Directional	To a certain Medium, some people are Sender, others are Receiver. This Sender-Receiver role is different among participants.
Multi-Directional	To a certain Medium, every participant is both Sender and Receiver. This Sender-Receiver role is the same among participants.

In reality, the role of being Sender or Receiver can be affected by both technical constraint and people's willingness. And in our definition, this role is relevant to the Medium. For example, TV is a typical Uni-Directional communication, but some TV programs allow audience to use telephone to actually have conversation with TV hosts or guests, which is Multi-Directional communication.

Similar strategies of utilizing the Message can also be derived, as shown in Figure 5. The difference between Figure 5 (a) and Figure 5 (b) is that the Message can NOT be

edited together, or can be edited together by the participants in communication. For example Wikipedia has the principle of "everyone-can-edit" (Jun Liu & Sudha Ram 2009). And Google Wave also supports the editing of common text body among users. When we consider strategies of utilizing Medium and Message together, we derived three modes of communication from our hypothesis, as shown in Table 9.

Table 9. Modes of communication based on strategies of utilizing Medium and Message

	Message can NOT be edited together	Message can be edited together
Uni-Directional	Presentation	----
Multi-Directional	Conversation	Collaboration

The premise of editing a message is being a Sender. Thus in Uni-Directional communication, Message is impossible to be edited together. So as this point, we have three social modes of communication: Presentation, Conversation and Collaboration. By their definitions, it seems that a Conversation could be conducted by several reverse Presentations. But unlike Presentation, messages from multiple Senders in a meaningful Conversation are associated, thus require a certain method to keep the threads traced. On the other hand, Collaboration requires the ability for all Senders to edit common messages. But if this editing ability is applied to messages in Conversation, confusions would be caused and the Conversation would be difficult to conduct efficiently.

When we combine these modes with the amount of communicators, we have the matrix of communication from social perspective, as shown in Table 10. As to Intrapersonal communication, the strategies of utilizing Medium and Message among participants don't apply. So we treat it as a special type of communication. Note that in the definition of Uni-Directional communication, we didn't specify the amount of Sender and the amount of Receiver to have detailed definitions. This is because in reality, specific situations are combinations of different types in Table 10. For example, musical performance is a combination of group collaboration and public presentation. At this point, we conclude that Table 10 is our categorization of communication barriers in terms of social aspect.

Table 10. Matrix of communication from social perspective

	Presentation	Conversation	Collaboration
Public	TV, Books	Electronic Bulletin Board	Wikipedia
Group	Group Presentation	Group Discussion	Group Collaboration
Dyadic	One-to-one Monologue	One-to-one Dialogue	Dyadic Collaboration
Intrapersonal	Self Diary, Self Calendar		

4. The taxonomy of communication

Until this point, we have already discussed all possible communication barriers based on model in Figure 3. And now we have four dimensions of communication, or in other words, four dimensions of barriers which could possibly be crossed by technology, as shown in Table 11.

Table 11. Four dimensions of communication derived from our hypothesis

Physical	Space of communication	Co-located, Remote;
	Time of communication	Real-Time, Intermittent, Shift-Time;
Social	Amount of people	Intrapersonal, Dyadic, Group, Public;
	Mode of communication	Presentation, Conversation, Collaboration;

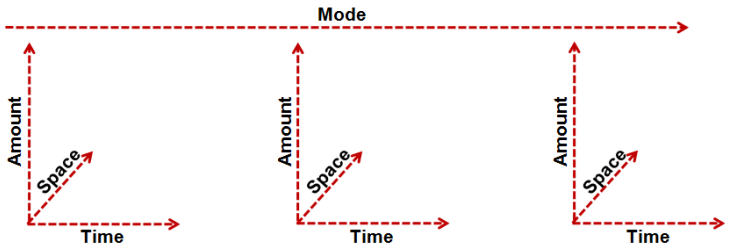

Figure 6. Ultimate structure of visualization

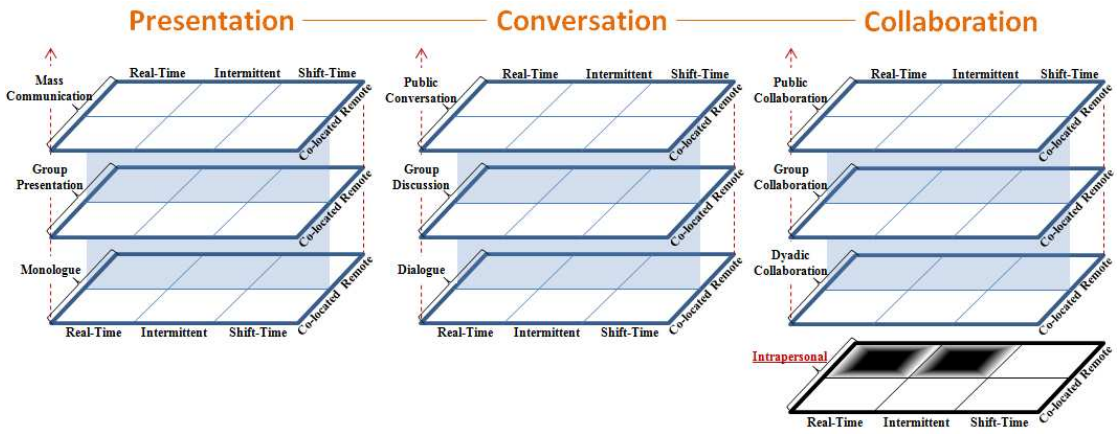

Figure 7. Ultimate visualization of the Taxonomy

However, it would be almost impossible for us to imagine 4-dimention framework. So in order to visualize all these dimensions, a certain structure must be defined first. In order to gain maximal information, an ultimate structure is shown in Figure 6. By structuring dimensions in this way, physical and social aspects of communication can be clearly identified, as shown in Figure 7. Each plane represents a social type of communication, and each cell in every plane represents a physical type of communication. Note that Intrapersonal communication is treated as a special social type which is isolated from others. The black cells in it represents that those types of communication are physically impossible to conduct.

The structure of this framework has some meaningful characteristics. Lower planes represent more private communications, whereas upper planes are more public. Planes on the right are more associated communications whereas planes on the left are less associated. In each plane, cells on the left represent communications which are more engaged, while cells on the right are less engaged. And characteristic about space dimension is intuitive. In this 4-dimension framework, communications close to each other have similar characteristics, whereas distant types are very much different. But

even types next to each other have at least one major difference according to their definitions.

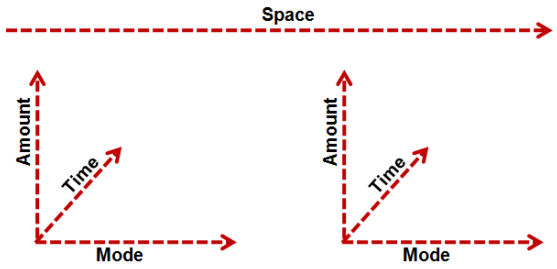

Figure 8. Practical structure of visualization

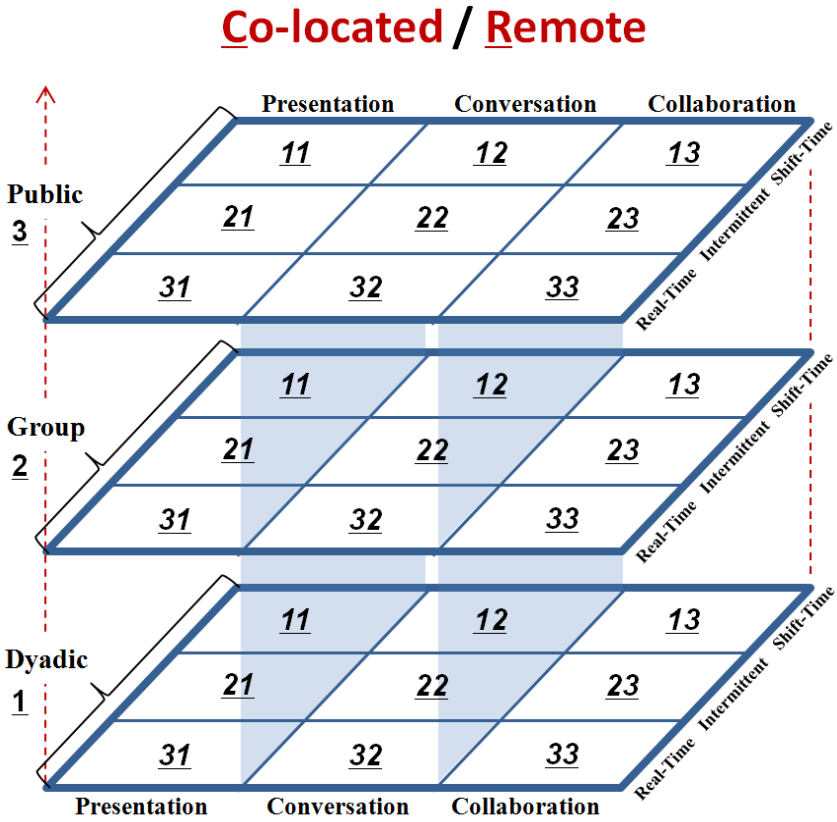

Figure 9. Practical visualization of the Taxonomy

However, the framework in Figure 7 is difficult to understand and utilize in real practice, despite of its rich information. For example, remote, shift-time mass communication is theoretically close to remote, shift-time public conversation, but graphically far away from each other. In practice, remote and co-located communications are often discussed separately. And interpersonal communication services focus on communication between people, where at least two people are involved. So a practical visualization of the taxonomy is shown in Figure 9, based on the structure shown in Figure 8.

Characteristics of the framework in Figure 9 remain similar. Lower planes represent private communication while upper ones are more public. Cells on the right are more associated communications, whereas cells on the left are less associated. In the dimension of time, cells close to readers are more engaged communications, while cells deep in the virtual dimension are less engaged.

Besides these intuitive characteristics of the model in Figure 9, based on definitions of these communication types and existing successful services, we propose three conceivable arguments about the taxonomy in Figure 9 for designing communication services, as follows:

1. The method developed to support one type of communication would not be suitable for another, or at least would not be the best solution for other types;
2. For an integrated system, multiple methods are not likely to be provided for one type of communication, in order not to cause confusion of use;
3. Types near each other are likely to be supported in one integrated communication system, whereas distant types are not.

The reason behind these arguments is the definitions derived from model in Figure 3. And these arguments are more suggestive than instructive, because they are derived from highly simplified hypothesis where details are lost. In reality, types of communication in our taxonomy are not separated but strongly related with each other according to context of use and actual meanings. Detailed methods of supporting the same type of communication in the taxonomy may also vary according to specific issues. Examples of applying our taxonomy and these arguments will be discussed in the next section.

In order to better refer to our taxonomy, we further developed a notation system to better denote types of communication in Figure 9. The general format is "X-a-bc". "X" represents the dimension of space, so it can be "C" or "R", which represents Co-located or Remote communication respectively. "a" represents the level of people's amount, and its value varies from 1 to 3. "a = 1", "a = 2" and "a = 3" represent Dyadic, Group and Public communication respectively, as shown in Figure 9. Similarly, "b" represents the time of communication and "c" represents modes of communication. "b" and "c" also vary from 1 to 3. "b = 1", "b = 2" and "b = 3" represent Shift-Time, Intermittent and Real-Time communication respectively; and "c = 1", "c = 2" and "c = 3" represent Presentation, Conversation and Collaboration respectively. The bigger "a" is, the more public the communication becomes; the bigger "b" is, the more engaged the communication becomes; the bigger "c" is, the more associated the communication becomes. With this convention, we can easily refer different types of communication in Figure 9. For example, real-rime, group discussion in meeting rooms can be represented by C-2-32. And Wikipedia's collaboration can be represented by R-3-13, which is remote, shift-time public collaboration.

5. Examples of applying the taxonomy

In this section, we discuss examples of applying our taxonomy to explain, analyze and suggest communication services. However, an important consideration needs to be mentioned first. The taxonomy in Figure 9 is based on our hypothesis, and our hypothesis disregards specific techniques and actual meanings. Thus although the taxonomy reveals the patterns of applying communication technology, in reality, the

way people use the technology may be different from what the technology is designed for and capable of. For example, e-mail is basically designed for R-1-11 and R-2-11, but because of its efficiency, people often use it to have conversations. Thus functions like "e-mail conversation" are developed these days to support R-1-12 and R-2-12. A similar case is SMS on mobile phone, where traditional SMS supports only R-1-11, R-1-21, R-2-11 and R-2-21, but people often use it to chat. Message service on iPhone supports R-1-12 and R-1-22 by organizing text messages between two people into chat-like form, which provides direct support to the mode of Conversation. Gmail is another good example of solving this problem. It has traditional e-mail service, which is R-1-11 and R-2-11, and "e-mail conversation" functions to support R-1-12 and R-2-12. IM is also integrated into the system, which supports R-1-22 and R-2-22. And integrated Voice and Video chat supports R-1-32. Functions are developed in Gmail to support each of these communications without overlapping, and these types are graphically next to each other in Figure 9, which we consider as a good feature according to our previous arguments. However, based on the unique characteristics of R-1-12 and R-2-12, better solutions could possibly be provided. For example, R-2-12 represents remote shift-time group conversation, thus issues like adding and removing members in the conversation or helping new comers trace history of conversation are needed to be supported.

PowerPoint presentation application can support R-2-11, C-2-21 and C-2-31. However, its support to C-2-21 is limited to controlling the time of each previously prepared slide, which is lack of freedom compared with traditional blackboard. Thus touch screen and related functions can be applied to better support C-2-21, and further support the whole presentation. Example can be teaching in classes where previously prepared slides fasten the delivery of information, and functions like sketching directly on the screen or through other devices give the freedom to lecturers whenever new ideas come out.

Twitter is a famous communication service which focuses on supporting R-3-11 and R-3-21 for the public. This means anyone, with a Twitter account, can present short text information to the public instantly. With its "Direct Messages" function, R-1-11 and R-1-21 are also supported. However, although every tweet is a personal broadcast, people often use it to have conversations. And Twitter supports R-3-12 and R-3-22 only by adding "@username" in tweets which indicates replying or mentioning another user. Thus, the context and threads of conversation are lost. So some third party Twitter applications trace the context of conversation between two people by arranging related tweets into chat-like form to support R-1-12 and R-1-22.

Google Wave is another attempt to combine services like e-mail, IM and wikis into one Unified Communication system, where all these services are supported by a seamless interface and experience. According to the demo in official website of Google Wave, the astonishing feature of the Wave is its availability of instant conversation and collaboration at dyadic and group level, which are R-1-22, R-1-23, R-2-22 and R-2-23. The feature of seeing what others are currently typing supports these types of communication in a very efficient way. And because Google Wave supports in-line reply, it makes the growing of a Wave nonlinear. Thus the feature of playback the whole Wave is designed to better support R-1-12, R-1-13, R-2-12 and R-2-13. However, confusions of use and arguments among researchers still exist. According to the demo, any messages can be collaboratively edited by any participants in a Wave, including each other's replies. And the system would link the Waves to form a tree

structure, which is why the in-line reply is available, because the reply is just another Wave linked to a certain point in the current Wave. This means basically, everything is just Wave which could be edited by all participants. So Google Wave just supports R-1-23, R-1-13, R-2-23 and R-2-13, but also allows users to use Waves to have conversations which are R-1-22, R-1-12, R-2-22 and R-2-12. This is very similar to the case of traditional e-mail, where presentation techniques are used by people to have conversations. Thus in Google Wave, pure presentation and conversation may be collapsed by collaborative editing, because in some cases people do NOT want their messages be edited by others.

In order to better support the modes of Presentation, Conversation and Collaboration, based on our taxonomy we think a better solution is to support them separately and allow them to link to each other. It means, besides current concept of "Wave" which supports collaboration, concepts like "Show" and "Chat" should also be provided. The name "Show" and "Chat" could be changed but the concepts they represent should be Presentation and Conversation. A "Chat" can be linked to any point in a "Show" or a "Wave", or vice versa. In this case, people would have a clear picture about what is only supposed to be read, what could be discussed and what could be edited together. The link between the concepts supports nonlinear threads of communication, which for example allows users to discuss about a certain point in a presentation or a collaborative work.

6. Discussion and conclusion

As mentioned by Diego Fernandez-Duque and Mark L. Johnson (1999), "We need to know what our deepest assumptions are, how they affect what we can think and know, and whether they need to be revised in various ways. Otherwise, we are blind to the implications of our models, including both what they highlight and what they hide from us". The traditional communication model in Figure 3 is so simple that although it has been mentioned very often, we actually take it for granted instead of considering its implications. In this paper, however, we argued that the model represents the design perspective of communication, or in other words, patterns of applying techniques to support communications between people. Based on the model, we derived four dimensions communication barrier and seven related factors in three categories, as shown in Figure 10. And based on these four dimensions we constructed a practical taxonomy of communication, as shown in Figure 9.

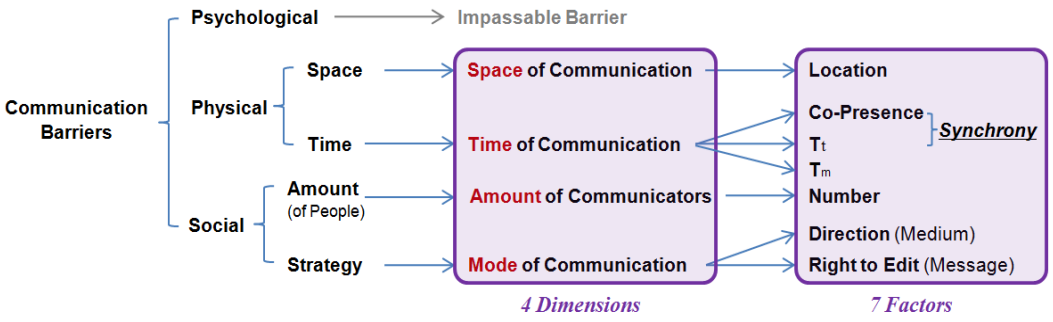

Figure 10. Structure of reasoning in our research

The result shows that despite of specific techniques, unique meanings and people's needs, communications have only a limited number of patterns. This means no matter what kinds of new techniques we may develop in the future to support potential unmet needs, we have to apply techniques in one of the ways shown in Figure 9. This seem-to-be sad conclusion could be useful when designing new communication services by providing clues about possible ways of structuring the service and also comparison with other services. However, even with advanced techniques these days, R-3-31 is only possible for minorities like TV and radio stations. It would also be interesting to think of services similar as Twitter, which allows anyone to do real-time broadcasting like TV and radio anywhere, at any time. Also until now, R-3-32 and R-3-33 haven't been supported by any technology yet, if ever possible.

In our hypothesis, we focused on communication between people and simplified it into only four basic elements. In real context, systems which have certain level of intelligence could also be considered as "people". For example intelligent chatting systems could recognize simple sentences and reply to them. This is useful when only simple communication is required and it's a burden for human to send simple information or reply to simple questions.

The characteristics and potential value of our research are very similar to the research of periodic table of elements in chemistry, where elements are categorized from certain perspectives and then arranged into a well defined structure. By considering our definitions, any communication event can find its places in our taxonomy. And by doing so the characteristics of the communication, relations of different functions in service and potential expansions are revealed. In reality, specific issues like forms of message, topics of communication and structure of organizations would require different combinations of communication types in our taxonomy. Thus for future research, we encourage researchers to analyze unique characteristics of each type in our taxonomy from various perspectives such as interaction design, psychology and sociology. And find better solutions for each type of communication and suitable combinations for specific contexts.

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