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Introduction

We set out to study how people interact with technology and furnishings in a collaborative environment. We were interested in how users collaborate with each other using technology artifacts in environments with configurable / movable and non-configurable desks, tables and chairs. Our data was collected via naturalistic observation, during two observation sessions for a total of approximately 4.5 hours.

While taking our notes, we focused most of our observation on users engaged in the act of collaborative work with at least one laptop on the table. We were most concerned with recording posture, body movement and language, interactions between laptops and users, and furniture usage / movement. This resulted in over 30 pages of typed-up field notes with observations, diagrams and fragmentary analysis.

Analysis

Motivation:

Our field notes were over 30 pages long and were raw data. Reading it gave us some vague direction, but we couldn't have been sure as to if that was what we were really seeing. There had to be a method in the madness, something that would get us to see more clearly what we could take away from the observations we had done.

Description:

We used grounded theory to conduct our analysis.

Each of us individually read through the compiled field notes and came away with some categories and concepts which seemed to stand right out. This was quite top-level and we came away with some direction and understanding of what we had observed.

We went away to do a more detailed analysis in terms of getting our concepts/phenomena from the data. We regrouped and started to group them on gut feeling, but got frustrated when we didn't get too far as we felt something was missing and some of the things we had identified seem to actually be properties of the categories which we would soon arrive at.

Once our categories were formed, we tried to see if we could relate the categories together, but certain ones like 'Furniture' and certain concepts like 'Office Environment' just didn't seem right. We visited the class slides to realize that that concepts and categories were better thought of as activities or events, and that contextual elements just weren't phenomenon. So we just threw them out and things began to make more sense. Now that we had our categories in place (with a few clarifications between our terminologies), we decided to go ahead and tackle the next step: Axial Coding.

Our categories were on white index cards and we had 4 other colors, which we used to separate the different aspects of axial coding in this order: conditions (blue), context (purple), intervening

conditions (green), action/interaction strategies (pink - lined side) and consequences (pink - non lined side). Please refer to the supplement for a typed up version of these index cards.

The conditions and context were a little slow in forthcoming, but once we got those down it was easy to continue in the same vein to collect the intervening conditions, action/interaction strategies and finally the consequences.

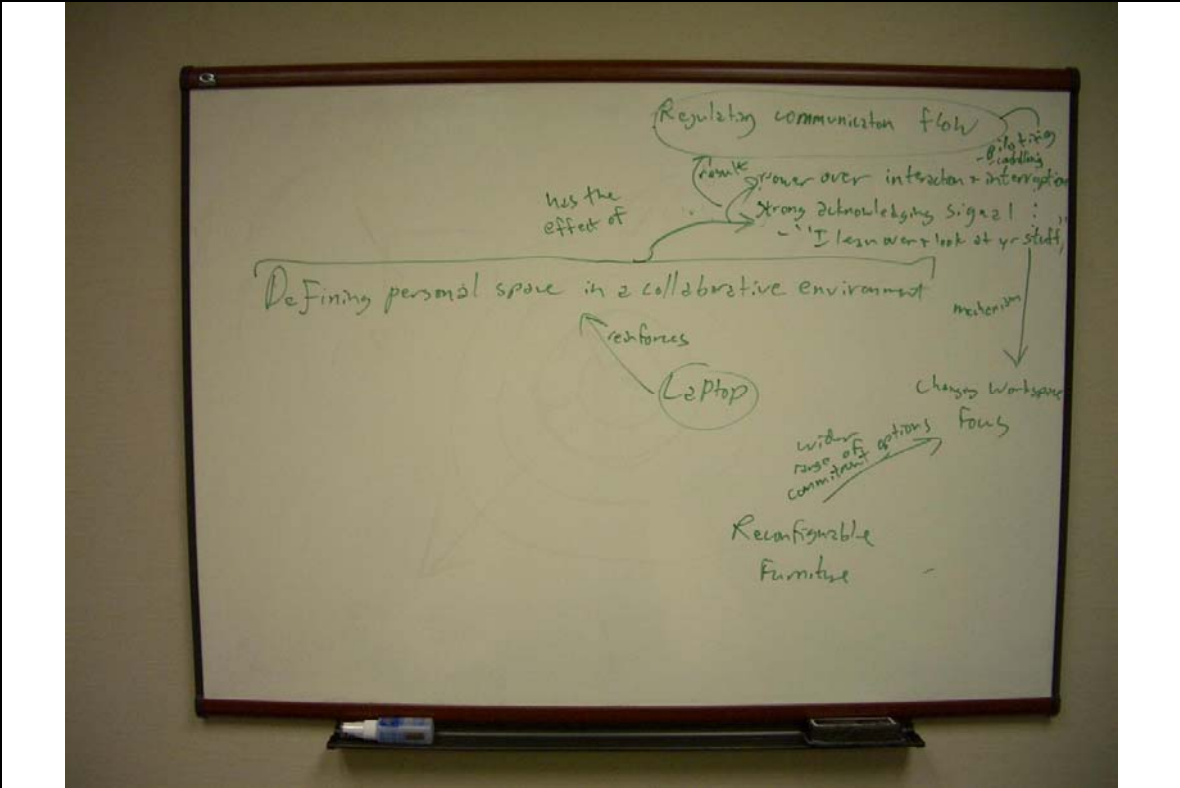
We then went through each and ever category trying to understand if what we had put down on the cards made sense, and if we had missed anything. This analysis of our current state of the coding allowed us to see a story emerging, which relied on Laptops, Furniture and the notion of Privacy. Thus emerged our core category, and the story line was developed.



Categories and Axial coding layout



The next day, we regrouped and modified our story line as well as our core category and how everything fitted into the scheme of things.

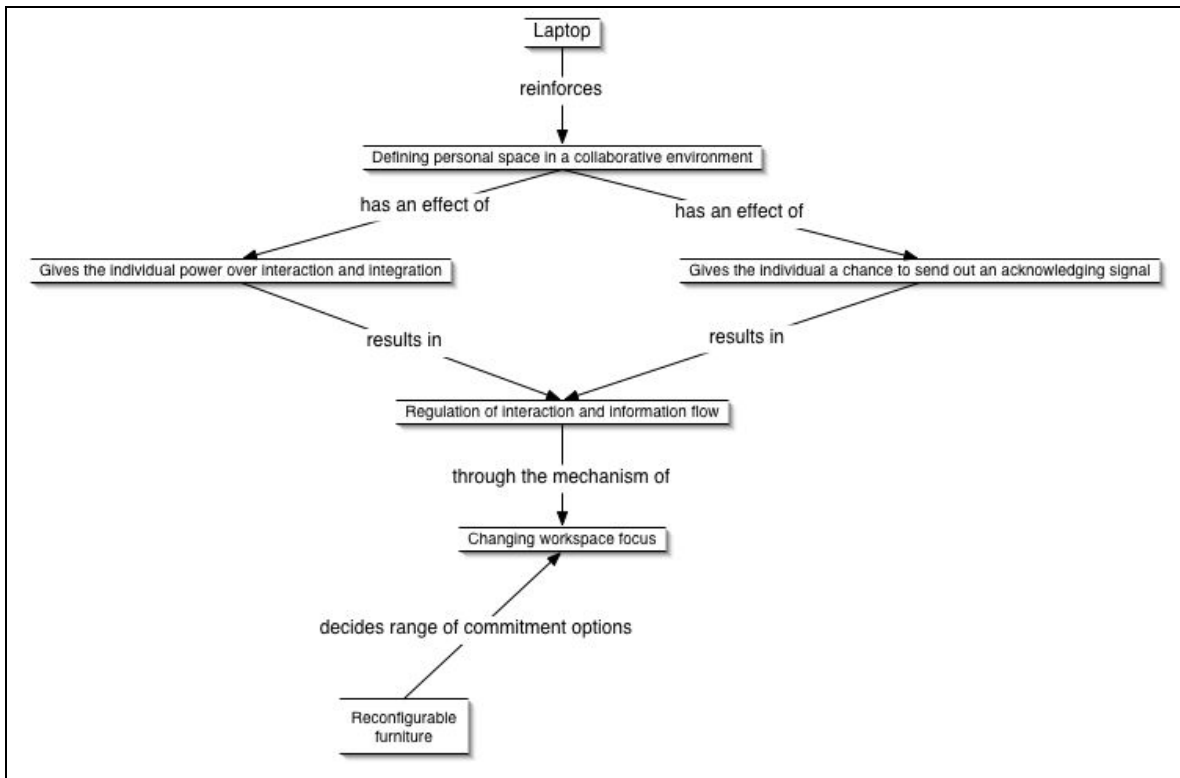


Final story line and core category: 'Defining personal space in a collaborative env.'

Storyline

“Defining Personal Workspace in a Collaborative Environment”

The usage of a laptop in a collaborative environment reinforces the individual perspective of the user on her work area. This has the effect of giving the user greater discretion over the mode and degree of interaction with other members of her group; conversely, a robust work perspective also functions as a stage for collaborative work that provides a strong signifier of coordination for those that share it. These effects result in a regulation of communication flow into coordinated and disjoint modes of work, whose primary selector is the individual user changing workspace focus. In order to provide optimal flexibility in a group’s workflow, this mechanism requires furniture and work surfaces that provide a high degree of configurability.



The emergence of the storyline

We identified our core category as the intersection of several of our categories – the definition of a personal workspace perspective was the foundation for both isolating and collaborative work behaviors, as well as factors related to positioning within the environment and usage of available furniture and materials. Furthermore, the primary effect of furniture configurations on collaborative work (which was part of our initial research question) arises in the development and definition of workspace perspectives among collaborators. We soon recognized that the Changing Workspace Focus category would be a key category in the development of our storyline. Users changed workspace focus repeatedly in our observations, and this seems to be a key signifier in the tempo of work. Furthermore, there was an interesting interaction between the ease of reconfiguring furniture, the availability and proximity of adequate work surfaces, and the level of commitment in changing a workspace focus. We could relate the “People Sharing a Workspace” and “Isolating Oneself From a Group” as two potential states bridged by “Changing Workspace Focus”. Furthermore, “Interacting with a Workspace” and “Active Communication” comprised two potential activities for each of those states. This pointed us to a storyline that focused on the dynamics of information and interaction flow within a group, and the tight vs. loose coupling of work within a collaborative activity.

Because the perpendicular screens of laptops force a deliberate and obvious motion on the part of users to share a perspective, Changing Workspace Focus becomes not just a mechanism of collaboration but a signifier of attention and acknowledgement. As such, the usage of laptops in collaborative activity implies that configurable furniture permits users to arrange their personal workspaces in the most convenient manner possible based on task and the group’s work tempo. For example, we frequently observed large groups at tables with configurable furniture arranging chairs and laptops such that pairs who needed to frequently shift between tightly and loosely coupled work could easily shift between workspace perspectives simply by turning their head or body. Meanwhile, members of the group engaged in more loosely coupled activities could position themselves such that they had adequate privacy and control over their level of interaction with the rest of the group.

In summary, while the storyline we derived from our observation tells us nothing new about the importance of furniture in collaborative environments, it does highlight for us the precise manner in which reconfigurable furniture enhances group interaction and underscores a particular relationship between laptops and the flow of collaborative work. We believe this research might serve as a springboard for the investigation of design options in furniture or the

development of support applications for co-located collaborative work that account for the changing of work perspectives.

Reflection

As this was our first attempt at a formal process of qualitative research, we made a number of slips. Our lessons-learned span everything from selecting a topic, to organizing our data gathering, to the conduct of our analysis.

In selecting our topic for research, we experienced several problems with gaining access. Our original sites of study, technology retail stores, proved to be quite difficult. For both stores, there was no local authority that could approve our study – we were forced to work through the public relations bureaucracy, who generally had little to no experience with such matters and had no motivation to assist us. At Best Buy, we had problems finding the right contact or gatekeeper to get approval for our study. After several weeks of being bounced back and forth, we were finally given a flat “no”. Conversely, at the Apple Store, we were provided with personal contact information of a PR manager almost immediately. This person showed great enthusiasm for helping us, and offered to look into the situation. We then spent a month trying to restore contact with her, with no success. (Ironically, Matt accidentally dialed her number a few days after we received IRB approval for our new study, and she picked up immediately). Our lesson learned was to focus on sites that have local decision-makers, and to never make assumptions about your access until you have a signed letter in your hand.

In conducting our observation, we found that having two simultaneous observers necessitated more planning than we had anticipated. A map of the area, with tables identified beforehand, would have been invaluable in merging our field notes. Furthermore, we failed to establish a common time-coding scheme for our first observation session, which also would have helped us to clear up ambiguities in chronologically ordering our notes. Finally, it would have been helpful to have prepared ourselves by selecting the analytical technique we used prior to gathering data. This would have enabled us to achieve better focus in note-taking, and guided the fragmentary analysis present in our field notes.

Our analysis went quite well, although on our first run through our field notes we had trouble grouping phenomena properly into concepts. Instead of thinking of our initial codes as “concepts”, which is too abstract, our open coding would have been better served by grouping phenomena into “events” or “actions” – things that happen rather than entities. However, instead of discarding the entities we put them to good use as properties and dimensions of the categories into which we grouped concepts. Perhaps it would be useful to make two passes through the data during open coding – one identifying events (“concepts” in grounded theory parlance) and another identifying actors or settings that can be used later to help to define categories of actions.

Some possibilities for further work we've identified from our analysis include cultural context of interaction (affecting issues such as personal space and privacy), time of day, and deeper investigation into environmental factors that are not related to furniture (such as power outlet availability, whiteboards, and traffic). We also might place additional emphasis on the role of other belongings (such as backpacks, food, jackets &etc) in defining personal space. Furthermore, our storyline could be greatly expanded and clarified by augmenting our observations with interviews and surveys, verifying some of our inferences and addressing such topics as privacy, intimacy, and power roles in a collaborative context.

Supplement: Open and Axial Coding

Category: Interacting with a Workspace

Properties:

- Social Context: isolated or collaborative
- Physical Commitment: standing or other awkward postures vs. sitting
- Attention Commitment: low (eating) vs. high (studying)

Concepts:

- Repositioning materials to set-up / interact
- Repositioning laptop to set-up / interact
- Arrangement of materials
- Interacting with laptop
- Setting up laptop
- Chatting Online [*Beki/Amy: inferred from posture / body language*]
- Writing (on paper / typing)
- Reading
- Eating
- Standing up
- Sitting down [*Beki/Amy: not observed, but inferred as the opposite of standing up*]
- Changing Music

Conditions:

- User wants to work alone
- User wants to socialize
 - o User might be setting up LT / papers to show things
 - o User might be arranging materials to make room for another person
- User wants to define their personal workspace

Context:

- Social Context
 - o Isolated: reposition how materials are set up to be used, or change mine, or chat with someone online, reading.
 - o Collaborative: change position of LT to share screen or move out of way for my papers / books.
- Physical Commitment
 - o Low: Standing or other awkward positions

- High: Sitting / creating a workspace for oneself
- Attention Commitment:
 - High: Reading, working
 - Medium: Chatting, web surfing
 - Low: Eating, Setting up laptop, Repositioning materials

Intervening conditions:

- Personal motivation: (dedicated, intermittent, distracted)
- Class schedule
- Time of day

(Inter)actional Strategies:

- User interacts with a workspace to perform work or socialize.
- User arranges / sets up materials in workspace to organize work.
- User wishes to avoid interaction with another person. [*Beki/Amy: inferred from body language – needs more study*]

Consequences:

- Another person is able to ascertain the user's openness to social interaction, based on intensity / nature of the activity and posture. [*Beki/Amy: inferred from body language – needs more study*]

Category: Changing Workspace Focus

Properties:

- Physical Commitment: moving self vs. furniture vs. posture
- Collaboration implications: moving to a shared workspace vs. an isolated workspace

Concepts:

- Repositioning my Laptop to focus on it
- Repositioning my materials to focus on them
- Moving furniture to focus on my workspace
- Changing posture to focus on my workspace
- Changing position to focus on my workspace
- Repositioning another Laptop to focus on it
- Repositioning other workspace materials to focus on them
- Moving furniture to focus on another workspace

- Changing posture to focus on another workspace
- Changing position to focus on another workspace

Conditions:

- User is prompted by another user to examine something
- User needs to refer to materials in personal workspace
- A collaboration finishes, and the user returns to personal workspace

Context:

- Collaborating
 - o Repositioning myself or laptop / materials to join another workspace
- Isolating
 - o Repositioning myself or laptop / materials to create personal space

Intervening Conditions:

- Physical state: tired vs. energetic
- Level of noise / distraction

(Inter)actional Strategies: *[Beki/Amy: inferred from body language – needs more study]*

- User desires to isolate themselves
- User desires to engage in active conversation with another
- User desires to interact with personal workspace
- User desires to return privacy to another user

Consequences:

- A collaboration may begin
- Privacy / control over social interaction returns to the user
- Privacy / control over social interaction returns to another user
- User begins to perform work

Category: People Sharing Workspaces

Properties:

- Activity: passive (looking) vs. active (indicating / gesturing)
- Interaction: questioning (seeking information) vs. answering (giving information)
- Role: pilot (controlling materials) vs. passenger (deferring to pilot)
- Inertia: ease of slipping into / out of sharing the workspace
- Physical Commitment: moving self vs. furniture vs. posture

Concepts:

- Examining information in the workspace
- Pointing out something in the workspace
- Repositioning Laptop to show
- Moving furniture to show
- Changing posture to show
- Changing position to show
- Repositioning materials to show

Conditions:

- Users desire to share information
- Users desire to establish a common context for work.

Context:

- Activity
 - o Passive - Examining information
 - o Active - All of the "showing" phenomena.
- Role
 - o pilot - more likely to reposition laptop / materials
 - o passenger - more likely to move self / furniture
- Physical commitment
 - o Low: changing posture
 - o Medium: moving materials / laptop
 - o High: moving furniture

Intervening Conditions:

- Familiarity [*Beki/Amy: this is sloppy – familiarity / assertiveness? Hard to know which without interviewing the subject.]*
- Furniture configuration

(Inter)actional strategies

- People will share workspaces in order to establish a common ground for discussion and shared work.
- People may share a workspace as a measure of intimacy or to temporarily answer a question.

Consequences:

- Users have less privacy in their interactions with their workspace

- Users lose a measure of control over their work
 - o Example: I scroll through a document that we're reading together, but must wait for you to be finished reading each page before continuing.

Category: Active Communication within a Group

Properties:

- Activity: socializing vs. collaborating
- Social Commitment: temporary vs. permanent membership
- Physical Commitment: moving self vs. furniture vs. posture to initiate
- Breadth of Focus: Number of people current within focus
- Conversation Activity: Speaking, gesturing, listening, questioning, acknowledging.

Concepts:

- Visiting a Group
- Joining a Group
- Discussing
- Questioning
- Working in Groups
- Changing Posture to Focus on a Person
- Changing Position to Focus on a Person
- Moving Furniture to Focus on a Person
- Level of Involvement / Commitment
- Changing Posture to Relax While Speaking
- Gesturing
- Speaking
- Listening
- Acknowledging

Conditions:

- User desires to socialize
 - o Principal reason for interaction vs. part of a larger collaborative interaction
- Need to accomplish a task or create a common understanding
 - o User desires to get information
 - o User desires to impart information

Context:

- Social commitment
 - o Low: Visiting
 - o High: Joining
- Physical commitment
 - o Low: changing posture
 - o Medium: moving materials / laptop
 - o High: moving furniture
- Breadth of Focus
 - o Most motion focuses on one or more active communicants
 - o Relaxing incorporates a widening of focus
- Conversation Activity:
 - o Questioners are more likely to listen and acknowledge,
 - o Speakers are more likely to gesture

Intervening Conditions:

- Time pressures
- Traffic level in the area
- Furniture configuration
- Time of day [*Beki/Amy: not really sure of the effect here – we need to observe at different times*]

(Inter)actional Strategies: [*Beki/Amy: again, mostly inferences here. Need some interview data to really flesh this out.*]

- People seeking information indicate attention as a means of encouraging the flow of information.
- People may widen or narrow their communicative focus based on their desire for information.
- When dividing focus between communication and workspace, less attention is paid to the laptop.

Consequences:

- Communication in a group becomes a process of shifting attention between people and workspaces.
- If you've just shifted your focus to me, I'm more likely to know that you're paying attention.

Category: Isolating Oneself from a Group

Properties:

- Commitment to Isolation: temporary, semi-temporary, permanent
- Social Context: solitary activity vs. interacting with outsiders

Concepts:

- Focusing outside the group
- Interacting with someone outside the group
- Leaving a group
- Changing position to focus outside the group
- Listening to Music
- Working Alone
- Changing Posture to Relax and Withdraw

Conditions:

- Interruption
 - o urgency of interruption
- Completion of a task
- Boredom

Context

- Level of Commitment
 - o Temporary
 - Focusing outside the group
 - Interacting outside the group
 - o Semi-temporary
 - Changing position / furniture to focus / interact
 - Listening to Music
 - o Permanent
 - Leaving the group
 - Working Alone
- Social Context
 - o Solitary Activity
 - Listening to Music
 - Working Alone

- Interacting with Outsiders
 - Focusing outside the group
 - Interacting outside the group
 - Changing position / furniture to focus / interact

Intervening Conditions:

- Level of Traffic in the Environment
 - Draws attention, provides social opportunity
- Environmental distractions
- Collaborative Style
- Level of coordination required or preferred by participants in collaborative work
[Beki/Amy: inference here. Need some interview data to really flesh this out.]

(Inter)actional Strategies:

- People remove themselves from a group as part of focusing on a task.
- People use listening to music and posture / position as an indicator / mechanism of removal / privacy. *[Beki/Amy: inferred from body language / posture.]*

Consequences:

- Leaving / rejoining group interaction becomes part of the cycle of work.
- Isolation has momentum: a user has more control over when they may rejoin the interaction and becomes a DRIVER of the interaction.

Category: Setting up the Environment

Properties:

- Desire for collaboration: high to low
- Furniture availability: high to low
- Furniture reconfigurability: high to low
- Work Surface availability: high to low

Concepts:

- Putting Bag on Chair
- Putting Bag on Floor
- Re-positioning Bags
- Selecting a Location

Conditions:

- Arrival
- Change of task

Context:

- Collaboration need
 - o High: put a bag on the floor to save room, choose a location with plenty of space
- Furniture availability
 - o Low: Move a bag from chair to floor to make room for a new arrival
- Work surface availability & Furniture configuration
 - o Affects bag placement
 - Low work surface availability, fixed furniture -> put bag on bench
 - High work surface availability, movable furniture -> put bag on floor or work surface, move to accommodate

(Inter)actional Strategies:

- People will set up their environment to accommodate other collaborators or to maintain their privacy
- Groups will change / select environments most appropriate to task, based on availability.

Category: Reacting to Environment

Properties:

- Furniture availability: high to low
- Furniture movability: high to low
- Audio / visual interference: none to extreme
- Level of commitment to reaction: mild to committed

Concepts:

- Reacting with Body Language / Gestures
- Moving furniture because of Environment
- Changing position because of Environment

Conditions:

- Interference (interruptive vs. gradual)
- Desire to see / watch something

Context:

- Level of commitment to reaction

- Low: React with gesture / body language
- High: move position / furniture
 - High furniture availability: change position
 - High furniture mobility: move furniture

Intervening Conditions:

- Light level / direction [*Beki/Amy: inferred from posture / body language, needs more study*]
- Noise level
- Space
- Familiarity ('shut up!' vs. move)

(Inter)actional strategy:

- People position themselves so they will not be disturbed by their environment [*Beki/Amy: inferred from posture / body language, needs more study*]
- People change positions when their environment becomes disruptive

Consequences:

- People are likely to discontinue work if they are disturbed and cannot leave / change.

Category: Reacting to Traffic (*subcategory of Reacting to Environment*)

[Beki/Amy: this entire category needs more data. It's based on inferences we made from observed behavior, however it makes some assumptions that we'd need a larger sample to verify]

Properties:

- Level of traffic: heavy to light
- Predictability of traffic direction: high to low
- Proximity to traffic: high to low

Concepts:

- Positioning facing towards traffic flow
- Positioning facing away from traffic flow

Conditions:

- User desires privacy
- User is open to interaction with passerby

Context

- If the traffic is heavy and predictable, a user who desires privacy will position his/herself facing towards traffic such that the laptop is hidden.

- If the traffic is heavy and predictable, a user who is open to interaction with passerby will position his/herself facing towards traffic such that they can see passerby.

Intervening conditions:

- Time of day
- Social connectedness to location
 - o affects likelihood of seeing people I know

(Inter)actional strategy:

- People who are alone and want privacy don't want passerby to see their laptop screen

Consequences:

- Passerby cannot see laptop screen.

Supplement: Selective Coding

Core Category: “Defining Personal Workspace in a Collaborative Environment”

Properties

- Work coordination: tightly coordinated vs. loosely coordinated
- Work tempo: how often work coordination shifts
- Work surface proximity: near vs. far
- Work surface availability: high vs. low
- Furniture configurability: high vs. low
- Ownership of materials: pilot vs. passenger
- Rearrangement of work materials: frequent vs. rare
- Perspective reinforcement: high (laptop) vs. low (sheets of large-print paper)

Relationships

- **Interacting With a Workspace (collaborative social context)**
 - o Social cues provided for user’s openness to coordinating activity
 - o Attention commitment has implications for how easy it is to change level of work coordination
 - o User’s strategy for focusing on work gives them a measure of control over coordination of work.
- **Changing Workspace Focus**
 - o The primary way by which work tempo is paced – shifting between tightly coordinated and loosely coordinated interactions
 - o Level of physical commitment to a focus shift has implications for the work tempo
 - o Proximity of work surface has implications for minimum level of physical commitment necessary for a workspace focus change
 - o Furniture configurability: more configurable furniture gives me more options for changing my workspace focus
 - o Level of perspective reinforcement in the target workspace implies the minimum level of physical commitment necessary.
- **People Sharing Workspaces**
 - o Level of work coordination implies interaction and activity

- “Ownership” (piloting) of materials or intervening condition of participant familiarity implies willingness to move / arrange materials vs. moving / arranging self.
- Level of physical commitment to sharing the workspace affects tempo – how long the users are likely to remain in tightly coupled work mode
- Consequence of losing a measure of control over interaction with materials implies that users lose individual control over work tempo.
- People can be forced to share workspaces due to low work surface availability or low furniture configurability.
- **Active communication within a group**
 - Higher physical commitment implies higher coordination of work.
 - Wider breadth of focus implies lower coordination of work
 - Conversation activity can affect tempo of work
 - Attention indicators important for consensus on work coordination
 - Consequence of shifting attention between people and workspaces affects work tempo
- **Isolating Oneself From the Group**
 - Corresponds to loose coordination of work
 - Social context of isolation important – if this is isolation as part of a larger interaction, then introversion might be part of the natural flow while extroversion disrupts the flow of work.
 - Activities and arrangement of materials / furniture to isolate oneself are part of defining personal workspace
 - Consequence of momentum-of-isolation and control issues imply isolation reinforces user control over tempo of work
- **Setting up the environment**
 - Strategy of setting up the environment to accommodate collaboration is related to configuration of furniture.
- **Reacting to the environment**
 - Audio / visual interference and interruption – can change work tempo and induce rearrangement of work materials
 - Traffic positioning has implications for perspective reinforcement – passerby cannot see laptop.