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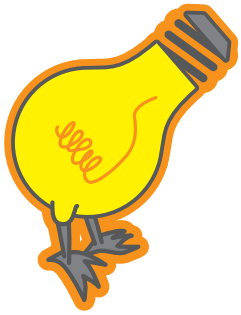

Fresh

Free Range Learning Support

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Abstract

This paper is part of a master's thesis project conducted at Interaction Design Institute Ivrea. In it, the author presents a design vision and experience prototypes for a service that supports mobile, lifelong learning.

Keywords: *mobile learning, free range learning, service design, interaction design*

Contents

Introduction

When you were three or four years old, you asked a lot of questions about the world you experienced.

- Why is the sky blue?
- Do fish drink?
- Why does the moon follow us?

Given your developing command of language and curiosity, it was an easy and rewarding way to augment your experience of the world.

By the time you reached six or seven years old, you probably stopped asking so many questions about the things around you. Perhaps you realized that the endless stream of questions began to annoy more than charm your parents. Perhaps you learned how to find the answers yourself. Perhaps, as many learning theorists suggest, your schooling had acclimated you to posing "appropriate" questions and giving "correct" answers.

In my master's project thesis, I hope to reawaken and re-enable this spirit of inquiry and engagement in the world for adult learners, through the development of an interconnected set of services I call *free range learning support*.

A scenario might best illuminate the concept.

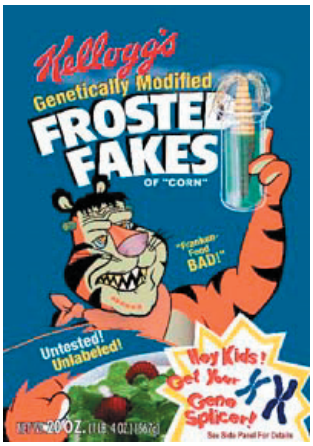
Imagine

You're walking to lunch with a group of coworkers, discussing a popular movie that uses genetics as a plot device. Someone recalls a pivotal line from the movie that mentions "gene splicing," but no one seems to know what it really means or how someone does it. Normally, the conversation thread might end here, as an hour or so might pass until you can get back to your desk, a dictionary, or the Web. But you are a subscriber to *Fresh*. You pull your cell phone out of your pocket and send an SMS to the service. In a matter of seconds, you have the definition of the term. At the next pause in the conversation, you can share the definition and continue the conversation thread.

SMS stands for Short Messaging Service and is commonly called text messaging. On nearly all mobile phones in Europe and increasingly in the United States, this service allows the user to send short written messages up of to 160 characters, or about 25 words.

On your way back, you're still wondering: OK, I know the definition. But really, how do you splice a gene? You don't know any geneticists, so you send the question instead to Fresh. "How do you splice a gene? It's so small! Nanoscopic scalpels?" This isn't a question that a computer can answer easily, so instead the service passes the question on to someone who is likely to know. Before you sit down to your desk again, you receive an SMS with a short answer to your question. You reply with "email more" and in a few minutes, you have received an email on your desktop computer with more detailed

information and some web links. You actually have to get back to work, though, so you can just keep it in your inbox until you're ready to give it some time.



An anti-genetic-engineering image created by Greenpeace.

Just after you finish work for the day, you read the email and follow a few of the links. Though there is information about the general science and recent developments of gene splicing, you are most surprised to learn that genetics are not just Hollywood plot fodder or some far distant technology. Genetics already play a part in food production, even in crops grown *right there* in your town. You're not an activist, but you're a little concerned. After forwarding the email to your coworkers who were part of the lunch conversation, you make a personal commitment to learn more. Using special software on your cell phone, you tell it to watch your surroundings for anything having to do with genetics.

Dog breeding is another kind of genetic manipulation.

On your way home, you receive an SMS asking you to look around for the "Pups R Us" dog breeders. The message tells you that selective breeding is a kind of genetic modification. This doesn't quite make sense with the scary stuff you read earlier. Dog breeding isn't anything threatening. It's cute and fuzzy and sloppy-tongued. You won't be back at your computer again until morning, and you have another 30 minutes to your commute, so you reply with "more." Moments later your cell phone downloads a web page of further information that you can peruse when you get home, discuss with your family, and follow up a little more tomorrow.

This scenario describes several examples of how the service supports its subscribers learning while "on the move," away from other references or resources. In the above scenario, you are free range learning about genetics, using a service that supports your burgeoning interest.

I will detail the service vision in later sections. But first, let's go back to the beginning of this idea to get an understanding of its context.

Why Learning?

Two principle reasons drive the need for learning infrastructures.

The push: Change is accelerating.

Everything in the Western world is speeding up, for better or worse. From the speed of computer processors to the time between events and their reporting, change is accelerating. What are important job skills when we are in school can be quaint anachronisms by the time we join the working world. It is no longer enough to spend the first twenty years of our lives being "educated" and then leave learning behind to join the workforce. To stay relevant as individuals or cultures, we must adapt to change by learning throughout our lives. (Gleick, 1999. Brockman, 2002.)

The pull: Learning improves our quality of life.

Mihaly Csikzentmihalyi has made the study of innately motivated learning, which he terms *flow*, his life's work. He states that, at its best, learning transforms us into better humans. It makes us more complex, raises our self-esteem and personal empowerment, and, on a cultural level, fosters inclusion and even social regeneration. It is innately enjoyable both while we're in process and also when we remember these learning experiences. (Falk and Csikzentmihalyi, 1990.)

With the need to stay relevant pushing us from behind and the promise of self-actualization pulling us forward, it is easy to understand why learning should be a concern, and ideally a goal, for every individual and the society to which he or she belongs. In fact, UNESCO came to this very conclusion in 1972 with its publication of *Learning to Be*, in which editor Edgar Faure argued for the member nations to prioritize learning as a cultural and humanitarian imperative. The report popularized the term "Learning Society" and set into motion political initiatives on lifelong learning that continue, primarily in Western Europe, to this day.

What is Learning?

For purposes of this thesis, I began with a standard psychology textbook definition from Zimbardo and Gerrig's Psychology and Life. (Zimbardo, 1996.)

> Learning is a process that results in relatively consistent change in behavior—or behavior potential—and is based on experience.

Two things are important to note in this definition. First, it does not specify that humans are necessarily the learners in question. This may be why it seems to exclude learning that occurs through conversation or reading, except as a subset of experience. Learning is observed in species much older than *homo sapiens*, and is not specifically dependent on any of our cultural constructs. This leads us to the second note, that learning is distinct from education. Education implies formal and often narrow systems dedicated to teaching and learning. These two points become important when we survey the history of mobile learning in a later section.

While the above definition helps identify learning's effects, i.e., long-term change in behavior or ability, it leaves the activity itself quite vague: "a process." Jean Piaget provides some further insight into the process. In his Genetic Epistemology theory, he identifies two distinct but complementary mental activities in dealing with new experience: *assimilation* and *accommodation*. In assimilation, new experience is simply stored in the learner's existing mental model of the world. This might interchangeably be called *memorization*. An example of this would be learning new nouns for a foreign language after already knowing the grammar. For the most part, the learner is simply adding to the stack of nouns she already knows. Accommodation, on the other hand, occurs when a new experience won't fit into the learner's existing mental model. It might more accurately be called *remapping*, because it requires a reworking of things the learner thought he understood. Seymour Papert describes such a moment in a personal anecdote from his book, *The Children's Machine*, in which he describes the moment he learned that, in a botanical sense, a daisy is not a flower. (Papert, 1994.)

A daisy, which is not a flower.

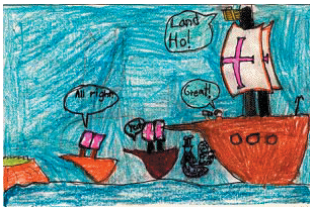
> I can't tell whether I was more shocked at this being so or my having lived so long without knowing it. A daisy not a flower? Come on! It's the prototypical flower—if you had asked me last year to draw a flower, I'm sure I would have produced something more like a daisy than like anything else. Though it seems silly now, and rather ignorant, I was really upset and excited. I ran from book to book in the small hours, trying to learn more. The news was bad: The putsch against standard nomenclature went beyond daisies to include sunflowers and black-eyed susans and chrysanthemums and dahlias. They were denigrated with names like "false flower" or elevated with fancy names like "inflorescence," but it appeared that in many circles it is a definite gaffe to call them flowers.

In case you are wondering, the botanic definition of a flower is a structure including a stamen and anther, pistil, stigma, and ovaries. In the buttercup, these parts are large and apparent. In the daisy these parts are very small and repeated. In fact, each petal is itself a *ray flower* and each yellow bump in its face is a *disc flower*. If you were a *Fresh* subscriber, you would have been able to get this information even without a footnote.

This new understanding was a completely different experience for Papert than his other flower-learning activities of discriminating species and memorizing their names.

A common accommodating experience for US school children is having to learn that Columbus did *not* discover America as they had memorized years earlier. Such information, which at first seems contradictory, forces the learner not only to memorize the new data, but also to reconsider all events related to this event, and question the reasons why the information was incorrectly represented in the first place. Accommodation is an important aspect to learning, as it is more likely to affect perceptions and behavior. For example, when young learners discover that North America was already filled with long-established peoples and cultures long before Columbus' journey, their attitudes about Native Americans may change.

Zimbardo and Piaget's views of learning are deeply rooted in psychological and cognitive traditions. These are not the only traditions that are concerned with learning. Anatomists dive deeper into the physical processes of learning and memory in neurological and neurophysiological theories. *Behaviorist* theories of the 1970s, led by B.F. Skinner, focus more on the behavior modification aspects of learning, and almost exclusively deal with animals. *Constructivist* theories focus on the internal processes of meaning-making, with a bent towards task-oriented, pedagogical conclusions. (Wenger, 1999.)



Columbus Sailed to America
by Kelli and Charlie

While these theories all address important aspects of the complex nature of learning, they have not deeply influenced this project. Instead, a more recent development in learning theory has proven deeply influential: the *situated learning theory*, which developed from work at Xerox's Palo Alto Research Center in the 1990s. Authors Jean Lave and Etienne Wenger put forth this theory, which builds upon Lev Vygotsky's *social learning theories* that emphasize modeling and imitation by learners in groups.

Situated learning theory argues that most learning normally occurs incidentally, as a function of individual participation in communities that share a common practice. Using apprenticeship as a model, the theory explains how learners move from being newcomers on the periphery of the community through activity and engagement to become "old-timers." The theory suggests that this type of learning is easier for us as social creatures. Notably for this thesis, this theory stresses the type of learning one would expect to encounter while being mobile and engaged in the world, though it may lead to more generalized types of knowledge as studied in schools. (Lave and Wenger, 1991.)

The focus of this project is to design a support system rather than to attain a pedagogical purity, so I have not attempted to declare any one of these theories the *correct* or even the *most correct* one. Situated learning theory seems to share similar priorities and scope, so it has been the most influential. Nevertheless, it is with a synthesized understanding of these diverse perspectives that I move forward to specify what the subset *free-range* learning might be.

What is "free range" learning?

In free-range farming animals are allowed to roam.

For those unfamiliar with the term, *free range* refers to a type of farm practice in which animals are allowed to roam free on farmland rather than being kept in cages or in crowded pens. As a marketing term, it is meant to conjure images of happy lives lived on rolling pastures beneath sunny blue skies. It also carries a connotation of being a more natural and more humane experience. I coined the term free range learning to refer to these positive aspects of being engaged in the world, and enabling our learning wherever we happen to be.

Academic circles refer to this type of learning as *mobile learning* or *m-learning*, and it is only with the recent increasing ubiquity of wireless networks and mobile devices that this approach has become feasible on a large scale.

It is my hypothesis that at the very moment we have questions about the world, we are more receptive to the answers and, thereby, in a better state to learn. This hypothesis has some grounding in the recognition of a particular physiological effect which psychologists call the *orientation reaction* or *orienting reflex*. Ivan Pavlov first observed it in his famous dogs, at the turn of the last century. Another Russian psychologist named Yevgeny Sokolov documented the same effect in humans more than half a century later, in 1963.

His Master's Voice by Francis Barraud.

Most people recognize this as the RCA logo, but Barruad painted a version of it of his own accord in 1884 before anyone at RCA ever saw it. Barraud shopped it around a few times to art galleries, magazines, and even the Edison Bell Company, but was unsuccessful until he showed it to the Gramophone Company. Eventually RCA acquired the rights for use in the United States. Had you taken a photo of this logo and sent it to *Fresh*'s **Cavalry**, you could have found this out even walking down the street.

The orientation reaction occurs for a number of seconds in response to unfamiliar stimulus. Dogs tilt their heads and prick up their ears. Both dogs and people look toward the source of the stimulus and adopt a readiness stance. Meanwhile, many subtler changes take place in the subject's body: muscle tonus increases, faster, lower-amplitude EEG readings, vasoconstriction in the limbs, vasodilation in the head, higher galvanic skin response, deeper, slower breaths, and a reduced heart rate. Sokolov showed that humans, additionally, display lower sensory thresholds during the orientation reaction. In short, the subject's body prepares for both "fight" and "flight" until the source of the stimulation can be resolved. (Denny, 1995.)

You may personally have experienced the effect after hearing an unexpected loud noise, such as a gunshot or a backfiring car. For a short duration afterward, your whole body feels a little loose and "buzzed." The canine orientation reaction was captured for popular culture most famously in the RCA logo: Most everyone can recognize the physical expression as Nipper hears his master's voice coming from the bizarre gramophone shape before him.

I believe that we experience a similar but less physiologically pronounced orientation reaction when we encounter some new information that doesn't fit our understanding of the world. I am not qualified to formally test this hypothesis, but I have already offered some anecdotal evidence above. Papert explains being "shocked," "upset,"

and "excited" from his daisy discovery. These responses are clearly physiological. Most people can recall similar moments of excitement when they discovered something that didn't seem to fit into their worldview. This effect only lasts a number of seconds, but Sokolov's research tells us that during periods like this, the mind is more receptive. If having an accurate mental model of the workings of the world is important, then we should not let this moment simply fade when we could instead act on it.

This free-range emphasis on knowledge-in-context also supports the situated learning perspective, as the learner is able to ask questions while engaged in real-world and social activities. Additionally, as we will see in a later section, the design of the system also enables anytime, anywhere contact with self-defined peer groups, extending and thereby supporting the learner's community of practice.

Why a Service?

Trying to envision a viable business model for such technology, a device- or lesson-centered model seems too limited for the long-term engagement required in the unfolding of our experiences in the world. A long-term service model gives interaction designers opportunities to provide blended learning, provide prompts for learners, further market penetration of baseline technology, tightly integrate components, and provide external learning motivation.

Blended Learning

The long-term relationship implied by subscription to a service provides a broader structure for blended learning across multiple devices and appropriate channels, i.e., the learner's mobile device, the Web, a physical location like a classroom or office, or even the mail (post). Though this complicates design and maintenance of the content in a number of ways, it does enable service designers to place components in the environment where they work best. It also allows learners to use the tools they prefer that fit their interests.

Technology Market Penetration

Early explorations in m-learning, such as those conducted in 2001 by Melissa Regan at the Stanford Learning Lab, indicate that modern cell phone displays with current network speeds are not engaging enough for mobile learning to be effective. (Regan, 2001.) A service model can further market penetration of the latest and greatest technology.

One of the reasons learners do not upgrade their mobile equipment is that the perceived benefits of upgrading do not outweigh the costs. A service model provides

customers with a clear value proposition, e.g., "If you choose the deluxe package with the new Nokia tall-screen Java-enabled phone, you will be able to download and use over 50 new learning modules." Since hardware costs can be distributed over the life of the service, perceived price decreases. (Rifkin, 2001.)

A secondary benefit to the "trade-up" model is that as devices are traded in, *Fresh* can resell or recycle them, keeping them out of the landfills and underscoring a commitment to sustainable business practices.

Low-tech service components offered in a "starter" package also indirectly aid technology penetration. As the learners gain mastery and confidence in the starter services with the low-end devices, they notice points at which better hardware would give them more options, providing experiential motivation to upgrade.

By using these practices to get recent technologies into the hands of its subscribers, the service benefits from being able to develop and release cutting-edge software. The service also benefits from word-of-mouth advertising as subscribers respond to inquiries about their sophisticated devices.

Learner Prompting

Research regarding learning and attention tells us that the efficacy of new devices suffers as they fade from learners' attentions. (Davachi and Maril, 2001.) One way to overcome this "fading effect" is to incorporate learner prompting into the designs. With device-structured business models, we would have to re-initiate contact with the learner to provide this prompting. Since there is no relationship established, such contact would be perceived as intrusive and unwanted, as is often the case with advertising. Framed within a service and controlled by the learner, however, prompts may be welcomed as a helpful aid to learning, and can encourage continued use of the service.

Tight Integration

Conceiving the components as a single service reveals opportunities for data sharing between the various inputs and outputs. For example, in this project, one component involves the delivery of location-based information and another allows the client to ask questions of the service. By logging the locations where questions are asked, we can build the database on which the location-based component relies.

Similarly, one component allows users to ask free-form questions of the service, which is forwarded for real-time answers by experts. Since the service has relationships with many clients of diverse interests, we can use this client base as the pool of experts.

Extensibility

Having an ongoing relationship between service and member allows the service to announce—as opposed to advertise—new technologies, hardware, and service components as they become available.

Learner Motivation

In a device- or lesson-based model, the primary value exchange occurs at the point of purchase. Afterward, issues of quality or guarantee may come into play, but these are meant to be exceptions and not the rule. Learner motivation between transactions is often a matter of luck and circumstance. In a service-based model, the learners are reminded each billing cycle that they are paying, and that it is in their best interest to maximize their use of the subscription. Additionally, as the learner reviews the charges on her bill, she reviews her recent learning activities, reinforcing them.

Why "Support?"

Learning is a complex, multilayered phenomenon. I am not yet sure anyone can lay claim to providing a systematized *learning* experience, as opposed to a systematized *educational* experience. But it is clearly possible to *support* learning, as I have tried to do. The title reflects this perspective.

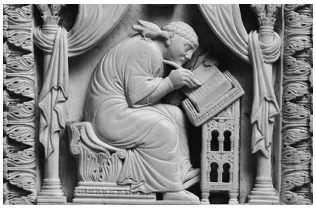
When did learning become mobile?

The question that begins this section is somewhat insincere. Since humans evolved from animals, who certainly learn, we can safely say that learning was "originally" mobile. That is, as prehistoric man roamed his environment, he had all the learning tools he needed: His body and his mind. The real question, then, becomes: when did learning become fixed?

Fixed in this sense does not mean that the *subject* is fixed. It is easy to imagine cavemen leading the young of their tribe to a certain tree to learn about it, or even groups of Greek men dressed in their chitons traveling to wherever Socrates happened to be to hear him speak. These would be properly described in learning theory as *situated*. Interestingly, one must be mobile to engage in such situated learning.

What I mean by fixed is rather that the learning takes place in a fixed *location*, regardless of the subject, as in a school. And it is in surveying the development of modern schooling that we can see how the concept of learning, originally situated in our experience of the world, slowly became rooted to the place of education.

Though some schools and universities existed in antiquity, such as Al-Azhar University in old Cairo c.970 BCE, the University of Fez in Morocco c.850 BCE, Pythagoras' Institute in Kroton in southern Italy c.520 BCE, and Nalanda University in old Bihar, India c.500 BCE, the modern Western concept of schooling grew more directly from European monastic tradition.



10th c Ivory Book cover depicting St. Gregory the Great in his Scriptorium

Since the writing of the Benedictine Rule in 529 CE, Western monasticism formally sought to remove itself from the outside world, choosing instead to focus on a life of religious contemplation and the reading and copying of sacred texts for posterity. Notably, the isolation of monasticism afforded study of subjects that were abstract and disconnected from the world. When Charlemagne in 819 CE and Pope Gregory IV in 1079 CE each sought to extend the church's influence, they decreed that monasteries, by virtue of the knowledge contained in their *scriptoria*, must establish schools to train priests and clergy. These schools focused on study of the *trivium* (logic, grammar, and rhetoric) and the *quadrivium* (arithmetic, geometry, music, and astronomy), which graduates would then apply to the real circumstances of their parish. In this we have the first example of a location dedicated to teaching abstract concepts to students who are meant to leave and apply the knowledge gained.

Bas-relief of medieval students at University

The year 1088 CE saw the establishment of the first European university that was independent of direct religious or governmental control. Called the *Studium*, this institution of learning was located in Bologna, Italy. Students here added the study of law to their more traditional studies of the trivium. The university model further evolved in the 1100s, as students in the monastic schools in Paris' Latin Quarter sought to expand the curriculum into different areas of knowledge, notably philosophy, debate, and logic. A century later the students in this district wrested control of the school from their chancellor and thereby the direct control of the church, cementing the tradition of the university as an intellectually independent institution.

As the industrial revolution popularized university learning, the baccalaureate degree gradually displaced apprenticeship as the preferred method of professional training. (Champion Ward, 1972. Lave, 1991.) This trend further spread the association of fixity with learning in higher education.

But the university is reserved for adult and young adult learners, and for a majority of its existence, specifically: affluent, white, male, adult and young adult learners. To discover how schools came to dominate younger levels of learning, we must trace a different thread beginning with Johannes Gutenberg and his printing press.

It was only in the 1500s and 1600s, the two centuries after the distribution of Gutenberg's printing technologies across Europe, that Western society became a reading society. Simultaneously, people came to realize that learning to read was easier if you did it at the same time you were acquiring oral language. Subsequently, over the

Johannes Gutenberg

course of the 18th century, childhood was culturally constructed as a time to be set aside for learning, and specifically, to become literate. (Postman, 1999.) This reached a culmination in the decades between the mid 19th and early 20th centuries, when mandatory education became widely legislated for all youth across the United States and Europe. Over the course of the century, the length of schooling (called *school life expectancy* in education statistics terminology) extended to an average of 16 years as of 2000. (UNESCO Institute for Statistics, 2003.)

Many students continue straight from mandated schooling into four or more years at university, and thereby spend the first quarter of their lives in schools. As a result, most citizens in modern Western societies associate deliberate learning with schooling even though, as we have seen, they are not the same thing. It is in this sense that learning has become fixed over the course of the 20th century.

The increased speeds of technological and societal change have, since the 1970s, been pressuring societies to decouple learning from schooling (as it is currently practiced), and to enable and encourage lifelong learning. (Champion Ward, 1972.) But, as a system, education is massive and difficult to change. Additionally, proposed alternatives may have been theoretically sound, but neither affordable nor scalable. Only the recent rise in popularity of mobile devices and their "anytime, anywhere" wireless connections has given us the technological foundation on which to develop scalable mobile learning support. The time is right for a service to capitalize on technology to support mobile learning.

The Design Process

The vision of the service model was developed in three broad stages.

In the first, through research into learning theories, I developed a list of learner needs. I then built an opportunity map by developing service components for learner needs in each of three learner channels: free-range, online, and offline. Finally, I drafted a service ecology to illustrate groups that would have a stake in the effects of the service.

In the second stage, I developed personas, which embody target users. I also developed example marketing materials that illustrate likely motivations for their joining.

In the last stage, I arranged the service components into a user-centered umbrella service, under which customers could select and customize components. I developed three experience prototypes, one for each of the main functions of the mobile device, and informally tested them with users in an academic setting.

Learner Needs

In my research, I was unable to find a major source that would clearly identify a list of learner needs. Some well-respected authors—such as Brookfield, Lave, Papert, and Wurman—had suggestions but did not attempt an exhaustive list. Some self-help authors, such as Gelb and Gross, provided suggestions but did not cite any research to support them. Others skipped the topic altogether. In my search I found an excellent course hosted at the Learning Disabilities Resource Community website titled "Learning to Learn" by Greg Gay at the University of Toronto. Though this course is not referenced in any of my other resources, I was impressed by its thoroughness and Gay's willingness to put a stake in the ground. I have developed the following list by distilling the suggestions in Gay's course and combining it with related suggestions from other authors.

Please note that this list was developed primarily as a foundation for brainstorming the service. As such, you will find that the descriptions are brief and cited only where a single author's perspective is prevalent.

Learner needs:

1. Goals
2. Help
3. Learning circles
4. Learning resources
5. Positive attitude
6. Prompting
7. Self-awareness
8. Skills

Goals: One form of validation comes from the realization and acknowledgement of learning accomplishments. Having clear, achievable learning goals helps learners focus their efforts and recognize when they have made advances.

Help from experts: Sometimes free-range learners may find themselves with a question that neither they nor their **Learning Circles** can answer. In such cases learners may need the assistance of subject matter experts.

Learning circles: Membership in a peer support group of similar interests (in situated learning theory, a *community of practice*) provides emotional sustenance, external motivation, distributed problem solving, social hierarchies for the development and reinforcement of identity, and diverse levels of expertise that encourage teaching what one knows and help with what one is studying.

Learning resources: Learners need resources that contain the content they wish to study, are the tools with which to study, or provide practical help to enable study such as car rides, babysitting, and financial aid.

Positive attitude: Learners, and adult learners in particular, must believe that they *can* learn, that they do not have to know everything, and that their opinions are valid. The absence of these beliefs undermines learning efforts. The presence of these beliefs encourages learning. Frequent validation of each accomplishment encourages continued involvement.

Prompting: Self-directed learning efforts can fall prey to habituation and may become overshadowed by other demands on the learners' attention. Occasional prompts help remind learners of their goals.

Self-awareness: Part of a learner's positive attitude comes from an awareness of their past successes and their strengths. Awareness of these personal attributes as well as of their learning weaknesses facilitates more effective *metacognition* (defined below).

Skills: Learning skills are a subset of crucial learner abilities. They include the following, and are detailed immediately below.

A. Asking good questions
B. Concentration and relaxation
C. Critical thinking
D. Language
E. Managing time and tasks
F. Memory
G. Metacognition
H. Overcoming information anxiety
I. Searching resources

Asking good questions: Asking questions enables learners to focus their interests into a single, addressable task. Questions also provide a means to check progress. According to a popular paper by Angelo V. Ciardiello, there are four types of questions learners can ask, based on four cognitive processes. He calls the categories *Memory*, *Convergent*, *Divergent*, and *Evaluative*. What constitutes a good question varies according to these categories. Ciardello notes that Memory questions are conducive to memorization, and the other categories are conducive to critical thinking and accommodation. (Ciardello, 1998.)

Concentration and relaxation: Learning is an attention-intensive activity. If the learner is distracted or nervous, attention suffers and learning becomes more difficult. Relaxation opens the cognitive channel for filling with the content of concentration.

Concentration and relaxation skills can be learned and exercised.

Critical thinking: Self-directed learning requires a great degree of autonomous thinking. Learners must be able to deconstruct poor or deliberately misleading arguments and be able to construct their own arguments clearly and reasonably.

Language: Almost all knowledge is contained and communicated through language. Mastery of the linguistic skills of speaking and writing increases a learner's ability and efficacy in learning. Language skills also come into play when discussing or representing what one knows.

Managing time and tasks: Just as metacognition is a core thought management skill, the practical skills of managing time and tasks help learners keep on task with their learning goals.

Memory: Sharpening short-term memory skills helps recall for social learning situations and convergent learning tasks. Developing memory skills also facilitates passing experience into long-term memory.

Metacognition: Metacognition means "thinking about thinking." Metacognition includes adjusting learning strategies based on an awareness of personal and group learning styles, strengths, and weaknesses. It also includes adjusting learning strategies to fit the task at hand. Another part of metacognition is *epistemic cognition*, or knowledge about knowledge, which includes awareness of what can and cannot be known, to what degree of certainty a thing can be known, how what is known came to be known, and what it means to know something. Recent studies suggest that metacognition is a major component of intelligence and learning capacity. (Gay, 2001.)

Overcoming information anxiety: Richard Saul Wurman coined the term information anxiety with the 1989 publication of his book of the same name. In his words:

> Information Anxiety is produced by the ever-widening gap between what we understand and what we think we should understand. It is the black hole between data and knowledge, and it happens when information doesn't tell us what we want or need to know.

The text describes the fears and tensions that accompany living in the information age, with its social pressure to know everything. This skill has two components: managing one's own self-expectations, and managing social situations in which the anxiety is brought to bear. Mastering it requires the following.

- Understanding the societal roots of information anxiety
- Admitting that no one, including yourself, can know everything
- Management of the fear of asking questions, even repeatedly

- The ability to manage social pressure
- The confidence that you can probably learn things you need to

Searching resources: In the information age, learners must possess skills in filtering the right learning resources from the vast number of available options. Core skills include familiarity with these systems, developing effective search strategies, familiarity with standard categorization systems, and effective keyword identification.

Learner Channels

As noted above, a service model affords multiple channels for interacting with the free range learner. To ensure that service components are placed appropriately, I identified three channels.

1. Free-range
2. Online
3. Offline

The first is **free-range**, when the user is mobile. Service concepts selected or designed for this channel must take into account the circumstances and use of mobile technology.

- Mobile learners are frequently distracted.
- Mobile technology displays are small.
- Mobile processor speeds are slow.
- Data throughput over wireless is slow.
- Storage space is minimal.
- Voice input is common and natural to the device.
- Switching between visual and vocal control can be awkward.
- Keyboard input is restricted and should be minimized.
- Light and sound conditions of use vary greatly.
- The amount of time that can be dedicated to a learning task varies greatly.
- For safety and usability reasons, mobile learners should never fear negative consequences of instant and possibly protracted disengagement with any given component.

The **online channel** contains those situations in which the learner is stationary, using technology that can connect to the Internet via a laptop or desktop computer.

- The learner has more control of the amount of time he or she can dedicate to the learning experience.
- The learner has some degree of control over the environment and can work to optimize it for her own learning style.
- Data throughput varies with connection type, but is typically much faster than the wireless network.
- The device has vastly greater storage capacities.
- The display technology is an order of magnitude larger.
- The processors are several orders of magnitude faster.
- Text input is easier and most users have an appreciable expertise.
- Voice input devices are rare.

When the service engages users in the **offline channel**, it must assume the learner has access to neither her mobile learning device nor her personal computer. Designing or selecting service components for this channel consider aspects of the real world.

- Social learning is best in person rather than mediated through technology.
- Some learners are intimidated by technology, or do not have access.
- Support in this channel is often cheaper and more sustainable, as learning materials can be made from more sustainable materials.

Opportunity Map

Cross-referencing the learner needs with the three channels created a grid from which I brainstormed service components, trying to fill in each cell in the grid with consideration to the constraints of the channel, the principles of the need, and the *personas* who would be using them. Service components listed in bold are detailed below.

The Opportunity Map

Need/Channel	Free Range	Online	Offline
Goals	**Question Suggestions**		**Ready Rooms**
Help from experts	**The Cavalry**		
Learning Circles	**LC Challenge** **Learn Gety**	Learning Circle community tools Matching services	Group facilitation Lecture series Meeting Places
Learning Resources	**Body learning** **Genius Loci** **SMS Reference**	Websites Resource Database Topic Node Network	Continuing Education Libraries Museums Zoos Educational Institutions **Wunderkasten**
Positive Attitude	Validation messages	Published articles	
Prompting	**Media Agent** **Question Suggestions** **Topic Drift**		**Wunderkasten** **Real-time Links**
Self-awareness	**Learner Profile**		
Skills	**All Ears** **Learn Gety** **Learning modules** **SMS reference**	**Learning modules**	**Wunderkasten**

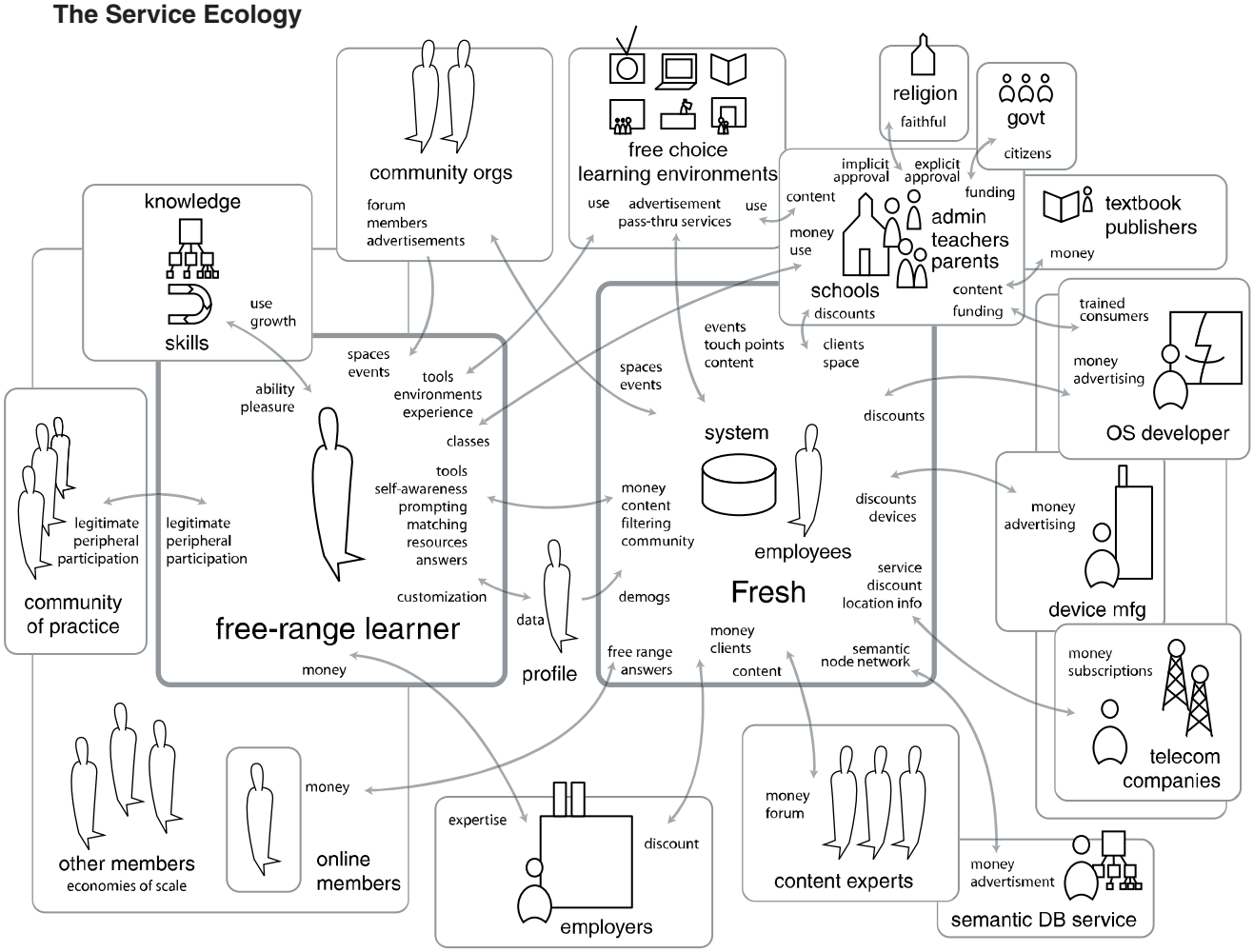
Service Ecology

A *service ecology* provides an overview of all the stakeholders and their relationships for a given system. Developing it will often reveal new stakeholders, potential partners, potential threats, or new relationships that must be taken into account for the system to be successful and sustainable. Designers also use the diagram to understand what interactions must be crafted.

Developing the service ecology for *Fresh* indicated that content providers would need almost as extensive an interface to the service as the clients. But as a paying client base is the most critical user group for viability, this thesis focuses on their experience.

In the diagram below, arrows indicate the direction of the value exchange in each relationship. What is exchanged is indicated in smaller text, near the ends of the arrows. Relative sizes of the groups indicate relative influence on the core service company.

The Service Ecology



Who will subscribe to the service?

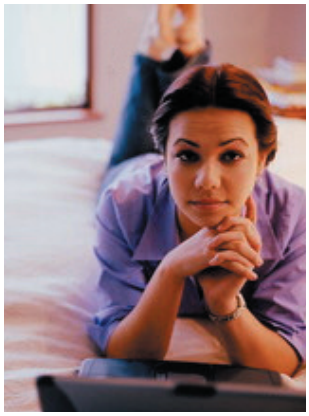
Personas are a common user-centered design tool. They are fictional characters that embody the target users of the system being designed. They help designers focus on solving problems for their users. They also help designers explain the systems they design through stories, called *scenarios*, centered on the personas' use of them. The scenarios developed for these personas are found on page 38.

Webmonkey.com defines psychographics as: the "warm and fuzzy" so-called qualitative data about consumer attitudes: political views, learning patterns, and music tastes all qualify for psychographic segmentation. These more ethereal qualities help advertisers and marketers fill in the gaps around basic demographic characteristics.

The first step in developing personas is to define target demographics and psychographics. By surveying the leading online learning services and Web portals and reviewing their marketing messages and information structures, I was able to infer groups of users these companies were actively engaging. I used these inferences to determine three broad target user groups: Young adults in school, working adults, and self-described lifelong learners.

The next step is to add convincing detail to the embodiments to "bring them to life." Though I hope that my service vision would be suitable for many countries, I felt competent to develop convincing stories based only in my home country.

Ellen: The Reluctant Student



Ellen has just entered her senior year at Lincoln High School in St. Louis, Missouri. She enjoys speech and English class, hates trigonometry, and is active in the tennis club.

Her parents both work full time. Her mother is a dentist and her father manages one of the larger theaters in town. Her younger brother Paul is just entering Lincoln High as a freshman. Ellen has a car and her mother told her to offer him rides, but she is charging him $2 for each one-way trip. This is both to defray gasoline costs and to dissuade him, since she'd rather drive her friends.

Her past summer was eventful. She celebrated her 17th birthday. She had her first job working in her mother's office answering the phone and filing papers. She hated it and swore to herself that she would never have anything to do with dentistry or office work.

She also broke up with her boyfriend when he left for college in New York. She still thinks of him, but he hasn't emailed her yet and she's upset with him.

She has a tight network of friends and when they are not together they keep in touch by cell phone, SMS, and instant messenger. Ellen's latest screen name is missLN, but she is liable to change it at any given moment.

The guidance counselors are already meeting with and prompting the students to prepare for their SAT tests and college admission procedures. Ellen is not keen on studying, but wants to get into a good college. She might be a political science major.

She is not ruling out the northeast.

Ellen thinks that learning is her full-time job at school, and she doesn't like it. She looks forward to the day when she graduates college and can start earning an income instead.

John: The Busy Worker

John is 40 years old. He has worked for ABB in Newark, as a Logistics Manager in New Jersey or 15 years now. He was recently promoted to manager of warehouse logistics and is finding the job challenging and mostly enjoyable.

He enjoys spending his spare time with his family, playing softball with his coworkers, fishing, carpentry, and traveling.

He is a family man that likes to spend time with his kids. His wife Elaine works full time as a claims adjuster so they alternate in taking their kids to different activities (hockey, ballet, soccer, scouts) in the evening.

As in most American households, the kids determine most of the schedule for vacations and television. John thinks that the most important thing is that they do things together, like hiking and fishing. Once a year they go to either Colorado or upstate New York to go camping.

When he and Elaine have time to themselves, they enjoy traveling to Canada to drive around and look at the landscape. John hopes to buy a little house outside of Montreal when he retires. He took some French lessons in college and can communicate well enough.

At work he is competent, but worried about keeping current with new trends in his field. He is also wary of some of the younger employees who seem to have more computer skills than he. With the current economic conditions, he is worried that he might get passed over for a promotion or even laid off if he does not keep his skill set current. This is stressful, because his family comes first and he cannot easily find time to arrange and attend evening courses.

John believes learning is restricted to schools, something his kids do, but that he might need to take up if he can find time to attend class.

Keiko: The Lifelong Learner

Keiko is a recently retired nurse living with her husband of 28 years in Pleasanton, California. They moved to Pleasanton three years ago to escape the high price of living in San Francisco, though she's beginning to question the wisdom of that decision now.

They enjoy their new house and are getting to know their neighbors slowly. She and her husband Yukio enjoy gardening, and they have met a few of the neighbors while tending the rose bushes along their driveway.

Since retirement, she has devoted more of her time to her favorite hobbies, including hiking and traveling. Together she and Yukio plan a major trip to Hawaii next year, where she looks forward to hiking the volcanoes and enjoying the views. Her daughter Suki gave her a digital camera for her recent 58th birthday, and she hopes to master it before her trip so she can send pictures to her friends.

She also enjoys retirement because it allows her to spend more time with Suki and her family, especially her 6-year-old grandson Austin. Though they still live in San Francisco, she keeps in touch by phone and email. Once a month or so Keiko and Yukio take the train to San Francisco to visit her daughter, and visit the library or zoo with Austin. This summer he will stay with them for a few weeks in Pleasanton. Keiko is looking forward to this and wants to make sure he enjoys his stay.

For Keiko, learning is a leisure activity, something she does for fun, on her own or with her family. It is also a means of enhancing her relationships with others.

The Service

How do learners become aware of the service?

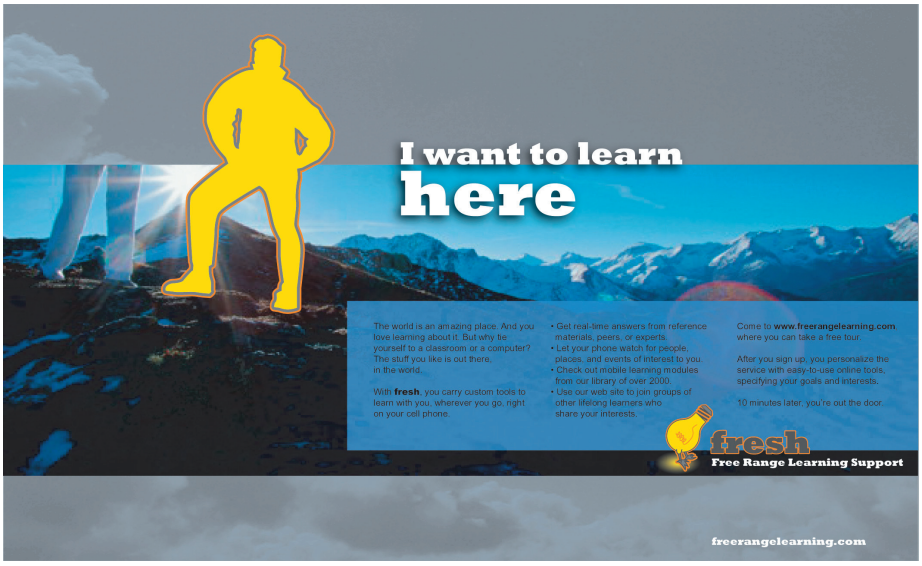
Advertisements

Because I assume that most users will self-select for this service, I developed three example advertisements to demonstrate the different appeals for each persona. Marketing is the beginning of scenarios since this is how potential members first encounter the service. Versions of these targeted advertisements could be placed on learning-related websites, in magazines, and on college campuses to increase awareness.

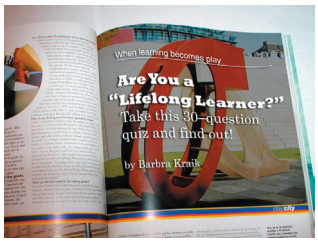
Poster targeting the Ellen persona.

Poster targeting the John persona.

Poster targeting the Keiko persona.



Publications



An example sponsored article.

In web advertisements and periodicals, potential members are invited to take a self-quiz. After answering a short questionnaire, they can read about their personal learning style. Links or URLs at the end of this test let potential members know that, as members, they could store this profile and build it over time, as well as hint about the wealth of resources available that exactly fit their learning style.

Partnerships

As illustrated in the service ecology below, a mobile learning company would need to coordinate many different constituent parts, including hardware vendors, developers of mobile operating systems, and mobile connectivity providers. Each of these has an existing customer base that might be receptive to upgrading or migrating to the service. In addition, *Fresh* can be used to increase revenues of the existing customers of partners. Advertisements could be included in these companies' existing touch points.

Real-time Links

Sparacino demonstrated how user preferences could be derived from user behavior in a learning environment. (Sparacino, 2002.) Using the same *Bayesian network model*, the service could integrate with the computer systems of partner libraries, museums, and even video rental stores to derive the learning interests of customers. Then, on checkout, the system could instantly include free information on the receipt about further local learning resources for the topic, with a URL for further information about the service.

A Bayesian network is a mathematical tool for modeling causal influences in a system. In graph theory it is also known as a *causal network* or *influence diagram*.

Bayesian networks are often used in computer systems in troubleshooting systems or to enable automated and complex decision-making.

Point of Presence

Younger users, such as Ellen, who associate learning with their schools, may not take pride in joining a learning service at first. Other users like John and Keiko, however, may be proud of their participation. For these users, customer-exclusive ring tones and eye-catching idle screens on their mobile devices may signal their involvement and invite discussion of the service from others nearby.

Website

Online advertisements can link to the service's website, where potential members can take a free tour of the services, read testimonials, learn about pricing, and sign up.

Ready Rooms

At *free-choice learning environments* such as museums and zoos, the service can sponsor small rooms on the grounds, which provide an overview of the environment, encourage goal

setting, and provide access to further learning resources on discovered topics of interest. The rooms would be free for use, but provide certain services only to members, such as printing exhibits of interest and where to find more information. The room would contain non-intrusive advertising materials for the service.

Once they become aware of the service, how do they join?

For the simplest features of the service such as **SMS Reference**, **The Cavalry**, **Media Agent**, and **Wunderkasten** (these components are described below) users could sign up on the website via phone. For other service features that require a proprietary interface or particular hardware, potential customers can visit one of the service's storefronts.

Providing a useful learning service depends on knowing some information about each member as a learner. New members would be encouraged to complete a learner profile.

Building the Profile

Most people enjoy learning about themselves. *Fresh* can take advantage of this fact to build learner profiles, manually and automatically, the results of which are used to raise the learner's self-awareness and encourage membership.

Explicitly

Members are free at any time to go online to take tests that refine their profile, or to manually adjust their profile if they feel that the results do not accurately reflect them.

Implicitly

As described in **Real-time Links**, cooperating free-choice learning environments can track visitors and infer their interests. Some members who join after visiting such places can benefit from having part of their learning profiles already created.

Similarly, desktop browser agents could passively note the sites at which participating members spend their time, and infer interests that are incorporated to the profile.

What information does the profile contain?

- Learning preferences:
    - What attitudes hinder their learning?
    - What is their learning style?
- Learning interests: What topics interest them?
- Expertise: What do they know already?

What do users do with this profile?

Simple awareness of this information contributes to the development of metacognition skills. For example, a learner who discovers that they learn best at night may deliberately choose to schedule their reading after dinner, and avoid study early in the morning. Additionally, learning achievements can be reflected by changes in a user's profile, over time for the learner's review.

What does *Fresh* do with this profile?

The profile can be used when matching learners in communities of practice. For example, in the **Learn Gety** service component, users visiting a history museum may want to be notified if another WWII aficionado is nearby for discussion.

With the service component called **Topic Drift**, past learning successes can be used to establish meaningful connections between topics the user would like to learn and what he or she already knows. Both **Learn Gety** and **Topic Drift** are discussed below. Several other service components rely on the stored information. Several other service components rely on the stored information.

Once they are members, how do they interface with the service?

There are five main touch points between the service and its customers: the offices or storefronts, monthly statements from the service, the website, mobile devices, and in a new no-tech service concept called **Wunderkasten**.

Offices

An example co-location.

While the main interactions involve the user through digital means, certain aspects of the service require a physical presence, including service and equipment maintenance, meeting places for learning circles and lectures, computer access, and analogue references.

The service would not necessarily need its own storefronts, as this is costly. Instead, the service could partner with businesses that have existing infrastructures to provide a presence at these locations, e.g., cellular service providers.

In addition, the service could partner with other entities such as libraries, schools, museums, and community centers for the use of their spaces as appropriate.

Website

The website can house online tools that augment and complement free-range tools, including an interface to a learning resource database, learning circle community tools, and learning circle matching services to find other members with similar interests.

Monthly Statements

An example billing statement.

Being a service, customers are charged each month for use of the service in the prior month. These statements can arrive via email or post, per the customer's preference, and provide a small, recurring opportunity to update customers on service changes or upgrades as well as new opportunities. It is also an opportunity to congratulate them for their level of participation and success in the service, helping the learner with their goals.

Mobile Device

Examples in this thesis show learners with cellular devices, but the use of any mobile, wirelessly networked device, such as a personal digital assistant, or PDA, is conceivable, as long as it could download and run the custom applications and connect to the Internet.

The focus of my thesis project is on interactions with a mobile device, because of the ubiquity of cell phones in today's market.

The mobile device would have three main functions for users.

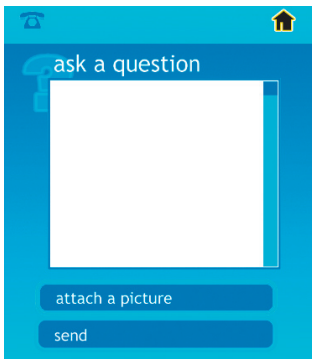
- Allowing him or her to ask questions.
- Watching for things of interest.
- Permitting further study.

Asking questions…

On the main screen, users can indicate that they want to ask a question. The resulting "ask screen" allows them to enter a question in text. If their device allows them to take photographs, it also provides an option to attach an image to the question. Once they complete their question, they have the option to send it to a computer for automated reference, to a group of pre-defined peers known as a learning circle, or, for a small charge, to the service for answering by an expert. These options are detailed below.

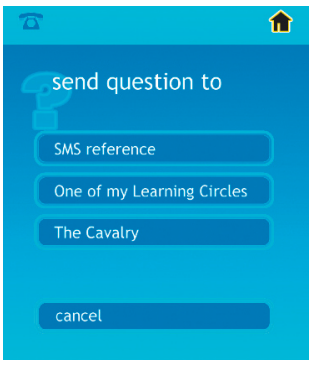
Any time a question is provided to the system from a mobile learner, the question is stored in the database with a note of the location from which it was asked. Doing so helps to build the location database on which another component, **Genius Loci**, relies.

…of a computer



This aspect of the service is called **SMS reference**. In it, novice users can submit natural language questions. The server can utilize state of the art natural language processing to try and discover the search parameters. More expert users could save time by using more formal search syntax. In both cases the server can send a response back via SMS to them immediately. Reference options include dictionary, thesaurus, reverse dictionary, language translations, and abbreviated encyclopedia reference. Other references can be added to meet the interests of the customers.

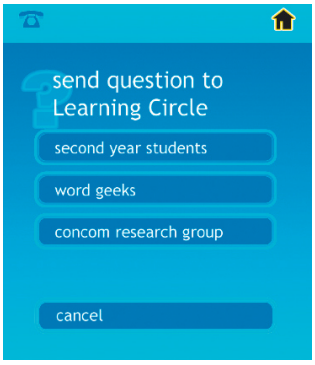
…of a learning circle



Via the website, learners can identify the contact numbers of a group of peers who share their learning interests. Within the service, these groups are called **learning circles**. This term is common to many adult self-study initiatives across the world. The origin of the term is difficult to determine.

In the service, members go online to define an alias for their circles and invite others to accept or decline participation. By sending a question to the alias, the server automatically forwards the message to every member of the circle, facilitating easy group dialogue between groups of mobile learners.

…of experts



This component of the service is called **The Cavalry**, reinforcing the idea that it might be called as a backup if neither **SMS reference** nor any of your **learning circles** provide an answer. Upon sending the question to **The Cavalry**, the server first checks to see if the exact same question has been asked before. If so, the last response to the question is sent immediately. If the question is not in the database, it is parsed for its likely topics and matched against the learning profiles of other members of the service who have identified that they wish to answer questions as experts. When any experts are not themselves mobile and available at their computer, they run a small application that alerts the server that they are available to answer questions in exchange for small credits to their account. It is also conceivable that as the service becomes successful, it could support full-time experts on popular topics.

When the server identifies the set of all available experts whose expertise matches the Cavalry question, the server forwards the question to them. On the experts' screens, the question and any attached image is displayed. If one feels that he can answer the question, he can "claim" it by clicking a button, at which time the question is removed from other experts' screens. The expert answers the question as best as he can in real time, including details about where to learn more and **Question Suggestions** that describe how the learner might change their question to get better, or more

accommodating, answers. The application sends the entire response to the server. The server sends the "where to learn more" information and the **Question Suggestions** to the learner's email address before forwarding the rest of the response.

Upon receipt of the response, the free-range learner may need further information. If the request is immediate, the new question is routed to the same expert to maintain context of the thread. For an additional cost, the user may request to speak directly with the expert.

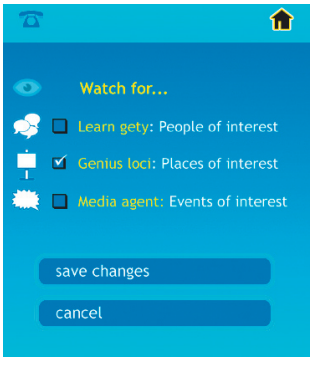
Upon completing the transaction, the free range learner can rate the expert for the clarity and speed of their response. Experts with many low ratings are flagged for possible removal from the system. Experts with many high ratings can be given additional credit for their participation.

Finding…

In addition to asking questions, customers can request that their mobile device watch for people, places, and events of interest. Additionally, they can request that the device passively listen to the learner's use of language and provide suggestions for improvement. The customers' interests are either derived from their interactions with the server or through the customer's learner profile. These components are referred to as *watchers*.

…interesting people

This watcher is called **Learn Gety**, after the Japanese product Love Gety, which matched Japanese teenagers with others in their vicinity according to the settings of a small key chain device. When active, **Learn Gety** compares the learning interests of the mobile learner with the mobile interests of others in their vicinity and notifies both parties if there is a topic match. The interaction design supports control and safety for the participants, including post-conversation ratings for collaborative filtering.



…interesting places

When mobile learners activate the **Genius Loci** watcher, their learner profile and location is compared against the database. Learners are alerted to any nearby item of interest via text and, if available, an image.

Of course, learners can set parameters for these alerts to avoid being barraged.

It was noted above that learner questions are part of the database on which this service component relies. This assumes that something in the environment triggered the question in the first place. Since this is not always the case, i.e., people often think of things unrelated to their location, these items in the database are treated differently.

They are represented tentatively to other users of the **Genius Loci** in the form of a question, e.g., "Do you see a church nearby? One user asked the following about a church in this location." If a number of learners answer "no" to such a question, the question is removed from the **Genius Loci** database. If a number of learners answer "yes" then the question is "solidified" in the database and treated as concrete.

…interesting events

As learning events are entered into the service database, they are tagged for their topics. These are automatically compared against the learning profiles of customers who have activated the **Media Agent** watcher. These customers are notified of the event. Using the device interface, they can indicate if they would like to attend. If so, the system can compare the event topic against the learner's other topic interests and check to see if there is any link in the database between them. If there is, the system can send the message to the learner around the time they are attending, helping to connect their current interests and encourage lateral thinking. If such a link does not exist in the database, the system can automatically submit it as a question to experts in the **Cavalry** pool.

…ways to improve language

When a learner is not using her cell phone, it can act as a passive recording device. In this service component called **All Ears**, the phone uses speech recognition to store what is spoken as text. To improve language skills, real-time parsers like the sort found in Microsoft's popular Word program check the text for grammar or vocabulary errors. Learners can opt to either receive a silent vibration at the moment an error is detected, or a day's summary that is emailed to them. Alternately, the stored text can be parsed for repeated words and themes from which new or potential learning topics can be derived and stored tentatively in the learner's profile. It is worth noting that because accurate, real-time voice recognition in noisy circumstances is many years away, this is the most distant of the ideas presented here.

Watchers as Prompts

One of the joys of the library comes while searching for a book and encountering unexpected books along the way. Perhaps their title or cover design catches our eye. Perhaps the book is near the one we seek, and thanks to the Dewey decimal system, they relate. Or perhaps it doesn't seem to relate at first, but as we indulge our curiosity, we discover a new interest or find an unexpected connection to our original topic.

Electronic searching rarely provides this type of peripheral experience, but such connections can both encourage, expand, and reinforce our learning. When learners seek this sort of experience, they can enable **Topic Drift** in their preference settings.

When enabled, the server extends its search beyond topics listed to include topics that connect to those listed. This function affects both the **Learn Gety** and **Genius Loci** components. For example, **Learn Gety** might connect one person who lists programming as an interest to someone who lists legal contracts as an interest, since the two involve instruction-giving. Learners may even enjoy a game whereby the connection is hidden, and the two learners must meet and find what their connection is. Since the possible number of connections is vast, building these connections is a viability concern.

Building the Connections

Though some commercially-available semantic node networks may include some of these links, paid *Fresh* staff can provide the default connections. Both staff and members can submit suggestions for new topics. If the links are obvious, such as a connection between art history topics and political history topics, staff can approve them. If the connections are less obvious, such as a Michelangelo fresco connecting to neuroscience, the membership can participate in online, collaborative filtering to determine if the connection should be formalized in the **Topic Drift** database.

In fact a neurosurgeon named Frank Lynn Meshberger has made just such a connection. When he visited the Sistine Chapel in 1990 he saw what no one before him has seen: the borders of the cloth in which God sits is an accurate and instructive map of the brain, with God sitting in the limbic system, the emotional center. Had you let the *art history* topic in your **Genius Loci** learning profile drift just one degree, you would have learned this while standing there admiring the fresco.

Default Connections

Ideally, each topic would connect in some way to common topics, to ensure that it is accessible to the greatest number of learners. Gardner's multiple intelligences provide a good basis for these default connections, as they accommodate very diverse (and possibly universal) experiences and interests. (Gardner, 1983.) The nine intelligences follow.

1. Verbal-Linguistic
2. Logical-Mathematical
3. Visual-Spatial
4. Body-Kinesthetic
5. Musical-Rhythmic
6. Interpersonal
7. Intrapersonal
8. Natural
9. Moral

Further Study on the Mobile Device

While the screens of mobile devices are not large enough to present engaging content, some customers may wish to study their interests in greater depth while mobile. For these customers, the service provides **learning modules** tailored for mobile use.

To overcome the limitations of the screen interface, this service component includes—for a small extra monthly charge—the use of **Body Learning** modules. These are marked as such when learners browse the catalogue of learning modules. To use a **Body Learning** module, customers must pickup or receive via mail a small "backpack" accessory for their mobile device, which provides sensor information about the environment in which it is being used, such as bearing, tilt, and even temperature. **Body Learning** modules reference this data to help engage more of the learner's senses. For example, the user could control graphically augmented 360-degree images of a given location by turning their body and adjusting the tilt of their phone. **Body Learning** has the additional benefit of making the service more attractive to kinesthetic learners.

Wunderkasten

I coined the name *Wunderkasten* from the German words for "wonder box." It references the 16th century "Wunderkammern," or "wonder rooms", which were rooms dedicated by wealthy owners to display collections of odd and wonderful (and sometimes fraudulent) objects from all over the world. These rooms and their smaller cousins, the "Wunderkabinet", are regarded as the forebears of the modern museum. Learners subscribing to the wunderkasten benefit from having customized tangible learning media, convenience of delivery to their door, real-world learning prompts and materials, and not least of all the pleasant surprise of receiving something in the mail.

How does it work?

In the service, learners browse through an online catalogue of available topics, and select those of interest to them, forming a topic queue. The first box in their queue is sent to them in the mail. The learner can keep the box and use its contents as long as he or she pleases. When finished, the learner uses their phone or Web form to arrange the return of their current box and, at the same time, the delivery of the next box in their queue.

Alternate Forms

The cost and potential inconvenience may be deterrents. It is expensive to ship boxes, and the service would be priced to compensate. Additionally, some learners may find it inconvenient or difficult to arrange delivery or return. For learners looking for a less expensive or mailbox-only option, the idea might survive translation to "wunderkarten," or "wonder paper," which is an envelope-sized preprinted booklet whose content is similar, but whose activities would involve cutting up the pages or using common objects around the home or office. This implies that the learners do not return the booklets, and, instead, purchase each one and only have to return "next booklet" cards in the mail.

A prototype of the first Wunderkast that subscribers would receive.

How is this free range?

The **Wunderkast** boxes each contain something to wear, something to display, and something to hang. These serve as social signals for others in the learner's environment. When someone asks about any of them, the learner is prompted to speak about or explain what he or she is learning. This reinforces the learner's experience, and invites the listener to join the speaker's learning community. Giving the option to keep small objects from the box speaks to people's need for an artifact of their experience. It validates the time and money spent and acts as an environmental mnemonic.

Format

The Wunderkast is a cardboard box roughly 15 cm on each side, suitable for shipping. Each Wunderkast contains the following:

1. **A label:** including the title, topic, and contents list. The label introduces the box to the learner.
2. **A contents list:** which acts as waybill at drop-off and pickup.
3. **A booklet** containing main information about the topic: the primary text about the topic. It contains a basic text that can be read in about half an hour, explanations of the activities, and explanations of the contained activities and objects. It also details the authors of the contents.
4. **Learn more:** a list of resources that tell learners where they can go to learn and do more about the topic.
5. **Related boxes card:** which informs the learner about boxes related to the current one. Topics indicated include supersets, subsets, and laterally related topics. Inspired learners can check one of the related boxes to indicate that they would like this one added to their queue.
6. **Price card:** which indicates the cost of any items the learner wishes to keep when they return the box.
7. A fan-bound set of nine cards with **intelligence links**, explaining how this topic connects to the prior one, from the perspective of each of Gardner's nine intelligences. (Gardner, 1983.)
8. A small coin-sized **sticker** showing the icon that represents the box and the title of the box. These stickers can be saved and connected on a poster as a visual reinforcement of the learner's journey through the boxes.

Several of the following:

- A solo activity
- A group activity
- Suggestions and materials for something to make
- Something to be worn
- Something to display on a desk, coffee table, etc.
- Something to hang from a lamp, a car's review mirror, etc.

Additionally, the **Wunderkast** author may add anything else that will fit into the box, survive delivery, and can be purchased or easily replaced. For example:

- Miniature dioramas
- Mnemonic devices
- Games

- Paper dolls/puppets
- Topic examples

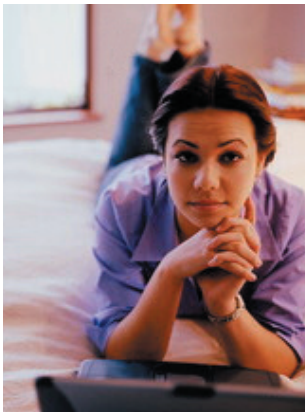
Learners with Web access can use these online functions as well:

- Browse and queue the topics visually.
- Review their **Wunderkast** history: which ones they had, when they had them, and who has had that Wunderkast before them.
- Add comments, ratings, and suggestions to box summaries.
- Link to web pages or other resources related to the topic.
- Request the development of new **Wunderkasten**.
- Apply to become a **Wunderkast** author.

The **Wunderkasten** is the last service component envisioned for *Fresh*. Reading them sequentially can be overwhelming, as they are complex to describe. They are, however, intended to be easy to use by each of the personas, as the next section illustrates.

Scenarios

The following fictional stories, called *scenarios*, illustrate how the design of the service supports the needs of the personas.



Ellen

Chooses *Fresh* as elective

Ellen and her friends choose *Fresh* as one of her elective classes for her senior year. After signing up, she takes some self-tests to build her learning profile. Ellen answers the questions honestly and is surprised that the results, which seem to describe her learning style quite well.

The first assignment in the class is to establish learning goals, using school computers to fill out online forms. Ellen is dreading her trigonometry class so she lists passing her course as a goal. She also wants to improve her tennis game, but since that's not really "school," she asks the teacher if it's acceptable. He says that Ellen should list her interests, whatever they are. When she finishes, the site gives her some options. She tries reading some of the online study for trigonometry, but the stuff bores her to death. Feeling a little guilty but not wanting to fall asleep, she decides to download a tennis module to her phone, and to check out the **Body Learning** device from the school.

At the park

Before Ellen can use the module, her friends decide to test how free-range this class really is. They ask the teacher if they can leave to continue at the park. The teacher says that they do not need to ask in the future. They leave school and go to the nearby park. They're not really in the mood to study, so they sit back in the grass, chat, and watch the clouds go by. But at a lull in the conversation, Ellen decides to try her tennis module.

She pulls her cell phone out of her purse and reads a short text about the basic tennis swing. It has a few animations in it, too. At the bottom of the screen is an option to try it. She fetches the **Body Learning** device from her purse and clips it onto the back of her phone. With the phone in hand, she tries the swing. The module uses sensors in the device to track Ellen's motion. When she finishes the swing and looks at the screen again, it shows the arc of her motion compared to the ideal arc. It's not perfect, so she tries a few more times. Her friends ask to try as well, and she helps them, augmenting the module's text with some of her own experience.

Tickets to the tournament

While returning to school, Ellen receives a message from her **Media Agent** telling her about an upcoming tournament in town. It asks her if she plans to attend. She talks about it with her friends and decides to go. When she confirms, the server looks for a way to connect the topic of the event—tennis—with any of Ellen's other interests listed in her profile. She only has one other interest indicated—trigonometry—but nothing in the database connects the two topics. So it sends a challenge to **Cavalry** experts whose profiles list both *sports* and *trigonometry*. One member accepts the challenge and does a little research, writes up a short text, annotates it with an image, and sends it back to the server, where it waits in a queue for a scheduled delivery.

While watching the tournament a week later, Ellen receives the message on her phone. It shows her how the arc of the tennis ball can be described mathematically with trigonometry. It even shows her a small graphic to illustrate the idea. Ellen looks up from the phone to see the tennis game in a new light.

John

Meets *Fresh* at the library

John's company asks him to attend a workshop at one of its offices in Stockholm in two months. The workshop will be in English, but John wants to learn a little Swedish before he goes. He stops at the public library on the way home, where he checks out a book on beginner's Swedish and an accompanying audio book. He also picks up a travel guide for the region. At the check out counter, John hands over the items. As the librarian scans them, the computer sends their ISBN numbers to a *Fresh* Web service that looks for patterns or groupings in the books. There is a clear pattern, and the service sends back a Real-time Link, which is printed out at the bottom of John's receipt. It reads, "Want to find out what's happening in Newark about Sweden? Come to http://www.freerangelearning.com/find.asp?062369"

At home, after dinner and putting the kids to bed, he shows the receipt to his wife and decides to look it up. He logs on to the Internet, opens his browser, and types in the URL. He is taken to a page showing the different local groups and activities about Sweden. He had no idea there was anyone else interested in it right there in Newark. He joins up on a trial membership. He follows a link to the beginner's Swedish learning circle. He ends up in a chat room talking to others about their experiences. Over the next few weeks he also decides to visit one of their regular weekly lunches at IKEA near the Newark Airport for speaking practice.

Picking up his son from school

John also downloads the beginning Swedish language module for his phone. While waiting in his car to pick his son up after baseball practice, John tries the module. He uses his earpiece and holds the phone in front of him on the steering wheel. The module begins. It shows him the number one on the screen and below it the word "ett." In his ear he hears "One. 'Et.' You try it." John says "Eht." It responds, "Excellent. Let's move on to the number two. Tvoh. You try it." John is able to get to eight before his son arrives.

As his son, Mark, gets in the car, John hands him the phone. Mark knows the interface well from playing with it last week, and he turns on the **Genius Loci** watcher for their trip home, setting it to show everything it finds. As the car moves through the streets, the phone sends its location to the servers at *Fresh*. The server compares the phone's location against its database, searching for the nearest thing whose topic matches John's profile, which only contains "beginning Swedish." It sends back what it finds. John is driving, so Mark watches the screen and calls out when it changes.

> "Dad, look for a church."
>
> "Yep, I see it."
>
> "In Swedish it's…kire-kah? Hang on, let me listen…No, sheer-keh."

John and Mark try a number of words this way.

At a stoplight, John sees a fountain. "Fountain" didn't come up on screen, so Mark uses SMS reference to request a translation of "fountain." The service sends him the response, "fontän", and notes where the phone was at the time the question was asked. It drops the query in the database. It will show "fontän" to the next member that comes by this same spot, running **Genius Loci** and interested in Swedish. John and Mark have helped to build the very database they are using.

Business trip to Sweden

On his flight to Sweden, John is more excited than scared. He is eager to try some of his Swedish skills. Stepping off the plane, he follows signs to retrieve his luggage. Just outside the airport he catches a taxi and manages to tell the driver where his hotel is located. On the trip, he has a mild panic, not knowing whether it's customary to tip drivers in Sweden. He gets out his phone and sends the question to **The Cavalry**. By the time he gets to the hotel, he has received the answer from another member of *Fresh* who used to live in Sweden. He knows that the tip is included in the price, but gives the driver 5 Kronor anyway.

Keiko

Gets *Fresh* as a gift

Keiko reluctantly joined the American Association of Retired Persons, strictly, as she'll tell you, for the discounts. It was in one of the newsletters that she read an article about *Fresh*. She dropped a few successful hints to her daughter, Suki, who gave Keiko a year's subscription as a Christmas gift.

Keiko doesn't like computers, so instead she uses the free telephone number to start her membership. By answering some questions from the operator, she completes a learning profile. She lists *nursing* and *rose gardening* as expertise and *Hawaii*, *hiking*, and *photography* as interests. She also lists *sharks* as an interest because her grandson Austin loves them so much. Keiko orders a cell phone. She also signs up for the **Wunderkasten** service, since it will give things for her to share with her grandson, Austin. In fact, she requests that the shark box be sent immediately for Austin's upcoming visit. Within a week, she receives her new phone and her first **Wunderkast** in the mail.

She opens the box to find it was full of things having to do with sharks. There is a small shark figurine, an odd brooch made from a shark's tooth, and what appears to be a pair of completely opaque sunglasses with a strange bump on the frame. She also finds a pamphlet of reading material on sharks, a listing of shark-related books in the Pleasanton public library, upcoming television programs, exhibits in San Francisco museums, and even the types of sharks in the local Monterrey Bay Aquarium and Aquarium of the Bay. She thinks most of it is for Austin, so she puts most of it back in the box. But she likes the brooch and puts it on. She also takes a little time to read the pamphlet.

Taking a walk around the block that evening, Keiko and her husband Yukio meet the Normans, neighbors from down the street. They fall into casual conversation, and Mrs. Norman asked about the brooch. Keiko forgot she was wearing it, but is able to share information about the service, her upcoming visit with her grandson, and much of what she can remember from the pamphlet.

Train ride to San Francisco

After Suki, on her way to Sacramento, drops off Austin that weekend, Keiko and he spend time reading and doing the various activities together. They make a shark hand puppet. Austin reads that sharks find fish via electric fields. The opaque glasses have small sensors that make a noise when they are in similar fields. Wearing them you can "see" like a shark "sees." Austin has some fun wearing the glasses and trying to find Keiko's cats.

Sharks have specialized glands called *ampullae of Lorenzini*, which appear as scattered dark spots across their snouts. The spots are holes which contain nerves seated in a gel that are very sensitive to the electromagnetic fields emitted at close range by all living things. If you had a chance to spend some time with the shark **Wunderkast**, you might have picked this up.

When it's time to go, Austin begs to bring the glasses. Keiko looks in the box and finds the price list. They're only $25, so it won't be terrible if he breaks them. She agrees. They gather together their things and drive to the Pleasanton train station.

On the train, Austin plays with his shark puppet, threatening to eat everything in Keiko's purse. As they ride, her phone sends its location back to the server. When she is half a mile from their home, the **Learn Gety** function automatically turns itself on. The server compares Keiko's location with the location of other learners with similar interests. At first it doesn't find a match, but at the San Leandro station, she receives a message. It tells her that another member of *Fresh* is nearby who shares an interest in Hawaii. She reads the member's profile on her phone, and ordinarily might enjoy a conversation. But today is about her grandson, so she declines a visit and turns the **Learn Gety** function off.

Heading to the Aquarium

Upon arriving at the Aquarium of the Bay, Keiko receives a message that as a *Fresh* subscriber, she and her visitors receive a discount on tickets, and are invited to use the **Ready Room**. They are curious about it, so as they purchase tickets, they ask the young man behind the counter where it is. He shows them on a map and points to it.

In the **Ready Room** are maps and diagrams that show an overview of the aquarium. There are also computers where they can plan their day. Austin wants to "drive," and he makes their plans with Keiko's input. Their first stop will be the shark exhibits. The software also encourages Austin to prepare some questions he would like to answer on his visit. He types them in. Meanwhile, one of the staff shows Keiko how to get additional information about the exhibits through her cell phone, by turning on the **Genius Loci** feature specifically for the aquarium. As they pass various exhibits, **Genius Loci** tries to find connections between the exhibit's topic and Keiko's profile, but only finds a few. The server sends challenges to **The Cavalry** for those topics that are not linked for future visitors with similar interests.

They enjoy their visit. Both of them are able to remind each other of things they have read and seen from the **Wunderkast**. At the White Shark exhibit, Austin asks the docent where the shark's dark glasses are, and Keiko laughs and explains to the docent what he means. The docent shows Austin where its "sunglasses" are.

After their visit, they stop by the **Ready Room** again, where they can print out a summary of their day at the aquarium. The summary includes information on places they can go and things they can do to learn more about the exhibits they visited. Austin is also reminded of the questions he asked before going in, and he and Keiko try to answer them together on their way home.

By the time Suki picks up Austin Sunday evening, he has convinced Keiko to let him

keep the glasses and the media guide so he can be sure to catch shark programs on the Discovery Channel. When he has gone, she calls *Fresh* to arrange pickup of the shark box and arrange to have the Hawaii box delivered.

When *Fresh* receives the box, it notes the missing items. A service representative calls Keiko and verifies that she intended to purchase these items, explaining that the charge will show up on her next monthly bill. Keiko agrees to the charges but only half-hears the operator, as she is engrossed in the Hawaii **Wunderkast**.

Experience Prototypes

Testing services of the implied complexity and breadth is difficult without developing deep infrastructures. Given the timeframe of the project, I decided to develop four experience prototypes for the proposed service instead: **SMS Reference**, **The Cavalry**, **Body Learning**, and **Genius Loci**. These were selected as they represented one component from each of the free-range mobile device functions, and because their underlying technologies were near-term and fully realizable in 2-3 years development time. They were developed to a point of unsupervised usability and given to subjects to use. Afterwards, users were interviewed about usability and viability issues.

SMS Reference and The Cavalry

The receiving cell phone connected to a PC running the Java application.

In this prototype, volunteers with cell phones were given access to a special phone number for nine days. During this time, they could send SMS requests to the number for automated dictionary, thesaurus, Italian-English or English-Italian translation lookups. The receiving cell phone sent the request via a cradle cable to a computer running a custom-written Java server. The program stored the request in a log file, parsed it, scraped responses from appropriate websites, formatted the responses, and sent the response back to the phone for immediate delivery. Response time was typically within 10 seconds.

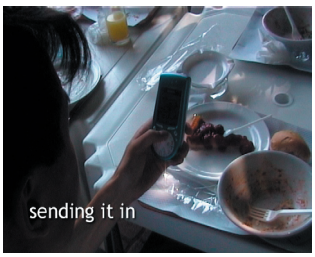
Scraping is a method of gathering information from Web pages, where the server requests the page from the Web, stores it in memory, and obeys programming to pick out only the relevant parts for use. This method is not permissible for commercial applications, and was only chosen to expedite the development process. In the ideal implementation, the service would establish relationships with the content providers.

An example response from the SMS Reference.

Users could also use the same system to send open-ended questions to the service. In response to such questions, the system emailed the question to the author, who would research the answer and manually send an SMS response. Response times varied but were usually provided within an hour.

Users were surveyed at the end of the week, in which they could review their logged queries, provide the location and circumstances of each query, and answer questions about the experience.

Experience Prototype Results



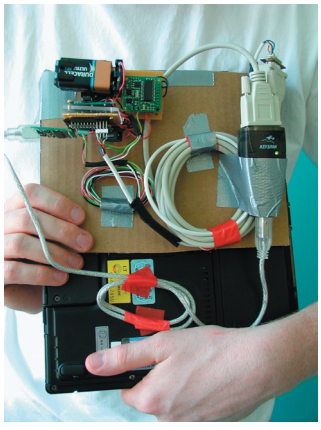
Still shot from a video showing use of the service.

Some small usability problems were discovered in the prototype. For example, the first iteration of the service used a dash as the command delimiter, e.g., "d-mobile" was the correct command to request a dictionary lookup of the word "mobile." It was discovered that for most of the test subject's cell phone interfaces, dashes are difficult characters to find and enter, accessible only through submenu systems that made the requests unnecessarily complex. In subsequent tests, the use of a delimiter was omitted, such that the command "d smile" would suffice. Though this required slightly more complex programming to be able to handle multiple-word requests, the benefits in usability warranted the change.

The responses indicated interest in such a service. Eight of nine volunteers said in post interviews that they would agree to have a small monthly fee added to their phone bill for the continued use of the service. The ninth volunteer became frustrated with the command syntax and when she finally mastered it, discovered that the word she requested, "diegetic," was not in the referenced dictionary. In her response she clarified that given a better dictionary, she would be interested in such a service. All would opt for a charge per request rather than a monthly service fee, at an average acceptable price point of 14 cents/request.

Volunteers reported a wide variety of circumstances that prompted their requests. Duplicate circumstances included native English speakers trying to explain a word with an intricate definition to non-native speakers, settling debates in conversation, and cooking using foreign-language and metric instructions. Significantly, three reported that they felt more empowered and encouraged to ask questions about things around them.

The surveys revealed an unexpected aspect of the experience. Users reported that the time delays involved with the Cavalry service were not always important. While a few users needed their information immediately, most felt it was enough to be able to "capture" the question at the moment they thought of it. For example, one user lost his cell phone for two days. When he found it and read the response to an earlier query, he was immediately reminded of the moment he asked the question and felt the time delay reinforced his interest in the topic.



The sensor "backpack" affixed to the back of a Tablet PC.

Body Learning

In this experience prototype, a Tablet PC was augmented with sensors: an accelerometer and two compass chips, letting the device detect its tilt and cardinal direction. This information was used to control a custom-written constellation browser module, which matched the tilt of the Tablet PC against a star map, enabling direct comparison with the night sky. The constellation display was framed on screen by a cell phone image,

A screenshot from the constellation browser.

to reinforce the idea that this would be used on such a device, and to test at the actual resolution of a cell phone display. By pressing one of the number keys on the interface, users could view the constellation lines and names, which would fade over the course of a few seconds. A different button would display the same information without fading.

Four volunteer students were given this device and asked to use it one night to find their star sign constellation in the sky. They were asked to try it once with key control of the display and once using the sensors. Afterwards they were given questionnaires about their experience.

Experience Prototype Results

The students spent 30 minutes in total with the device, switching between users, who acted as guides, and others, who spent time watching the sky. Each found their constellation using the sensors first. Three were able to find it in the sky afterwards. The fourth student's constellation had not risen yet, but the student was pleased to know where it would rise. All enjoyed looking at the foreign constellations visible "under the ground" using the device.

When the sensors were disabled and the students asked to use key control to move the display, they reported that the experience was as enjoyable, but entirely different. Manually, the task was to apply knowledge learned with the sensors. One of the users asked to switch back and forth between the manual and automatic mapping modes to test his guesses.

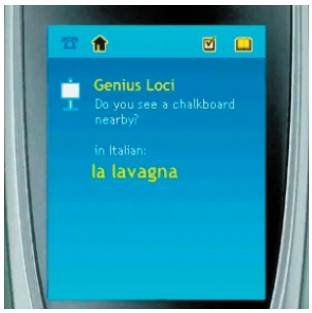
A still frame from the video of the constellation browser in use. (Shot in Infrared.)

The students spent time connecting their constellation with other nearby or well-known constellations, to aid in their memory. For this they left the constellations visible rather than use the fading display. None reported preferring the fading mode.

Some usability problems were uncovered in the questionnaire. The students' eyes had difficulty adjusting between the backlit LCD screen (even with a black background and dimmed graphics) and the night sky. The size and the weight of the Tablet PC became uncomfortable during the demo, making them want to cradle the device and not hold it up to the sky. These issues would not be identical in the ideal implementation.

In the questionnaire, the students were able to imagine some surprising applications for such a device for their own learning interests including 3D time-scrolling displays of historical sites while on vacations, distant-object labeling for panoramic views, and exploring famous artworks. All noted that they would probably not use the device in their daily lives on a regular basis, and so would be most interested in renting them while on vacation or visiting art galleries, rather than including the cost of a device in their service.

Genius Loci

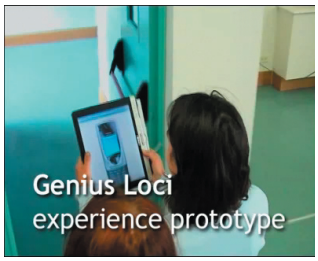


A screenshot from the Genius Loci demonstration software.

As location-based information accumulates and overlaps, personalized filtering for topics of interest becomes paramount. (Sheth, 1994.) In this experience prototype, a database of location-based Italian-language information was built. Five adult students who were currently enrolled in an intermediate Italian class were given a Tablet PC containing custom-written Java and Macromedia Director applications. These applications interfaced an off-the-shelf wireless network positioning engine, called the Ekahau Positioning Engine.

The students were given the Tablet PC and asked to tour the building, looking for space tags which had been defined by the author. Their instructor accompanied them. Afterwards, they were given vocabulary tests of the items they encountered, and asked to complete a survey of the experience.

Experience Prototype Results



Still frame from the video of the prototype in use.

The students enjoyed the novelty of the device and the "treasure hunt" style of learning. One expressed a desire to be able to hear the words displayed. Other students agreed with this. Another student wished to read example sentences with the words.

The accuracy of the engine is not perfect or instantaneous, and this, combined with the limitations of the prototype, led to some frustrations among the users, who expected immediate response from the system and more control.

In the post-prototype questionnaires, the students remembered most of the words they encountered in English. They could only recall the Italian translations of the words less than 60% of the time, but no great emphasis was placed on the results.

The post-prototype questionnaires explained the differences between this experience and the experience of the actual service. When asked to imagine the service throughout Ivrea, all indicated that they would pay a small price on their monthly phone bill, as they felt it would be a positive aid to their Italian studies. Given control over the number of responses per day, they would request an average of four messages per day, specifically when they were mobile. The average acceptable maximum price for such a service was three euro per month.

Conclusion

Would the service reawaken and encourage the spirit of inquiry in adult learners?

I believe so. My primary reason is not because of my arguments, though I believe they are sound. It is not in the persuasiveness of my description, though it seems engaging. It is not even the subjective feedback from the users of my experience prototypes, though it was mostly positive.

Rather, the reason I believe that the service would be a success in this regard is that I have witnessed the idea take hold in my peers. Admittedly, this is a skewed and statistically insignificant test group. But we are in a critical context at this institute, and they have had the most direct experience with the idea. Throughout the year I developed these ideas and arguments in presentations and in casual conversations, and my classmates were always part of the discussions. Once they got the idea, and especially after I developed the functioning experience prototypes, I noticed the emergence of a certain response. When in casual conversations during meals, or walking about the city, if someone ran across a question they couldn't answer, or a word they wanted translated, or an interest they wanted to capture, they would turn to me, jokingly, make cell-phone key-entry motions with their fingers, and describe it as a "free range learning moment." They wanted to capture their interest, to act on it. One member of the institute's staff reported that when she and a friend toured a nearby city, they caught themselves standing in a grand monastery and wondering why they didn't have the service right then.

If the mere *idea* of being able to engage the world in this way has had a positive effect on the spirit of inquiry, I am confident that the real thing would encourage it much more so.

Appendix I—*Fresh* in the Museum

I originally came to Interaction Ivrea to return my career to museum interaction design. In fact, I began this thesis thinking specifically about the museum experience. How did I get from museums to a lifelong, mobile learning support service?

At first I considered the differences between the things in museums, which mostly don't change, and the ideas around the things, which change with shifts in cultural attention, advances in science, each new interpreter, and even each new observer.

Interaction design fits best with the latter space, the idea space. So I conducted a search for authors who had developed a theory along these lines, and came across Falk and Dierking's "Learning from Museums: Visitor Experiences and the Making of Meaning." (Falk 2002.) Their synthesis of different learning theories and associated recommendations led me to conceive of any visitor experience as one of meaning-making and learning. Additionally, the learning that occurs at a museum occurs at a whole class of institutions, which they call *free-choice learning environments*, including zoos, libraries, television, the Internet, and even conversations with friends. I began to ask a series of questions: how can I design interactions that support the learning that occurs in any of these places? If I can support learning in *any* of these spaces, why not support learning in *all* of these places? If you can support learning in all of these places, how about *any* place? How about the outside world? If I can support learning across multiple visits, how about across a *entire lifetime*? Hopefully my thesis project provides the beginning of an answer to these questions.

How then does the final vision of the service work with museums? They and other free-choice learning institutions would play three roles in the service: as touch points for the service, as major content providers for the mobile functions, and as a major learning resource in the resource database.

Touchpoints

Services are an intangible good. But they rely on tangible interfaces, called *touchpoints*, to communicate with their users. Museums are excellent touchpoints for a lifelong learning service because their audience has already expressed an interest in free-choice learning simply through their attendance.

The **Ready Room** service component was developed specifically to take advantage of the museum as a physical touchpoint. Not only does the service benefit from having a physical presence here, but the visitors benefit from having a moment of preparation and expectation-setting. Assuming that visitors can achieve the goals they set for themselves (and the software should help them set achievable goals) the museum also

benefits from having more satisfied visitors who can remember exactly what they got out of their visit.

Learning Circles and service-sponsored events need physical places to gather. Museums have been increasingly renting their spaces after hours for purposes such as this, and *Fresh* could drive recurring use.

Museums concentrate learners who share topic interests, and as such would provide an environment where members using the **Learn Gety** watcher are more likely to find others with similar interests. This encourages visits to the museum for this purpose and use of the service in these places.

Content providers

Museums already have a great deal of content developed for their collections and subject matter experts in their curators. Some of the content is specific to the objects themselves, but often the interpretations use the artifacts as examples of a more general knowledge.

A museum can further its presence and authority through migrating its existing content to co-branded **learning modules**.

The museum space is dense with opportunities for **Genius Loci** space-tagging. Many efforts are already underway to provide this sort of interaction in museums. *Fresh* provides an interconnected, standardized, customizable, and extensible platform for this content.

Curators, as experts in their field, can commit some of their time to be top-of-the-line **Cavalry** experts, answering the deepest and most difficult questions. The museum can also benefit from tracking the questions asked in its space when adjusting existing exhibits or deciding on new ones.

Wunderkasten are essentially mini-exhibits in a box. Curators can work with exhibit and interaction designers to author boxes in their fields of expertise. Many museums have shops that would enjoy an additional channel for people to try their most educational and interesting products. Art museums can host boxes for deep learning about the most popular items in their collections, even when they are not on display.

Destinations for Discovery

As was noted in the **Body Learning** component description, modern mobile devices are too small and slow to be deeply engaging. Learners following their interests in the

service's resource database may wish to eventually move beyond the screen to spend time in an environment where the learning is social, the displays are awe-inspiring, and the interactions are deeply engaging. It is not *Fresh*'s core business to provide such concentrated environments. The service would need to point to museums and other free-choice learning environments as places where learners could engage this kind of wonder.

Appendix II—Annotated Bibliography

The seven months constraint for this project conflicted greatly with the depth of my chosen topic. There was little time to acquire, read, and synthesize even the most major works in this field. Given my time budget, I tried to first gain a broad understanding of learning theory by reviewing sources on the Web. From this I identified major historical theories, popular modern directions, and ideas that resonated with me personally. I ordered the books whose reviews indicated that they detailed these things well, or were original sources. Though it has been too fast an education in learning, I feel I have gained a solid grounding in the field from which to develop the project.

Abell, George O., David Morrison, and Sidney C. Wolff. Exploration of the Universe. 6th ed. Philadelphia: Saunders College, 1991.

Summary: This is a college-level astronomy textbook.

Use: I used this as a resource for developing the content for some of my prototypes.

Ackermann, Edith. 1996. "Perspective-Taking and Object Construction: Two Keys to Learning." In Constructionism in Practice: Designing, Thinking, and Learning in a Digital World (Kafai, Y. and Resnick, M., Eds.). Mahwah, New Jersey: Lawrence Erlbaum Associates. Part 1, Chap 2. pp. 25-37

Summary: Ackerman compares the implications of three modern experiments to Jean Piaget's original Tree-Mountain experiment to illustrate that the internalization model of learning is still valid and can co-exist with the analytical perspective of situated learning. She further hopes to show that Piaget's internalization task of accommodation requires applying a stable objective viewpoint of a new situation. Short descriptions of the experiments follow.

- The **Tree-Mountain** task, Piaget's original, had children are asked to envision other's perspectives of a miniature scene before them.
- The **Cat-dog** experiment requires young children to guess what another person sees on the other side of a flashcard.
- A **Mental Rotation** and **Perspective-Taking** experiment has blindfolded children move around a 3D model before guessing another observer's perspective.
- The **Shadow Box** had participants with different perspectives collaborate to imagine what the complete subject looks like.

Use: These experiments do go a long way to explaining the problems with the original experiment and its historical interpretation. But, I don't think she has tied the two disparate analytical positions together as she claims to have. However, she has made more room for more the accommodative learning function, one on which my service focuses. She has also made it clear that children may be cognitively more advanced than Piaget gives them credit for, which only means my service might stretch, with some modification, to an ever younger audience than I had imagined.

Ackermann, Edith. “Piaget’s Constructivism, Papert’s Constructionism: What’s the Difference?” Massachusetts Institute of Technology, 04 Dec. 2002

Summary: Ackermann compares and contrasts Piaget and Papert’s learning theories. She introduces Piaget’s Constructivism, and criticizes the theory for being too concerned with accommodation and not including the social aspect of learning. She contrasts this with Papert’s Constructionism and its focus on learning through making and social interaction around the making. The paper includes small sections discussing situated learning and Vygotsky’s learning theory, and suggests a perspective to integrate the views .

Use: I read this paper as I was trying to get a grasp of Papert’s Constructionism (since I find his writings often oblique). Ackermann’s summaries helped me understand each of the theories in terms of the other. Being already familiar with some of Piaget’s work helped.

Allee, Verna. “Knowledge Networks and Communities of Practice.” Journal of the Organization Development Network 132 (2000). 08 Nov. 2002.

Summary: Allee describes the Communities of Practice learning theory from an organizational development perspective. She first argues that for organizational knowledge management as general a corporate initiative by identifying the fact that tacit knowledge, in people, is the prime resource available to companies. She then notes that tacit knowledge is built up in communities of practice, discussing each part of the term in turn. She lists the benefits of communities of practice in general, and details arguments why companies should support their creation and maintenance.

Use: I read this article before I received the book Communities of Practice. I hoped to get an overview of the theory. Allee is writing from the perspective of organizational development, and so it was sometimes difficult to decipher what had been narrowed for knowledge management and what was a fair representation of the original theory. Since having read the original work, I would suggest referencing it instead.

Axelrod R., The Evolution of Co-operation, London: Penguin; 1990

Summary: Axelrod extends game theory principles to illustrate the development of cooperation in many domains that lack a central authority. After detailing the game theory principle called the Prisoner’s Dilemma, which encourages participants in a zero-sum circumstance to look after their own best interests, Axelrod notes how cooperation would ensure the most positive outcome for everyone. He shows how it evolves naturally in computer systems, social systems, and nature, using illustrative stories. He closes the books with direct advice to his readers on when to choose cooperation and when to choose selfishness.

Use: This book illustrates the deep-structure reason why cooperation is the best, most logical response to most free-choice thinking. The principles did not end up playing directly into my project except to underscore some of what may be the reasons we learn so well in communities of practice.

BBC News (uncredited). “Mobile gadgets offer new lessons.” BBC News 28 May 2003. 29 May 2003 <http://news.bbc.co.uk/1/hi/technology/2940936.stm>.

Summary: This article discusses the benefits of mobile learning in general. It also discusses the m-learning project and the learning materials company Cambridge Training and Development in particular.

Bloom, B.S. “Major Categories in the Taxonomy of Educational Objectives.” 1956.

Summary: Following the 1948 Convention of the American Psychological Association, Bloom and D. Krathwohl developed a comprehensive list of categories of cognitive objectives in the school. Their list includes actions encouraged by the cognitive categories.

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

Use: I used these summaries to try and develop my list of free range learner’s needs. It was interesting to compare Ciardiello’s 4 cognitive categories to Bloom’s 6.

Bork, Alfred. “Four Fictional Views of the Future of Learning” 04 Dec 2002.

Summary: Brok provides short descriptions of four science fiction author’s visions of learning in the future: Arthur C. Clarke’s *The City and the Stars*, George Leonard’s *Education and Ecstasy*, James Cook Brown’s *The Troika Incident* and Neal Stephenson’s *The Diamond Age*. He then identifies the salient aspects of these visions, and finally discusses why these aspects have not yet been realized.

Use: Bork’s informative summaries of each work led me to reading two of the four books that he mentions. Those two books are included in this bibliography.

Brookfield, Stephen. “Adult Cognition as a Dimension of Lifelong Learning” Lifelong Learning: Education Across the Lifespan. Eds. J. Field & M. Leicester. Philadelphia: Falmer Press (forthcoming)

Summary: Brookfield surveys research filtering for topics relevant to adult learning. Through the article, he introduces four critical adult cognitive capacities.

1. Dialectic thinking
2. Practical logic
3. Metacognition and epistemic cognition
4. Critical reflection.

The next part of the article discusses affective dimensions to adult learning. Sadly, the first four of these are inhibitive.

- Impostership
- Cultural Suicide
- Incremental Fluctuation
- Lost Innocence
- Community

Use: The first part of Brookfield’s article helped inform the background research into learning theory. The second part of the article influenced my development of learner needs, from positive and negative perspectives. I highly recommend this article for the quality of the writing and the frankness with which he shares difficult emotional realities of adult learners.

Cassell, Justine, Nicholas Negroponte, and Mitchel Resnick. “Creating a Learning Revolution.”. 04 Dec. 2002.

> **Summary:** This short opinion article describes the MIT Media Lab’s arguments for (technological) educational reform in three areas: How children learn, what children learn, and with whom children learn. It provides six guiding principles that support its work: direct exploration, direct expression, direct experience, multiculturalism, multilingualism, and multimodality.
>
> **Use:** This article helped me to further understand Papert’s constructionism and the Media Lab’s learning bias towards children.

Champion Ward, Frederick, et al. Learning To Be, The world of education today and tomorrow. Paris: UNESCO, 1972.

> **Summary:** Edgar Faure edited this research report for Unesco in 1972, arguing for the member nations to prioritize learning as a cultural and humanitarian imperative. The report popularized the term “Learning Society” and set into motion political initiatives on lifelong learning that continue, primarily in Western Europe, to this day.
>
> **Part 1** begins by comparing historical and (then) modern educational practices. Over the next chapters it outlines the modern economic and educational context across the globe. He explains four schools of thought as how education interacts with society.
>
> **Part 2** deals with future scenarios of education and how they impact the rest of society. It then discusses new educational research understandings in a number of different fields. It then presents goals for education reform, linking the effects to an individual’s becoming fully human.
>
> **Part 3** introduces the concept of a learning society and suggests ways that a society might reach this ideal.
>
> **Use:** When I was couching my project primarily in terms of the learning society, this massive document provided a clear historical context for the activity surrounding the topic today, especially in the UK. As the committee was paid to research formal education and not learning, however, their recommendations are all school-related, and not directly applicable to my final results.

Ciardiello, Angelo. (1998). “Did you ask a good question today? Alternative Cognitive and Metacognitive Strategies.” Journal of Adolescent & Adult Literacy. 42, 210-219.

> **Summary:** Ciardiello derives four types of questions from four cognitive processes: memorization, convergent thinking, divergent thinking, and evaluation. He introduces a system of inquiry-based learning, called TeachQuest. It lists the different questions and describes the cognitive functions required to answer each. It also shows the keywords commonly associated with each category and provides some examples of each. The TeachQuest system is aimed at teaching high school teachers how to encourage divergent questions from their students.
>
> **Use:** I followed a few of Ciardiello’s references when identifying the “Ask good questions” learner skill. Subsequently I used these four categories of questions to inform the functionality of the Goal wizard/Question Engine.

Clarke, Arthur C. The City & the Stars. : Yestermorrow, 1999.

Summary: Originally published as *Against the Fall of Night* and rewritten in 1954, this fictional story describes a civilization in the far future in an ancient city called Diaspar. There are a number of elements, which relate to learning systems. Characters use immersive, interactive adventures called sagas with entertainment and educational value. The lead character, Alvin, uses a voice-controlled computer to unsuccessfully try and create a work of art. And there is a formalized student-tutor system, in which the parents play a part.

Use: I would like to think that free-range learning systems one up Clarke's sagas in that members of the service will be involved in real-world, on-demand circumstances that fuel their learning. It is interesting to note that Clarke institutionalized the master-apprentice model with the tutor (though he plays next to no part in the story) years before social learning would emerge to its modern level of importance.

CNN (uncredited) "Mobile phone sales to take off." CNN 2 Dec. 2002. 15 May 2003. <http://edition.cnn.com/2002/BUSINESS/12/02/nokia/index.html>.

Summary: This article discusses investment company Merrill Lynch's recommendation of Nokia stock and its supporting projections for the future.

Denny, Nathan R., Ph.D. "An Orienting Reflex/External Inhibition Model of EMDR and Thought Field Therapy." The International Electronic Journal of Innovations in the Study of the Traumatization Process and Methods for Reducing or Eliminating Related Human Sufferings 1 (1995). Mar. 2003 <http://www.fsu.edu/~trauma/v1i1/contents.html>.

Summary: [From the paper] The clinical phenomena of the conduct of EMDR and Thought Field Therapy were interpreted in light of concepts in the field of classical conditioning with emphasis on the orienting reflex and its external inhibiting effects on conditioned responses. A model was proposed using the temporary suppression through external inhibition of the fear and avoidance conditioned responses to disturbing memories.

Use: Unable to directly acquire a translated copy of Sokolov's *Perception and the Conditioned Reflex*, I had to rely on texts such as Dr. Denny's, which describe the research.

Dervin B., 1999. "Chaos, Order, and Sense-Making: A Proposed Theory for Information Design." Information Design: 35-58.

Summary: Dervin presents a theory of learning called sense-making, which is a constructivist framework for systems making. She names four main components to sense-making, which she suggests by example as a way to structure ways of access to a computerized learning support: Situation, Outcome, Gap, and Bridge.

Use: This dense theory provides insight to the ways many people approach problems in the learning domain. It influenced my thinking of how a service search engine, knowledge base, or profile questions might be designed.

Dewey, John. “The School and Society: being three lectures by John Dewey supplemented by a statement of the University Elementary School.” Chicago: University of Chicago Press. (1907)

Summary: In these three lectures Dewey proposes a participatory philosophy of education, reviving a long-dormant spirit of inquiry-based learning. Using many personal anecdotes from his observation of classrooms, he outlines the effects of industrialization, globalization of the economy (!) and the coming information age(!) on children from the social, humanist, and institutional perspectives. Dewey also provides an instructive history of schooling from the Middle Ages onward.

Use: Dewey is primarily concerned with the education of young children, and so it is somewhat difficult to apply his ideas to a modern mobile learning service for adults. What relates is the idea that problems in activity encourage learning and can lead us to the whole history of mankind and its present knowledge. In this light, mobile learning seeks to give learners the tools to follow that lead wherever they are in the world.

Falk and L. Csikzentmihalyi, M. Flow, New York: Harpers; 1990

Summary: This book describes a theory of inherently-rewarding activities. Csikzentmihalyi begins by researching why people pursue activities for which they are not paid. He then identifies certain feelings the subjects when they are engrossed and encapsulates them with the name flow. It then forwards a prescription for the deliberate use of such activities for improving one’s quality of life.

Use: Csikzentmihalyi shows how important the quality-of-life and inherent-rewarding aspects of learning are, tempering my original economic-only approach. I am also convinced that my service has built-in psychological reinforcement since it is based on learning.

Falk J., and Dierking L., Learning From Museums, Visitor Experiences and the Making of Meaning. Oxford: Altimira; 2000.

Summary: Falk and Dierking synthesize and describe many modern learning theories into a single theory, which they apply to museums. They suggest the positive term free choice learning as an alternative to informal learning. They identify three main contexts in which free-choice learning occurs: Personal, sociocultural, and physical. They provide suggestions on how museum professionals can work to optimize each of these contexts.

Use: Deconstructing their synthesized theory led me to much of the most recent research in learning today, which influenced the design of the service. It was also from their term free-choice learning that I partially derived the term free-range learning.

Funderstanding.com. 1998. 07 Nov. 2002.

Summary: Among other education reform topics, this website provides clear summaries of 12 influential learning theories.

1. Constructivism
2. Behaviorism
3. Piaget’s Developmental Theory
4. Neuroscience
5. Brain-based learning
6. Learning Styles
7. Multiple Intelligences
8. Right Brain/Left Brain Thinking
9. Communities of Practice

10. Control Theory
11. Observational Learning
12. Vygotsky and Social Cognition

Each listing provides a definition, a discussion, and a summary of how the theory impacts learning. Some listings indicate reading references.

Use: I used these summaries as a basis for broad understanding to popular theories of learning. It was an excellent introduction to the topics, letting me determine which seemed to fit my project and research those theories more fully.

Gagne, R. (1985). The Conditions of Learning (4th ed.). New York: Holt, Rinehart & Winston.

Summary: Gagne sets out a theory of Conditions of Learning. He defines five types of learning for which different types of instructions are needed.

1. Verbal information
2. Intellectual skills
3. Cognitive strategies
4. Motor skills
5. Attitude

He describes an 8 point hierarchy of skills regarding intellectual skills, which must be mastered in sequence.

1. Stimulus recognition
2. Response generation
3. Procedure following
4. Use of terminology
5. Discriminations
6. Concept formation
7. Rule application
8. Problem solving

He then describes nine instructional events and the correlative cognitive tasks.

1. Gaining attention (reception)
2. Describing the objective (expectancy)
3. Stimulating recall of prior learning (retrieval)
4. Presenting the stimulus (selective perception)
5. Providing guidance (semantic encoding)
6. Eliciting performance (responding)
7. Providing feedback (reinforcement)
8. Assessing performance (retrieval)
9. Enhancing retention and transfer (generalization)

Use: Gagne's focus is on the acquisition of intellectual skills, with original application on military situations. The work is comprehensive, accessible, and well-considered. His conclusions are recommendations for instructors rather than learners. This information would be an excellent self-awareness or "learning about learning" module.

Gardner, H. (1983). Frames of Mind. New York: Basic Book Inc.

Summary: By defining intelligence as "the capacity to solve problems or to fashion products that are valued in one or more cultural setting" Gardner was able to open the range of what is encouraged and appreciated as intelligence. He backed his theory with biological and cultural research to develop an original list seven intelligences. (He later added two, thus the list of nine used in this thesis.)

Use: By validating forms of intelligence other than the traditionally-lauded verbal and computational, Gardner gives everyone the opportunity to realize how, rather than whether, they are intelligent. This overcomes feelings of "impostership" often reported by adult learners. In adopting this view of intelligence and incorporating it at a deep level, the service becomes accessible to a wider audience.

Gay, Greg. Online Course: *Learning to learn*. 2001. Learning Disabilities Resource Center. Jan. 2003.

Summary: This self-paced e-learning course material helps the user learn about and develop skills to improve their ability to learn. Each module contains learner goals, readings, activities, web resources, and opportunities for participants to hold online discussions. The main topics follow.

1. Consciousness
2. Metacognition
3. Learning Styles
4. Thinking Styles
5. Memory
6. Language
7. Reading
8. Writing
9. Problem Solving
10. Creativity
11. Biology of Learning

Use: This excellent course by Greg Gay at the University of Toronto is thorough and clear in its presentation and references. I developed the learning skills list by distilling the suggestions in Gay's course and combining it with correlative suggestions from other authors.

Gilmore, James H., and B. Jospeh Pine. "Welcome to the Experience Economy." Harvard Business Review (1998): 98-105.

Summary: The authors describe three historical economic stages of development: commodities, goods, and services, and predict the emergence of a fourth: experience. They claim that this last economic stage is an inevitable evolutionary step and predict it as the primary differentiation of companies in the future.

Use: Though I do not accept an Experience economy as the next foregone evolutionary stage of our economy, the theory presents some important points to consider when designing a service to be better than a service.

Gleick, James. Faster: The Acceleration of Just About Everything. Pantheon. 1999.

Summary: Gleick provides many examples of modern life's acceleration: telephone redial buttons, packaged foods, even car chases in moves. He argues that part of the reason lies in the devices that turned it into a commodity: elevator buttons, wristwatches, time zones, atomic clocks, and nanosecond computer speeds. He also argues that the sum effect of all our efforts have been negative: we now have less free time than our forebears.

Use: Gleick's book is an excellent resource illustrating one of the core imperatives informing the need for learning as a lifelong skill: everything is faster. We must adapt to the change.

Gross, Ronald. Peak Learning: How to Create Your Own Lifelong Education Program for Personal Enlightenment and Professional Success. New York: Jeremy P. Tarcher/Putnam, 1999.

Summary: Gross describes 7 themes useful to adults interested in lifelong learning, drawing on a number of other resources and anecdotes along the way.

1. You can learn to learn.
2. You are already a superb learner on occasion, and you can build on that natural skill to make the rest of your learning easy, enjoyable and productive.
3. You have your own personal learning style, which you can identify, take advantage of, and strengthen to become an even more accomplished learner.
4. You learn best when you are most active mentally (and sometimes physically), making your own decisions about what, how, where, and when to learn and using strategies that activate your mind.
5. You can design your optimal learning environment, one that makes your learning more comfortable and hence more effective.
6. You can learn most enjoyably by choosing from a rich array of media, methods, and experiences.
7. You can accelerate your career by L(earning) your Living – mastering new skills and knowledge virtually every day at your work.

Use: This book's focus seems to be on changing the adult learner's attitude about learning. Its small section on learning skills are not exhaustive, but is complemented nicely by his next book, Socrates' Way.

Gross, Ronald. Socrates' Way: Seven Master Keys to Using Your Mind to the Utmost. Tarcher/Putnam, 2002.

Summary: Gross describes 7 imperatives to adults interested in learning more about Socrates and adopting the Socratic method as a learning strategy, drawing from a number of other resources and anecdotes on the way.

1. Know Thyself.
2. Ask great questions
3. Think for Yourself
4. Challenge Convention
5. Grow with Friends
6. Speak the Truth
7. Strengthen Your Soul

Use: This book focuses less on changing the reader's attitude about adult learning and more on the skills necessary to become a lifelong learner. He is one of the few popular authors I could find willing to list learner needs and skills.

Harris, Paul. "Goin' Mobile." Learning Circuits July 2001. 2 Mar. 2003 .

Summary: Harris introduces the concept of mobile learning to his readership, using Global Knowledge's PDA textbooks for business courses as an example. He presents some pro and con arguments from various market experts, including separate sections to review Sun Microsystem's ISOPIA, Global Knowledge, and PDAs in the classroom.

Hein, George E. "Constructivist Learning Theory." 15 Oct. 1991. Exploratorium. 08 Oct. 2002.

Summary: Hein provides an overview of constructivism and outlines 9 key principles of the philosophy.

1. Learning is an active process.
2. People learn to learn as they learn
3. Constructing meaning is cognitive
4. Learning involves language
5. Learning is a social activity
6. Learning is contextual
7. One needs knowledge to learn
8. It takes time to learn
9. Motivation is a key component in learning

Hein applies these principles to the museum domain. The article contains an excellent annotated bibliography.

Use: This article helped me greatly in understanding the tenets of constructivism, one of the most popular learning theories today. I tried to incorporate as much of these tenets in the design of my service as I could.

Institute for Learning. The Exploratorium of San Francisco, CA. 08 Nov. 2002.

Summary: The Exploratorium maintains educational and learning research it funds or occurs in its building on this site for educators. Its site houses many helpful, well-linked, and well written articles.

Use: Their commitment to and success with constructivist theories helped convince me that it may be one of the most functional educational theories available. I found a number of influential papers in this bibliography through the Institute's site.

Ismel, Susan. "Adult Learning in Groups." 1997. U.S. Department of Education. 07 Nov. 02.

Summary: In this short paper Ismel describes the nature of group learning with a facilitator, differentiating between cooperative, collaborative, and transformative topics. She includes 3 questions whose answers guide formation of adult learning groups.

1. What purpose is the group learning experience designed to achieve?
2. What is an appropriate role for the facilitator?
3. How should groups be formed?

Use: Ismel's distinctions of topics is incorporated in the workshop facilitator's aspects of the service.

Keegan, Desmond . "From e-learning to m-learning." Ericsson. 22 Mar. 2003 .

Summary: In this online paper supported by the Leonardo da Vinci program of the European Union, Keegan describes how learning theory and technologies have evolved through three ages, corresponding to larger cultural trends.

1. Distance Learning evolved with the Industrial Revolution of the late 18th century and the development of postal and transportation technologies.
2. e-Learning evolved with the Digital Revolution of the 1980s when desktop computers and later the Internet became ubiquitous.
3. m-Learning will evolve as a result of the mobile, or wireless revolution occurring since 1999, as wireless technology proliferates.

The paper further describes many m-Learning initiatives going on in 2001 in the European Union, and details three projects conducted on three differing mobile devices.

Use: This paper gave me a solid understanding that learning takes advantage of all new mass market technologies. It is also one of the few resources available on the Internet about the birth of the nascent m-Learning discipline.

Lave, Jean, and Etienne Wenger. Situated Learning : Legitimate Peripheral Participation. Cambridge, Massachusetts: Cambridge Univ Pr , 1991.

Summary: This book presents research to support the analytical perspective that legitimate peripheral participation in communities of practice is the principle defining activity in learning. They cite examples of situated learning in the apprenticeships of midwives, tailors, butchers, and others.

Use: At first I thought situated learning theory was in complete contradiction to my aims until I realized that I was taking advantage of a mobile *situations* and *communities of practice* before even knowing these terms. Personal experience tells me that their complete dismissal of internalization models of learning is too extreme, but they have reintroduced a n effective and well-researched perspective of learning as a social and situated phenomenon to the academic and learning communities. Since coming to this understanding, situated learning has become the major influential theory for the development of this thesis.

Leonard-Barton, Dorothy. "Designing with the Enemy: Creative Abrasion". The International Design Conference in Aspen. Aspen, Colorado. 1996.

Summary: In this speech, Leonard-Barton argues that innovation is the core capability of any organization and suggests techniques and tools that encourage innovation and innovative people in the workplace, including fail forward and empathetic design. She uses examples from large companies that are striving for innovation such as Sears, Nissan, and Interval, to support her arguments.

Use: This underscored the concept that learning is adaptation, and helped me understand that businesses may be interested in using my services for their employees.

Meshberger, Frank L., M.D., “An Interpretation of Michelangelo’s Creation of Adam Based on Neuroanatomy”. Journal of the American Medical Association, vol 264. 1990.

Summary: In this article Meshberger illustrates how the Sistine Chapel panel titled “The Creation of Adam” shows a medically accurate representation of the brain.

Use: I happened to read this text while working on the thesis, and was struck by the strange connection between neuroscience and art history. It is the discovery of these sorts of surprising connections that keep me enthralled with the world.

Papert, S. & Cavallo, D. 2000 “The Learning Hub: Entry Point to Twenty First Century Learning.”

Summary: This short paper argues for the global development of specialized learning centers, called learning hubs, founded on Papert’s constructionist theories. These hubs would be made up of visionaries who wish to change the nature of learning for the better. The paper discusses an overview of the organization of these hubs and concludes by proposing forms these hubs might take.

Use: This article helped me to further understand Papert’s concept of constructionism and one way the Media Lab envisions its implementation on a global scale.

Papert, S. (2000). “What’s the big idea? Steps toward a pedagogy of Idea Power.” IBM Systems Journal, vol. 39, no. 3-4.

Summary: Papert presents a theory of education that judges students on their ideas, using many personal examples. He includes a small application of probabilistic thinking to technologically-empowered education, citing experiences with his LOGO system which are “powerful in its use”, “powerful in its connections”, and “syntonic.”

Use: This article helped me to further understand Papert’s concept of constructionism and its implementation for children via the LOGO system.

Papert, Seymour. The Children’s Machine: Rethinking School in the Age of the Computer. Basic Books, 1994.

Summary: In this follow-up to his book *Mindstorms: Children, Computers, and Powerful Ideas*, Papert surveys the decade since the prior book’s publication for how the proliferation of computers have affected schools and education. In discussing the successes and failures he has encountered, he examines underlying assumptions about learning, teaching, education, and school.

Use: I could not easily get a hold of *MindStorms*, and I believe that this may have detracted from my reading. I found Papert’s anecdotal style of writing to be distracting, but useful in parts as documentation of the learning process itself.

Postman, N. and Weingartner, C. Teaching as a Subversive Activity. New York: Dell Publishing Co., Inc., 1969

Summary: A critique of the educational system (of its time) and an introduction to the Inquiry method of education and learning, a derivative of the Socratic method. The book includes early incorporation of constructivist theory and some salient deconstruction of McLuhan. In it Postman introduces the charming concept of "crap detecting," his term for critical thinking. The book concludes with suggestions for educational reform.

Use: Postman is always an entertaining, engaging, and inspirational read. I include critical thinking as a learning skill because of the end-reason arguments he and Weingartner posit in this book.

Quinn, Clark. "mLearning: Mobile, Wireless, In-Your-Pocket Learning." LINE Zine Sept. 2000. May 2003. <http://www.linezine.com/2.1/features/cqmmwiyp.htm>.

Summary: Dr. Quinn introduces mobile learning to his readership via examples, including references to wearable computing. He surveys the state of the art through the offerings of several content and hardware companies. He concludes with a look to the future.

Use: Dr. Quinn's final paragraph describes a circumstance where "the learner will not know, nor care, where the learner model is kept, where the content resides, nor how the communication is handled," which is excellent support for my project.

Regan, Melissa. "Tomorrow's Teaching and Learning." Online posting. 8 Jan. 2001. Tomorrow's Professor. 26 Feb. 2003.

Summary: In this academic paper available online, Regan discusses a project undertaken at the Stanford Learning Lab in evaluating a mobile learning prototype. The subject matter for the prototype was learning language. From the user study, Regan concludes that screen sizes and restrictions of cell phones available at the time (2001) are too small and limiting to provide compelling information.

Use: Though cell phone display technology has advanced a great deal in the 2 years since Regan's project, it is not widely distributed. One benefit of structuring my project as a service is that we can deliver a baseline technology to the client. Even at a maximum display quality, however, to be mobile, the screens must remain below a certain size. It was with this study in mind that I developed the **Body Learning** component.

Rifkin, Jeremy. The Age of Access: Everything is a Service. London. Penguin Books, 2001

Summary: Rifkin presents social and economic evidence that the industrialized world is already in what he terms the age of access, in which the concept of capital ownership is replaced by concepts of access to resources. Part one of the book, The Capitalist Frontier, provides evidence of this shift and outlines the larger reasons for the change. In part two, Enclosing the Cultural Commons, he discusses what effects such a shift may have on different aspects of culture, which he says will be massive, requiring shifts in our relationships not just with corporations, but with one another as well.

Use: It was partially our own institute's focus on service design and partly the inclusion of chapter five (Everything is a Service) in one of our first-year readers that gave me the idea to approach learning as a service.

Romiszowski, A. J. (1984). Instructional Development. London : Kogan Page ; New York : Nichols Pub. Co., 1984.

Summary: Romiszowski presents his research and detailed categorization of skill-acquisition and knowledge. His graphic representations succinctly describe the relationships and components in his theory.

Use: I included Romiszowski's diagrams in my thinking and in creating some of my prototypes.

Roschelle , Jeremy. "Learning in Interactive Environments: Prior Knowledge and New Experience.." Public Institutions for Personal Learning: Establishing a Research Agenda. : The American Association of Museums, 1997.

Summary: This paper summarizes research on the roles of prior knowledge in learning in three sections: learning research in science, major theoretical perspectives on the process of conceptual change, and useful empirical methods for studies.

Use: It is from this argument that I developed the idea of metadata for hyperlinks in the Topic Drift component.

Schrage, Michael. "Design for Facilitation, Facilitation for Design: Managing Media to Manage Information." The International Design Conference in Aspen. Aspen, Colorado. 1996.

Summary: Schrage discusses his ongoing work at MIT, principally about the need for collaborative learners to create prototypes. He provides many examples, slowly building a constructivist argument for their use in the workplace. He provides suggestions for successfully facilitating meetings about prototypes. He concludes with some speculations about prototypes in the future workspace.

Smith, Mark K. infed.org the home of informal education. 2000. 28 Oct. 2002.

Summary: Infed.org provides excellent overviews of many topics, theories, and authors dealing with informal education.

Use: This site gave me excellent overviews, helping me determine on which topics I should pursue further research.

Stephenson, Neal. The Diamond Age. Spectra, 1995.

Summary: Touching on many aspects of a technological future, Stephenson's tale centers on the relationship of a young girl with a smart book capable of teaching her personalized, vital lessons throughout her life. The book first teaches basic reading and writing skills, then self-defense and etiquette (not at the same time), and finally computers and programming. Throughout the tale, the human voicing and acting for many of the characters becomes a sort of surrogate mother to the central character.

Use: Stephenson's story presents an advanced vision of inquiry-based learning and legitimate peripheral participation in a single device. While it presumes many artificial intelligence advances, which seem very far away, it is an inspirational and entertaining read.

Synchrologic (uncredited). “Mobile Learning Adds Up .” Synchrologic 08 May 2–3. May 2003. <http://www.synchrologic.com/2003/05/08/WN/0000-0230-WN_200305091930491_1.html>.

Summary: This article reviews the pilot mobile learning project co-developed by Northern Alberta Institute of Technology and Seneca College of Applied Arts and Technology in Ontario. The project is described as a success from both a student and instructors. The four results of the study are quoted below.

1. Students and instructors consistently recommended that the colleges continue to explore the potential of wireless networks and devices for teaching, learning and providing college services.
2. The effectiveness of a wireless curriculum is dependent on the reliability of technology.
3. Assessment of student learning should be based on a multi-factor approach that includes technology as one of several key issues.
4. Handheld computers may be more effective in certain disciplines than others.
5. Students benefit from multiple training approaches to familiarizing them with the technology device.

The Future of Learning Group, Mission Statement. Massachusetts Institute of Technology, Epistemology & Learning Group. 12 Oct. 2002.

Summary: The writing on this web page sets forth the mission of the Future of Learning Group, from three perspectives: educational reform, theoretical underpinnings, and immediate global problems in learning.

Use: This web page helped me understand that the Future of Learning Group’s interests are principally in children’s learning, and their practical approach to improving it.

The National Education Commission on Time and Learning. “Prisoners of Time.” 1994.

Summary: The National Education Commission of Time and Learning traces the ideas that founded the amount of time United States children spend in school, trace the changes (and lack of changes) across the last century, and make recommendations for a different sort of learning time for the future.

Use: Moehlings excellent statistical research into child labor and mandatory education laws helped me construct the context section of the thesis.

The Next Fifty Years. Ed. John Brockman. New York: Vintage Books, 2002. 206-215.

Summary: In this collection of 25 essays, scientists predict what will happen in the next 50 years. Roger C. Schank’s article Are We Going to Get Smarter? focuses on intelligence, education, and learning. He begins by disparaging both the concept that all great thoughts have already been thought, and its corollary, that education is a process of memorizing the classics. He predicts a complete knowledge environment and proposes a new episteme centered on good question-asking and adaptability. He concludes with a vision of virtual, inquiry-based schools.

Use: Schank’s article summarizes in scientific terms what some fiction authors have described in their vision of the future. While the developments necessary for this future to become reality are too far away to have impact on my nearer-term project proposals, I feel that my project is a first state towards his learning society.

The Sixth Framework Programme. 2002. European Commission. May 2003. <http://europa.eu.int/comm/research/fp6/index_en.html>.

Summary: This website contains all information pertinent to participation in the European Commission's Sixth Framework Programme for Research and Technological Development, the major research tool for the European Research Area.

Thibeault, Jason . "Learning on the Go." pdaEd. 8 Feb. 2003. <http://www.pdaed.com/vertical/features/learning.xml>.

Summary: Thibeault discusses some reasons PDAs are playing a larger role in mobile learning: lower costs, display improvements, and faster processors. He also discusses two trends encouraging their adoption: corporations seeking cheaper training and an increasing numbers of telecommuting employees. He cites the integration of voice and data and ubiquitous and seamless wireless networks as the next major hurdles for cell phone/PDA combinations to succeed in the market. He concludes with some near, mid-, and long-term forecasts.

Tuckman, Bruce. "Developmental Sequence in Small Groups." Psychological Bulletin 63 (1965): 384-399.

Summary: Tuckman's classical 5 stages of group development are presented in brief.

1. Forming
2. Storming
3. Norming
4. Performing
5. Adjourning

Use: I tried to facilitate these stages in the design of the online Community of practice services, to encourage growth to the fourth stage, performing, and to alleviate the guilt sometimes felt by groups needing to adjourn.

University of Bologna. General Description: History. European Community Course Credit Transfer System (ECTS). Commission of the European Community. University of Bologna. History 1994/95.

Summary: Bologna University discusses the formation and evolution of its university from the Middle Ages onward.

Vinge, Vernor. Fast Times at Fairmont High. The Collected Stories of Vernor Vinge. : Tor Books, 2001.

Summary: This fictional short story set in the near future follows two students as they try and cope with the demands of adaptive learning in a high tech environment. Salient features include the blending of school and commerce, the blending of actual-and virtual-reality as viable modes for learning, the task- and team-based projects, and threat of obsolescence as experienced the lead character's father.

Use: This was inspirational reading.

Wenger, Etienne. Communities of Practice: Learning, Meaning, and Identity. Cambridge, Massachusetts: Cambridge UP, 1999.

> **Summary:** From the frontispiece: [This book] presents a theory of learning that starts with this assumption: engagement in a social practice is the fundamental process by which we learn and so become who we are. The primary unit of analysis is neither the individual nor social institutions but rather the information "communities of practice" that people form as they pursue shared enterprises over time. In order to give a social account of learning, the theory explores in a systematic way the intersection of issues of community, social practice, meaning, and identity. The result is a broad conceptual framework for thinking about learning as a process of social participation.
>
> **Use:** This is one of the definitive publications on Communities of Practice, which I have acknowledged as a core learner need and for which I have tried to develop service components that consider and facilitate the social aspects of learning.

Zimbardo, Philip and Richard, Gerrig. Psychology and Life 14th ed. New York. HarperCollins, 1996.

> **Summary:** This is a college-level psychology textbook.
>
> **Use:** I used the definition provided in the text early in my research to understand learning from a psychological perspective.

Appendix III—Related Projects

The scope of *Fresh* is broad enough that many projects in disparate disciplines relate to it. The most important and influential of these are listed below.

All Ears

Dragon Naturally Speaking: ScanSoft's Dragon NaturallySpeaking software boasts the most accuracy in real-time speech recognition.
<http://www.scansoft.com/naturallyspeaking/>

Microsoft Office: Microsoft's Office Suite provides a common example of real-time spelling and grammar parsing.
<http://www.microsoft.com>

Body Learning

Body Mnemonics: Angesleva's innovation is to give devices such as PDAs and communicators a mechanism for detecting their orientation with respect to their owner's body, so that by tapping a shoulder, say, or a pocket, the user can access different functions. The Body Mnemonics system depends on accelerometer path detection algorithms such as could be used for the Body Learning modules.
<http://www.mle.ie/~jussi>

Virtually Healthy: The Virtually Healthy research group at Media Lab Europe is developing galvanic skin response games that help learners relax, by measuring galvanic skin response as an input. The affective learning companion is the basis for the galvanic skin response scenario.
<http://www.medialabeurope.org/research/therapeutic/projects.html>

Visual and display apparatus: M. Kent Norton received a patent from the U.S. Patent Office in 1994 for a Visual and Display Apparatus. First part of the patent abstract:
A compact hand-held viewing apparatus that automatically determines the three-dimensional direction in which it is pointing and automatically presents information to the user related to features which are visible in the field of view of the apparatus in that three-dimensional direction. This is similar in idea to the constellation browser.
<http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&p=1&u=/netahtml/search-bool.html&r=1&f=G&l=50&co1=AND&d=ptxt&s1=5,311,203.WKU.&OS=PN/5,311,203&RS=PN/5,311,203>

Genius Loci

Ambient Agoras: Part of the EU-funded Disappearing Computer initiative, Ambient Agoras aims at providing situated services, place-relevant information, and feeling of the place ('genius loci') to the users, so that they feel at home in the office, by using information technology (IT) in an innovative way, e.g., mobile and embedded in the environment. "Ambient Agoras" adds a layer of information-based services to the place, enabling the user to communicate for help, guidance, work, or fun. It integrates information into architecture through smart artefacts, and will also focus on providing the environment with memory, which will be accessible to users. The computer as a device will disappear, but the functionality will be available in a ubiquitous, and invisible fashion. Finally, "Ambient Agoras" will augment reality by providing better "affordances" and information processing to existing places and everyday objects. It aims at turning places into social marketplaces (='agora') of ideas and information where people can interact and communicate.
<http://www.ambient-agoras.org/>

DUMBO: Annotate Space is a project to develop experiential forms of journalism and nonfiction storytelling for use at specific locations. Stories are presented through text, images and audio files that participants can download from the Web to their handheld computers and take with them to the place of interest. The prototype experience is Annotate Space DUMBO, an interactive, anytime walking tour of the Brooklyn waterfront neighborhood of DUMBO (Down Under the Manhattan Bridge Overpass).
<http://www.panix.com/~andrea/annotate/>

Intel R&D: Location-aware computing: Intel is dedicating some of its research and development to helping standardize (and capitalize on) location-aware computing technologies, protocols, specifications, and standards. They publish an excellent white paper on the field on their website.
<http://www.intel.com/labs/wireless/lac/>

London Tate Modern's Tour Devices: While multimedia tours have been tried out in the USA, this is the first in the world to use a location-sensitive wireless network. This means that visitors no longer need to spend time searching the multimedia tour to find the relevant information for a room, because the network pinpoints their exact location in the gallery and feeds the correct information to them at the right time. Genius Loci would work in this way, but over a much broader area, and with user participation in building the database.
<http://www.tate.org.uk/home/news/multimediamoderntour.htm>

Semaphore: Semaphore, part of Cornell University's NOMAD initiative, is a prototype application that draws on the capabilities of a wireless networking infrastructure to

deliver context dependent information to users. The prototype application will also include the ability to locate other users on the wireless network. Projected development of the application includes the ability to leave persistent notes for other users attached to a particular context or physical/virtual location. Semaphore is the technological model for Genius Loci.
<http://www.nomad.cornell.edu/research/>

The Dinosaur Factory: Each visitor to the Hayashibara Museum of Science receives tour aides: A PDA device called "FACT Scope" and headsets. These tools are supported by Bluetooth wireless communications technology to access our digital network at any time. Users can obtain FACTory information such as explanatory text with a digital picture and/or sound. There is also a kiosk-type query machines distributed throughout the space. Each participant is registered as a member. A personal page on the museum's website is generated automatically and contains the tour "records" which they may use for further learning at home or school.
<http://www.dinosaurfactory.jp/en/>

Learn Gety

Intro: This ad-hoc interest-matching wireless network device prototype from Berkeley built on the idea of Japan's Love Gety, adding a query-response mechanism to the interaction.
<http://www.coe.berkeley.edu/engnews/fall02/10f/Intro.html>

Love Gety: Love Gety is no longer manufactured, but many companies have followed its lead. As described in the January 1998 issue of WIRED: Affectionately called the "Lovege," the oval device has three buttons the user sets according to the kind of activity she or he has in mind: "talk," "karaoke," and "get2." (The latter is a wildcard—but perhaps could mean "get to it.") Once the holder selects a mode, the device searches for Love Gety holders of the opposite sex in a five meter radius. If it locates a holder with the same mode, the "get" light flashes and the device beeps, so the pair can find each other. The Learn Gety service component works similarly to Love Gety, but with a focus on learning rather than dating interests.
<http://www.wired.com/news/news/culture/story/12899.html>

MANET: The purpose of this working group is to standardize IP routing protocol functionality suitable for wireless routing application within both static and dynamic topologies. The fundamental design issues are that the wireless link interfaces have some unique routing interface characteristics and that node topologies within a wireless routing region may experience increased dynamics, due to motion or other factors.
<http://www.ietf.org/html.charters/manet-charter.html>

Learning modules

Cerego: Cerego learning science is a Japanese mobile learning service. Its two products: MILA (PDA software) and iGO (Cell phone software) are built around a teacher-student enterprise-level server architecture. While it claims to provide deep learning, it is principally about education, i.e. memorization of assigned texts and the automation of student tracking.
<http://www.cerego.com/index.html>

Fathom: Fathom: the source for online learning, is a well designed e-learning portal. At the beginning of my project, I was able to infer some of the successful topics and topic categories, which were succeeding with an e-learning portal. Unfortunately by the submission of my project, Fathom had closed business.

Question suggestions

Ask Jeeves: Ask Jeeves, Inc. is a leading provider of natural language, question answering, and advanced search technologies for consumers and companies. The company offers these technologies through two business units; Web Properties—a set of online media properties and search services, and Jeeves Solutions - an enterprise software business.
<http://www.ask.com/>

ELIZA: ELIZA emulates a Rogerian psychotherapist. ELIZA has almost no intelligence whatsoever. It uses tricks like string substitution and canned responses based on keywords. When the original ELIZA first appeared in the 60's, some people actually mistook her for human. The illusion of intelligence works best, however, if you limit your conversation to talking about yourself and your life. ELIZA and her descendents all use the natural language parsing used to improve the questions.
<http://www-ai.ijs.si/eliza/eliza.html>

SmarterChild: ActiveBuddy, Inc. provides software for developing and hosting interactive agents, such as SmarterChild, which delivers instant access to games, movie show times, news headlines, stock quotes and more.
<http://www.smarterchild.com>

Real-time Links

Predictive Networks: Predictive Networks has developed a set of "relevance-based navigation tools" that leverage custom behavioral profiling and guidance technologies. Predicitve is another example of a successful algorithm for deriving user preferences by

observing their behaviors.
<http://www.predictivenetworks.com/>

The Cavalry

Google Answers: Google boasts 500 researchers who field questions for a fee—usually within 24 hours. They guarantee the results. Google Answers are the model for this service component.
<http://answers.google.com/answers/>

Topic drift

Everything2: This site is a text-based semantic node network, which allows its users to create new nodes of meaning to which all others can contribute. At the bottom of each page are links of varying relation to the main topic. Everything2's open-ended structure and addictive surfability ground my faith in the usefulness of this component and serve as one its main inspirations.
<http://www.everything2.com>

The Creativity Pool: This site lets users type in a topic, and its search engine finds related ideas for inspiration. Users can read other's ideas, browse from a menu to the left of related topics, or post their own. Users can also collaboratively filter the ideas they read.
<http://www.creativitypool.com>

Wunderkasten

Discovery Suitcases: Dr. James Bradburne developed these suitcases while he was curator at MAK Frankfurt. Families can borrow a suitcase, which leads them on an adventure trip through different collections of the museum. The suitcases contain exhibits to touch, smell and listen to, puzzles and games. The multi-channel nature of these suitcases and witnessing first-hand their success influenced the structure of what should go into each Wunderkasten.
<http://www.mak.frankfurt.de/>.

Joseph Cornell: This artist's body of work consists of beautiful, intricate boxes filled with mixed media collages.
<http://www.ibiblio.org/wm/paint/auth/cornell/>

Netflix: Netflix, a DVD-by-mail service, allows users to create and manage a DVD queue online. Netflix was the delivery model for the Wunderkasten.
<http://www.netflix.com>

Teknoteket: When this science-oriented Scandinavian children's magazine was still being published in the 1980's, it included a small container with activities related to the magazine content with every issue. A fellow student of mine, Magnus Torstensson, used to subscribe when he was a child, and recalled having eagerly anticipating the arrival of each one.

The Internet Movie Database: The deep interconnectedness of imdb.com encourages browsing and the construction of broad connections in the user's head. This influenced my decision to include the Related Boxes function of the service.
<http://www.imdb.com/>

The Well Hung Art Company: Art can also easily habituate into the background of the user's attention. Services which let individuals change the art in their homes and business ensure that the signal is kept fresh.
<http://www.wellhungart.co.uk/home.htm>

"Give up learning, and put an end to your troubles."

Lao Tsu, Tao Te Ching, translated by Gia-Fu Feng and Jane English