

Applying Cultural Historical Activity Theory to Software Testing Research

Workshop on Teaching Software Testing 2006
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The purpose of this paper and the associated discussion at WTST is to introduce the Cultural Historical Activity Theory (CHAT) framework. I believe this framework is potentially useful to you as professors, instructors, consultants, and testers. The paper begins with a case study that will serve as a focal point of the paper and the workshop discussion. After the case study, the paper describes and defines the framework and key ideas. These ideas are illustrated with specific examples from the CHAT literature and applied to the case study presented at the beginning of the paper. I hope WTST participants will help flesh out ideas on how this framework can be applied to software testing. Throughout the discussion, I hope we will develop a second case study.

iNetFolio Case Study at VendorBuilt College

Electronic portfolios have become a hot discussion topic on colleges and universities across the country. Batson (2002) has written about “the electronic portfolio boom” and Cohn and Hibbits (2004) have called electronic portfolios “higher education’s new ‘got to have it’ tool” (p. 1). The convergence of widespread Internet access and web-enabled databases has contributed to the emergence of a new breed of electronic portfolio that allow administrators to collect and aggregate data for a variety of purposes: documenting progress toward meeting accreditation standards, program evaluation, and student achievement.

*iNetFolio*¹ is one of the large commercial providers of this type of service. They offer a web-based tool designed to help high school and college students compile electronic portfolios of their work to satisfy demands of various accrediting agencies. *iNetFolio* is marketing their services to many departments, but on most campuses, teacher education programs are among the early adopters as they move from their traditional paper-based portfolios to electronic. Education faculty struggle to comply with increasing accountability, recent changes to the accreditation

¹ Throughout this paper, I will be referring to individuals, institutions, and vendors by pseudonyms. Thus, *iNetFolio* is not the company or product’s true name.

process, and the accrediting agencies' demands for data and *iNetFolio* has been very successful at marketing their service to satisfy those needs at the department or college level. In their marketing efforts, they stress the ease and convenience of data collection and reporting for accreditation purposes. Once decision makers decide to adopt and implement the *iNetFolio* solution, they require each student to purchase the *iNetFolio* subscription (\$79 to \$99) from the local bookstore or company website. There is no direct cost to the adopting college or department, but successful implementations may incur costs for additional equipment or personnel. For students, the initial subscription lasts for three years. In many cases, this allows them access to the service throughout their program of study and for one year beyond. After the initial subscription lapses, renewal is \$60 per year and is paid directly to the company.

Implementation details vary by institution and *iNetFolio* offers VendorBuilt College (VBC) as a successful example of how their product is used with a mature implementation. VBC is a small liberal-arts college in Florida. Students in the education department at VBC are encouraged to start their portfolios early and to assist them in this program-required task, one of the faculty members developed a template for students to use to get started. See Figure 1. The template is organized around the 12 Florida Educator Accomplished Practices (FEAPs) that outline generic skills all teachers should have in the areas of communication, assessment, knowledge of subject matter and planning, among others. For each standard, students must provide one or more artifacts from their work that offers evidence of their mastery of that standard. At VBC, faculty designated the specific artifacts that must be used in eight of the twelve standards. Students may select their own artifacts for the remaining four standards. Students must provide a copy of the completed rubric (grading sheet) for the artifact. In addition to the artifacts and rubrics, students must also write a reflection on the artifact outlining why the included artifact offers compelling evidence of mastery of the standard along with a narrative discussing how the artifact helped them to develop skills, how the student might change the artifact, any inherent weaknesses, and/or how they might apply what they've learned to their future careers. Finally, for each artifact, faculty have identified and prepared a list of relevant standards.

Materials > < previous next page > Copy | Print | More... show properties

Fall 2005 Education Portfolio

AP5: Diversity

Introduction
 Directions to Student
 Philosophy of Education
 Matrix of Artifacts
 AP1: Assessment
 AP2: Communication
 AP3: Continuous Improvement
 AP4: Critical Thinking
AP5: Diversity
 AP6: Ethics
 AP7: Human Development and Learning
 AP8: Knowledge of Subject Area
 AP9: Learning Environment
 AP10: Planning
 AP11: Role of Teacher
 AP12: Technology
 Field Experiences
 Credentials
 Letters of Recommendation
 Lesson Plan Submissions
 Internship Evaluations

Artifact and Rubric



Place the your case study from ESOL 315 as the artifact and rubric providing evidence of the AP of **DIVERSITY** in this section. You may upload, cut and paste, attach or scan your materials in. If the project was done in . you may also provide a link. Provide an introductory description of the artifact including its name, class in which it was generated, and semester the class was taken.

Reflection Piece

In this section, you will reflect on the artifact(s) that you have chosen to include in your portfolio to demonstrate your abilities in the area of **DIVERSITY**. You should present your reflection in a narrative form explaining how this artifact has affected you. Consider the following:

- What have you learned from doing this?
- What skills and knowledge have you taken from the processes leading to this artifact?
- What would you do differently if you could redo this artifact? Is there anything you would change?
- Are there any inherent weaknesses in this artifact?
- What did you find most useful about doing this artifact?
- How have you grown? How has this work contributed to or demonstrated evidence of growth?
- What can you apply from the completion of this artifact that may help you in future teaching situations?

When you write your reflection be sure to use the pre-service indicators as a guide to supporting your argument that this evidence or artifact does indeed reflect the Accomplished Practice. Use the language of the indicator and AP itself and either highlight it, underline it or bold it to indicate to the reader its source.

Your narrative can be livened up in a number of ways to make it more interesting: you can vary the size, the font, the color, the highlighting, and the format of your overall piece to make it more readable and engaging. You can also include pictures of your materials, documents, and supporting items. these may be scanned, linked to, or copied into your document. You can also attach documents, pictures, files, or rubrics to your reflection: This will be the major way we will share information with individuals reviewing our portfolios.

Standards

FEAP.2	ACCOMPLISHED PRACTICE #2: Communication
FEAP.2.2	STANDARD: Communication -- Uses effective communication techniques with students and all other stakeholders.
FEAP.4	ACCOMPLISHED PRACTICE #4: Critical-thinking
FEAP.4.2	STANDARD: Critical-thinking -- Uses appropriate techniques and strategies which promote and enhance critical, creative, and evaluative thinking capabilities of students.
FEAP.5	ACCOMPLISHED PRACTICE #5: Diversity
FEAP.5.1	EXPECTATION: The preprofessional teacher establishes a comfortable environment which accepts and fosters diversity. The teacher must demonstrate knowledge and awareness of varied cultures and linguistic backgrounds. The teacher creates a climate of openness, inquiry, and support by practicing strategies such as acceptance, tolerance, resolution, and mediation.
FEAP.5.2	STANDARD: Diversity -- Uses teaching and learning strategies that reflect each student's culture, learning styles, special needs, and socioeconomic background.
INTASC.3.E	K: The teacher has a well-grounded framework for understanding cultural and community diversity and knows how to learn about and incorporate students' experiences, cultures, and community resources into instruction.
INTASC.3.G	D: The teacher appreciates and values human diversity, shows respect for students' varied talents and perspectives, and is committed to the pursuit of 'individually configured excellence.'

Figure 1. Page from the VBC portfolio template.

Notice that the template provides specific instructions outlining the institution's requirements. Students delete these instructions, replacing them with their artifacts, rubrics, and reflections as they work on their portfolio. The faculty-selected standards are listed at the bottom of the page. The navigation bar on the left side allows students and portfolio reviewers to navigate through different sections of the portfolio. The tab labeled Matrix of Artifacts includes the list of specific requirements. This matrix is also distributed to the students as a handout.

To use the *iNetFolio* service, students must work at an Internet-connected computer with a web browser. Each subscriber/student receives a user name and password to log on to the iNetFolio system. New portfolios, assignments, lesson plans, and websites are created through the web browser. Students can upload documents as attachments or enter text into a text entry field. The system allows images to be uploaded and displayed on portfolio pages. Each page has a Save button to save work that is in progress.

Students can generate visitor passes to allow others to see their work. At VBC, it has become common practice for seniors to share their portfolios with younger friends who are looking for ideas about what to do with their own portfolios. Subscribers can also share their work with other *iNetFolio* subscribers as editors or reviewers. Professors often require students to add them as reviewers so they can make comments on specific pages. Portfolio authors can review the comments as they make modifications. Professors can also develop rubrics specific to assignments and grade the students according to those rubrics. Some professors use this electronic capability while others prefer to do grading in paper format.

Students shared the following experiences and anecdotes² in a series of interviews and thinkaloud work sessions:

CATHY: I have Dr. Lancaster for two classes and she assigns these big, huge projects and both of these projects are required to be included in my portfolio and she knows it. But she won't let us turn our projects in electronically. She makes us print them out and everybody knows she likes all of this creative stuff and we have to do all this "cutesy" stuff to get a good grade. Then, I have to do just as much work all over again just to reformat everything to go into the portfolio. I don't have time for this. Most of the time the scanners in the lab aren't

² The *iNetFolio* product and student quotes are based on data from my not-yet-completed dissertation. The quotes have been synthesized a bit and are not from any specific person but they do reflect actual concerns of real students using a portfolio authoring tool.

working and so it's really hard to scan the things that need to be scanned. I did a lot of the project using *Microsoft Word*, but when I try to copy it from *Word* and paste it into the tool, everything just goes crazy. I end up with all of these spaces that I didn't put there and sometimes it takes away some of my formatting and it adds other formatting and I spend hours just trying to clean that up and it just doesn't work. This was a 36-page paper and who has time to retype everything? I know I don't.

PHOEBE: We spent a lot of time talking in class – those of us in the same major. We were allowed to pick four artifacts, but we didn't feel like we had good ones for any of those four standards. So we sat around trying to figure out how we could turn a paper on the Civil War into a communication artifact. It was just ridiculous, but whenever somebody had a good idea about one thing, we'd all kind of try to do the same thing.

MALLORY: The professors here make us include these certain projects and we're not allowed to switch them out for others that we like better. I want to use this portfolio when I go on an interview and some of the things they want me to include are bad choices for me. They keep telling me it's a good idea to use this portfolio on interviews and then they require me to include these projects. And I just don't want to show this to a potential employer because it wasn't very good. There was a lot going on in my life when I did that project and I did a terrible job. I'm embarrassed to show it to anyone. I can do much better and that's what I want to put in my portfolio and I think I that should be allowed. And do you know what else? There's no way to burn my portfolio to a CD so if I want to take it on a job interview I might not even be able to use it if there's no Internet connection in the interview room. What happens if it decides to go down during my presentation? Then I will look like a fool. I also can't make a backup of my files or keep a copy after my subscription runs out. That's just not right. I should be able to get my stuff.

HANNAH: Look! Look! I have two pictures in one section and I didn't think *iNetFolio* could do that. How did I do that? I don't know how I did that! Everybody, come see this!

ANNE: I was just *so* stressed out about all of this. You see, I have to have this done because it's a graduation requirement and I felt like I was behind and had to get caught up. The service was running really slow and I didn't get everything done I needed to get done before the computer labs closed the other night. So, since I don't have Internet access at home, I went home to get my roommate's laptop. She has a wireless card and the library has wireless access. So I came back in the middle of the night and I went and sat on the library steps after it closed so I could pick up the signal and work on my portfolio. It was really creepy because this scary-looking guy came by. I kind of moved so he wouldn't see me and, lucky for me, he didn't. After he was gone, I stayed a lot closer to my hiding place, but I kept working. I had to. I got everything done, too.

ALICIA: I've learned a lot about HTML from using MySpace. I don't know if you're familiar with it or not, but I think it's probably taught a lot of our generation how to do HTML. I can put on backgrounds and pictures and make links in my profile. I spend a lot of time using MySpace.

TUCKER: My professor graded my project and filled out the rubric or grading sheet using this portfolio tool. I'm required to show that in my portfolio and I don't know how. The professor said she doesn't know how either except for me to print it out, scan it, and then add it as an image. That doesn't make sense to me. I want to see if I can figure out a better way because I have to do this – like 30 times – and I don't have a scanner at home. Between my classes and my part-time job and trying to have a life, I don't have time to come to the computer lab hoping that (a) the scanners are working and (b) that I can actually use one when I need it.

JUSTIN: I have *iNetFolio's* tech support number programmed on my speed dial.

RAFAEL: “You need to understand the time that's involved in it.” Rafael points out that problems crop up and little things add up to a lot of time: time to do the artifact, go match it to an accomplished practice in the words of the accomplished practice, write the reflection, do the revisions. There are 12 artifacts and all of the revising and scanning that go along with each of them. At our interview, he was days away from graduation and spent seven hours the previous trying to scan documents and had been on campus for another three when I spoke to him again. His chief complaint at this point is that there's a disproportionate amount of stuff to be scanned: many pages of evaluations, 12 practica, six observations, 12 rubrics, and a picture on the splash page. He's quick to point out that scanning images also requires resizing them as well.

The CHAT Framework

Among activity theorists, the notion of “doing something” involves context and purpose. The actors in the activity are “doing in order to transform something” (Engeström, 1987). In developing his model, Engeström set forth four criteria. The first was to make a model that was “the smallest and most simple unit that still preserves the essential unity and integral quality behind any human activity” (p.67). He also wanted a dynamic model that would allow for change. The third criterion was that the model account for context and finally, he wanted a model that accounted for the role of culture inherent in activity. He developed the model depicted in Figure 2.

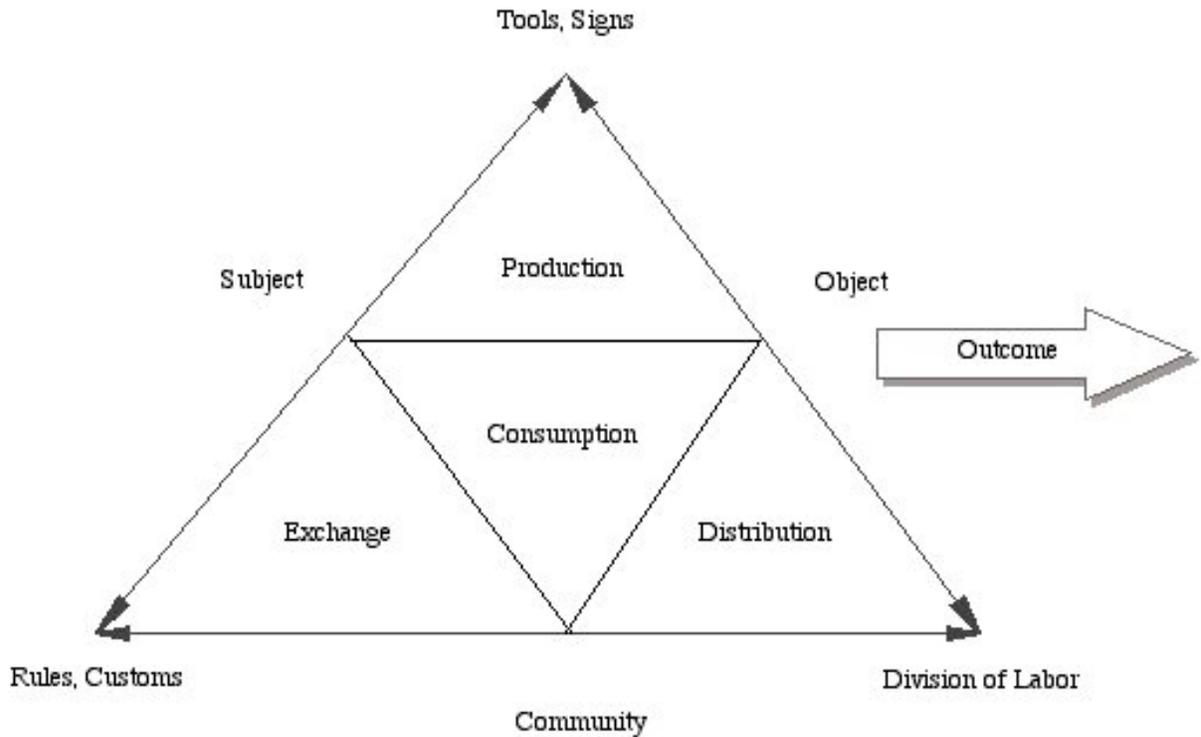


Figure 2: Engeström's CHAT model

One of the first steps in using the framework is to consider the “unit of analysis.” This is, of course, driven by what you are interested in examining and the size of the project. As I explain CHAT to others, I have sometimes used a flashlight metaphor. Activity-theoretical researchers shine a flashlight on a system of interest. It can be held at a distance to take a broad or longitudinal view. Alternatively, the flashlight can be held close to shine a bright light on a smaller area of interest. The width of the flashlight beam can be adjusted somewhat to determine the scope of the examination or directed to various parts of the activity system. Engeström has used the CHAT framework for activities as large as the health care system in Finland and as small as doctor-patient interactions.

For the *iNetFolio* case study, let's define the “unit of analysis” as the users at VendorBuilt College over a specific semester. Due to the nature of the implementation at VBC, any given semester (except summer) will offer access to students just being introduced to the *iNetFolio* product as well as students nearing graduation. Most faculty and administrators will

also be in the picture in any given semester. Accreditors also have an interest in the portfolio system and their interests are important. However, they will probably not be physically present.

As we apply this model, we must choose a subject to analyze. The *subject* may be an individual or a group. Our choice determines the perspective or point of view for the analysis. In the VBC *iNetFolio* case study, the most obvious choices are students and faculty. However, administrators, accreditors, potential hiring authorities, and friends and family might also have a stake. For this analysis, let's focus on the students as the subject. Later, we can take a different perspective – that of faculty, perhaps.

The next node in the model is that of the *object*. An object can be raw materials being transformed into something else; concepts one must learn; or a 'problem space' at which an activity is directed (Center for Activity Theory and Developmental Work Research, n.d.). The object can be, and often is, shared with others who may also be attending to the same object. The object carries the purpose or motive for an activity. In our example, the object is to create an electronic portfolio, but what is the motive? The answer to that question (and there could be many) speaks to the outcome(s) or *purpose(s)* for the activity. It's important to note that this purpose may evolve. From the student perspective, the fact that creating the portfolio is a requirement for graduation is certainly a motive for working on it. For many students, that will be the driving motive. Other possible motives include record-keeping for the learning and the work they've done; usefulness for job hunting; plans for advanced degrees or credentials such as the prestigious National Board Certification.

In this model, *tools* mediate the interaction between subject and object. These tools can be tangible (as in a hammer or a computer), symbolic (language or icon), or psychological (mental models or heuristics). A tool can be used in different ways at different times or across different activity systems. The students in the case study use a wide range of tools including the *iNetFolio* service, the faculty-created template, computers, scanners, course syllabi, electronic help resources, *iNetFolio* tech support, and many other things. They even use their professors as tools when they ask them for advice or turn to them for explanations.

Community is located at the base of this model. The community is the group of individuals who share the same object. In the case of students creating electronic portfolios at VBC, the community is comprised of other VBC students, the faculty (yes, they are in more than one area of the model), potential hiring authorities, accreditors, and friends and family.

Notice that the intersection of community and object is labeled *division of labor*. Labor can be divided both horizontally and vertically. Horizontal division of labor is across members of a community with approximately the same status. In our case study, senior students shared their portfolios with junior students to give ideas about what was expected. Additionally, students helped each other think about some of the decisions that went into the portfolios. The vertical division of refers to tasks divided across the different divisions of power. In this case, faculty developed a template to help them with their task.

The final node in this framework is at the intersection of community and subject. The interaction of the subject with the community is typically governed by *rules, norms, and conventions*. These may be formal (part of the system), informal (quirky adaptations by this group) or technical (policies, laws, or mandates). In the VBC *iNetFolio* case study, rules include the portfolio requirement, the rules governing the format and structure of the portfolio, the methods for turning it in, the fact that it is a graduation requirement, and the custom of senior students sharing portfolios for their younger peers to review. Those requirements were heavily influenced by the demands of the accrediting body.

Figure 1 illustrates four additional subsystems that can be analyzed within a central activity: consumption, production, exchange, and distribution. In the interests of time and space, I do not intend to discuss them in this paper.

EXERCISE:

Throughout this paper and the WTST discussion, we're going to explore the usefulness of the CHAT framework for testing. I have applied the CHAT framework to a case study focused on *iNetFolio's* end users. Your task is to now apply it to the testing effort at *iNetFolio*. Start by considering the CHAT framework and how you might apply it to a realistic testing effort. You don't have to write anything down, but try to have some ideas ready for the discussion.

Networks of Activity

The CHAT framework recognizes the networked nature of activity. Within a central activity, other activities are embedded or nested. Engeström (1987) calls these object-activities because they share the same object and outcomes. There are also nearby activities focusing on the production of tools to be used in the central activity. Another type of activity is subject-producing. These activities focus on recruiting, training and educating subjects or potential

subjects for the system. Finally, there are rule-producing activities where the focus is on creating rules, policies, and/or legislation impacting the central activity. Frequently, activities occur in parallel.

Because of the networked nature of activity, various elements of the activity can move from one node in the framework to another throughout the course of the activity. Russell (1997) illustrates this movement idea with a familiar example – the grocery list. His family keeps a photocopied list of items (tool) they regularly buy posted on the family refrigerator (rules, norms, conventions). He and his daughter (subjects) have organized the list (tool-producing activity) to correspond with the aisles in the grocery store. They have recruited other family members (subject-producing) to help out by marking items they want or need on the list (division of labor). One might imagine family members add items to the list as they go about their routine activities. Perhaps the daughter adds candy to the list because her class Valentine party is in the coming week. Another member of the household removes the last roll of toilet paper from the cabinet and notes that the family needs toilet paper in the next shopping trip. Someone else in the family might want a special dessert and add the necessary ingredients to the list. Once he and his daughter (the subjects in his example) go to the grocery store, the list fulfills a tool role to help them complete their shopping trip (the new object). Sometimes when they return home, they use the list as a tool to mediate family arguments about what was purchased or not purchased by the item's presence (or absence) on the list. One of the norms in the Russell family is that if a family member has forgotten to put an item on the list, he has no basis for complaint if and when the desired item is not purchased (rule-producing activity).

Now let's apply the idea of networks of activity to the electronic portfolio authoring activity at VBC. If we examine the Matrix of Artifacts and how it has moved through the system, we can get a good idea of the networked nature of this system. To do this, we will have to examine some nearby activities requiring us to temporarily adopt perspectives other than that of students. Let's begin with the creation of that matrix. Of course, the matrix was designed to communicate requirements to students, so we need to go back a bit in time for faculty and administrators to outline what they planned to require of student portfolios (a rule producing activity). These rules were reduced to writing and displayed in the matrix to duplicate and distribute to students (a tool-producing activity). Once students have the matrix, many use it to keep track of their requirements. They use it as a tool to monitor their own progress, marking it

up in a variety of ways. In looking more closely at the VBC template, one finds students are required to update the matrix and include it in their portfolio to help a portfolio reviewer understand where different artifacts are electronically filed. Reviewing completed portfolios, you also find that many students have chosen to re-organize the matrix and decorate it with color before putting it back in their portfolio.

EXERCISE:

I have offered some examples of the nested and networked nature of an activity system by as evidence in the portfolio authoring system at VBC. Please consider the networked nature of the testing activity and generate some ideas to contribute to the discussion. Think about nested, parallel, and nearby activities.

Contradictions and Tensions

Contradictions and tensions develop within and between nodes of the activity. Engeström (1987) argues that the essential contradiction in each element of the activity stems from the contradiction between “use” value and “exchange” value. These internal contradictions manifest themselves in external contradictions. As a result, an activity can have four layers of contradictions. The first, or primary, level of contradiction occurs within the elements of the activity. However, there can also be tension between two different nodes of the activity. These tensions are labeled secondary. A tertiary tension arises between one form of activity and a culturally more advanced form of the same activity. The final layer of tension, quaternary, is a tension between nearby activities.

Holt and Morris (1993) conducted a retrospective analysis of the Challenger shuttle accident to illustrate the first three layers of contradiction. Their work is a good tutorial on analyzing layers of tension. In their analysis, they look specifically at the Flight Readiness Review (FRR) that was in place at the time of the accident. The contradictions stemmed from the competing pressures to put safety first and to make 24 flights per year. In the rules node, Holt and Morris identified “safety first vs. timely flight” as a primary contradiction. The decision makers (subjects) node also had a primary contradiction as they tried to put safety first while at the same time being cost conscious. The FRR tool had a primary contradiction as decision makers used “the FRR as a checklist that NASA follows ‘to the letter’ (what one might call the ‘hard reading’), as opposed to an FRR that NASA follows only when convenient” (p. 105). One of the important secondary contradictions in this analysis is the one between the decision makers

and the FRR tool as decision makers tried to juggle the competing pressures of safety and cost. The tragedy of the Challenger accident moved safety to a higher priority within the FRR. According to Holt and Morris' analysis, at the time of their analysis, the system was at a tertiary contradiction because the system had changed to make safety a higher priority even though the cost pressures remained.

Contradictions and tensions are important to the activity theorist because they give rise to the "need states" which lead to change as the actors in the network seek ways to satisfy needs the existing activity system can not satisfy. Let's examine the idea of tensions and changes by taking a closer look at the *iNetFolio* case study.

Primary tensions are conflicts that reside within a specific node of the framework. An important one in this scenario is the student as cost-conscious consumer. Typically, college students have limited budgets insufficient to cover all of their needs. In at least one case – and certainly more – students may not have Internet access and scanners at home where they typically work on their assignments. This contradiction put Anne on the library steps in the middle of the night as she tried to meet a deadline. The students have also made it clear they expect the tools they use to construct their portfolios to work well together. The copy and paste problem from *Word* to the software tool is infuriating to them.

An example of a secondary tension is the professors' requirements that students include their graded rubrics in the portfolio even though *iNetFolio* doesn't provide a convenient way to display rubrics – even those already in the system.. This is a conflict between the tools node and the rules, norms, and convention node of the activity system. A tertiary tension is a conflict between one activity system and a culturally more advanced form of the same activity system. Cathy has told us about Dr. Lancaster's requirement that projects be submitted in paper format (a less advanced form of the activity) and also be included in the electronic portfolio (a more advanced form of the activity). Students want a convenient way to reformat their *Microsoft Word* documents for the *iNetFolio* tool. The final quaternary tension is between the central activity and nearby activities. In this case, faculty requirements for specific projects to be included in the portfolio are driven by accreditation demands. They want consistency across portfolio selections because this makes a more convincing case that the portfolios are valid and reliable measures and therefore and appropriate means of assessment. These goals are in conflict with students'

plans to use the portfolios to represent themselves in job interviews. The students want to highlight their unique qualifications to fill a job.

EXERCISE:

Think about the testing effort for *iNetFolio*. What contradictions and tensions might participants in that effort face? See if you can think of examples at all four levels.

Changes in an Activity System

Changes in an activity system can come from within the system or from nearby systems. The changes occur as actors identify new or better ways to solve needs in the system or to solve needs not satisfied by the existing system. An innovation might remain with an individual, changing only that individual's activity. However, these innovations are frequently shared with other actors and, where appropriate, are adopted by others. The activity system is changed by these innovations.

Engeström offers an interesting example from the history of Chemistry. In essence, chemists in the latter half of the 19th century had a well-entrenched system of organizing the elements by similarities. At that time, organizing the elements by atomic weight (as we do today) was unthinkable because dissimilar elements would be placed next to each other. For D.I. Mendeleev, the need to organize the elements became urgent as he progressed with his textbook *Fundamentals of Chemistry*. According to the account Engeström reports, Mendeleev had written two chapters of his book and had to decide which chapter to include next. He was under time pressure because of upcoming travel when he received inspiration for organizing the elements by property and atomic weight while playing solitaire. Recall that the table is organized vertically by property and horizontally by atomic weight. Thus, the modern Periodic Table of Elements was conceived during a game of solitaire.

The *iNetFolio* case study had an accidental discovery that is likely to lead to change. Hannah was the first to put two images in the same section of her portfolio, but she couldn't replicate it. A couple of weeks later, Alicia made a similar accidental discovery and was able to replicate what she did. From there, she used her knowledge of *MySpace* (a social network popular with the college crowd) and a free photo hosting service to leverage her discovery into a way for her to post as many images as she wants without worrying about *iNetFolio*'s server space limitations or the one image per section limit many students found constraining. She

shared how she did this with her professor and her peers. At the end of the semester, it was too soon to tell if this change to the activity system would gain enough traction to last. The professor shared it with other students and the younger students showed interest in adopting the change so it looks like this innovation may gain a toehold.

EXERCISE:

Think about your background in testing. What changes have you seen enter the activity of testing and what caused them? Can you imagine any needs that would lead the testing organization or individuals within the testing organization to violate something they perhaps shouldn't violate?

Utility of CHAT

Barab, Evans, and Baek (2004) suggest “Activity Theory might provide an ideal position – one with sufficient scope and depth – for observing individuals at work, alone or in collaboration with others, using electronic tools” (p. 205). Jonassen (2002) claims “Activity theory provides an alternative lens for analyzing learning processes and outcomes that captures more of the complexity and integratedness with the context and community that surround and support it” (p. 51). If true, these assertions offer Activity Theory as a tool for professors, consultants, practitioners, and students in software testing. Let's imagine some of the possibilities.

CHAT is likely to be especially useful for research that focuses on human uses of technology, examining newer technology applications, and conducting risk analysis. Professors can use the framework to help ensure they consider the broad implications of a contemplated change to an activity in their classroom, in their department, or across the university campus. They can also use it as a framework in their research. In the classroom, the CHAT framework offers a structure for classroom discussions that require systems-level thinking and a tool for students' own analyses, theses, and dissertations. Practitioners and consultants can apply this framework to their clients' organizations and workplaces.

Topics can be broad:

- How does the industry work on or respond to a specific problem like security threats?
- What effect will the proposed legislation have on the software industry?

- How might the latest innovation effect the long-term health of the industry??

Analysis can be more narrowly focused:

- What impact does the use of *Agitator* have on the development process?
- How does an exploratory tester think about his approach to a new product?
- How will the user of this product actually use it?
- Will this change in our process solve the problem we've been having?
- What risks can we find at this point of tension?

One of the specific applications I can envision for the CHAT framework is to use it to develop a scenario test. To review, “the ideal scenario test has five key characteristics. It is (a) a story that is (b) motivating, (c) credible, (d) complex, and (e) easy to evaluate” (Kaner, 2003, p. 20). In a scenario test, the tester devises a challenging sequence of tasks that a real user would do and an influential stakeholder would consider important. Such testing combines related features to determine if the software delivers the promised benefits in a way that stakeholders find acceptable. To use CHAT in developing a scenario test, a tester can observe and interview actual users to find out what they do with the software under test, what they would like to be able to do using the software, what they find difficult to do with the software, and how their tasks and the software involve other systems.

EXERCISE:

What scenario test(s) might the iNetFolio test group develop for their product?

Using CHAT in Research

Most CHAT research is conducted using qualitative approaches because these methods enable researchers to examine the social system in which the focus of research is embedded, a critically important aspect of the CHAT framework. Qualitative methods are especially appropriate for research conducted where setting and context of the research is important. The face-to-face interactions of qualitative researchers with their research participants facilitates data collection on matters including individual experiences, perspectives, attitudes, and values.

Gall, Gall, and Borg (2003) write about three major genres of qualitative research: an individual's lived experience; society and culture; and language and communication. Typically, qualitative methods involve extended engagement with research participants including interviews and observations. Some researchers also use content analysis techniques to examine

transcripts, journals, diaries, memos, documents, archives, and other physical artifacts for information and insight. The research questions, the accessibility of informants, and the time and skill of the researcher help to focus the inquiry and suggest appropriate data collection methods.

An extensive treatment of data collection methods and analysis is beyond the scope of this paper. For more information about qualitative methods, there are several good introductory texts. One of the most basic is Marshall and Rossman's (1999) *Designing Qualitative Research*. This small book provides a broad-strokes overview of many of the key issues. For more details, excellent examples, and references to other work, I highly recommend Michael Quinn Patton's (2001) *Qualitative Research & Evaluation Methods*. Miles and Huberman's (1994) *Qualitative Data Analysis: An Expanded Sourcebook* provides an extensive treatment of strategies and tactics the qualitative researcher can use throughout a study: the early stages of data analysis (including coding, memoing, and sequential analysis); exploring and describing; explaining and predicting; ordering and explaining; and drawing and verifying conclusions. Throughout their work, they emphasize the representation of data.

Creswell (1994) offers "a data analysis spiral" (p. 142) useful to explain how qualitative data can be analyzed. The spiral image conveys the researcher's repeated visits to and trips through the data. The entry point to the spiral is data collection with an account (scenario test, report, thesis, or journal article) at the exit. Between these end points, the researcher passes through a number of loops to make meaning from the raw data.

The first loop is data management. In this loop, researcher efforts focus on organizing data to facilitate retrieval and preparing data for analysis. Yin (1994) offers three useful principles: use multiple sources of evidence; create a case study database, and maintain a chain of evidence. The first principle, multiple sources of data, can be incorporated in the research design. The remaining two principles can be facilitated by computer-aided qualitative data analysis software (CAQDAS). Two popular titles include *Atlas.ti*, and *Nvivo*. These packages can serve as the project database and their memo capabilities can provide the "chain of evidence" Yin suggests.

The next loop in the data analysis spiral is reading and memoing. This phase involves reading and re-reading the collected data, making notes about emerging themes and insights, noting interesting developments for further investigation, and forming initial codes. Researchers can record memos on paper or using the software.

The primary focus of the next stage is description. For this phase, the researcher collects details and quotes from interviews and observations. The goal at this stage is to understand, as much as possible, what is happening in the context of interest.

The next loop in Creswell's spiral is classification. This phase focuses on themes, patterns, and recurring ideas or language. In this phase, the researcher begins to identify the areas for further scrutiny. The initial volume of data begins to be reduced as the nuggets are examined and the rest is eventually set aside. Interpreting the data, the next loop of the spiral, begins when the researcher makes sense of the findings. The bigger picture begins to emerge and meaning develops. Finally, in the last loop of the spiral, the researcher begins to focus efforts on representing and visualizing the data. The stories are told, the narrative is written, and the models are developed.

To work your way through a free tutorial and to learn more about software options for qualitative data analysis, visit *Online QDA* at <http://onlineqda.hud.ac.uk/>. For information on some of the specific tools useful to the qualitative researcher, please visit the website (<http://becky.editme.com/Survival101/>) for an upcoming workshop at ACM's Southeast Conference co-presented with Andy Tinkham of Florida Tech and Penny Beile of University of Central Florida.

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