KENNETH M. MOORMAN

`http://www.cs.transy.edu/kmoorman/`
`kmoorman@transy.edu`

Work Address
Transylvania University
300 N. Broadway
Lexington, KY 40508
(859) 233-8245

Home Address
3425 Holwyn Rd.
Lexington, KY 40503
(859) 219-1638

Objective

To enhance my teaching of computer science within a liberal arts framework in order to best prepare students for graduate school or the workplace, while also continuing a research program exploring issues of computational modeling, human and machine natural language comprehension, creativity, emotional intelligence, learning, and their interactions.

Degrees

Ph.D. in Computer Science (Artificial Intelligence). Cognitive Science Certificate. Psychology Minor. Thesis title: *A Functional Theory of Creative Reading: Process, Knowledge, and Evaluation*. Georgia Institute of Technology, Atlanta, GA (1997).

Masters of Science in Computer Science. Georgia Institute of Technology, Atlanta, GA (1996).

B.A. in Computer Science and Mathematics, Minor in History. Transylvania University, Lexington, KY (1991). Graduated *summa cum laude*, with honors in computer science and mathematics.

Selected Honors

Third place, Lulu Awards at the Lulu Technology Circus (2002).
Bingham Startup Grant, Transylvania University (1997).
Finalist, Marr Student Paper Award, Cognitive Science Conference (1996).
Georgia Tech Cognitive Science Student Paper Award (1996).
Graduate Student Paper Award, Creative Concepts Conference, Texas A&M University (1995).
SAIC Paper Award (1995).
Fannie and John Hertz Foundation Fellowship (1991-1996).

Grants

Faculty and Student Enrichment Kenan Grants (Summer, 2004). Worked with Stuart Branham, Darren Carrico, and Matthew Lala to research, build, and utilize a 16-node cluster computer. Dr. Mike LeVan was co-director of the students.
Faculty and Student Enrichment Kenan Grant (Summer, 2003). Worked with Charles Erwin on computer chess program.
Faculty and Student Enrichment Kenan Grant (Summer, 2002). Worked with Becca Abney to develop an intelligent dictionary system.
David and Betty Jones Faculty Development Grant (Summer, 2002). Worked with Bentley Walker on the DSAM auditory modeling project.
David and Betty Jones Faculty Development Grant (Summer, 2001). Worked with Bentley Walker on the DSAM auditory modeling project.
David and Betty Jones Faculty Development Grant (1998). Grant allowed me to explore issues in emotional modeling and social lying.

Experience

Transylvania University, Lexington, KY (Fall, 2003 to present). Associate Professor of Computer Science.

Transylvania University, Lexington, KY (Fall, 2000 to present). Computer Science Program Director.

Transylvania University, Lexington, KY (Fall, 1998 to present). Coach, Transylvania Academic Competition Club.

Transylvania University, Lexington, KY (Fall, 1997 to present). Director of the Computer Science Laboratory.

Transylvania University, Lexington, KY (Fall, 1997 to Fall, 2003). Assistant Professor of Computer Science.

Transylvania University, Lexington, KY (Summers, 1997 through present). Co-assistant director of Academic Summer Camps: *Computer Camp for Middle School Students*, *Computer Camp for High School Students*, and *Academic Camp for Appalachian Students*

Transylvania University, Lexington, KY (Summers, 2001 through present). Co-assistant director of *Advanced Computer Camp*.

Transylvania University, Lexington, KY (Summers, 1997 and 1998). Co-assistant director of *Science and Technology Camp*.

Georgia Institute of Technology, Atlanta, GA (Spring, 1997; Fall, 1996; Summer, 1996; Summer, 1995). Instructor for CS2360, Knowledge Representation and Processing.

Selected Publications

Ashwin Ram and Kenneth Moorman, eds., *Understanding Language Understanding: Computational Models of Reading*, (1999). MIT Press, Cambridge MA.

Ashwin Ram and Kenneth Moorman, "Towards a theory of reading and understanding." in *Understanding Language Understanding: Computational Models of Reading*, (1999). MIT Press, Cambridge MA.

Kenneth Moorman and Ashwin Ram, "Creativity in reading: Understanding novel concepts." in *Understanding Language Understanding: Computational Models of Reading*, (1999). MIT Press, Cambridge MA.

Ashwin Ram, Ronald C. Arkin, Kenneth Moorman, and Russell J. Clark, "Case-based reactive navigation: A method for on-line selection and adaptation of reactive robotic control parameters." *IEEE Systems, Man, and Cybernetics*, 27B(3), (1997). *Appears in longer form as Tech Report GIT-CC-92/57, Georgia Institute of Technology, 1992.*

Kenneth Moorman and Ashwin Ram, "The role of ontology in the creative understanding process." *Proceedings of the Eighteenth Annual Cognitive Science Conference*, 1996.

Kenneth Moorman and Ashwin Ram, "Integrating reading and creativity: A functional approach." In *Proceedings of the Sixteenth Annual Cognitive Science Conference*, 1994.

Kenneth Moorman and Ashwin Ram, "A model of creative understanding." In *Proceedings of the Twelfth Annual AAAI Conference*, 1994.

Kenneth Moorman and Ashwin Ram, "A new perspective on story understanding." *31st Annual Association for Computing Machinery Southeast Conference*, 1993.

Kenneth Moorman and Ashwin Ram, "A case-based approach to reactive control for autonomous robots." *AAAI Fall Symposium on "AI for Real-World Autonomous Mobile Robots,"* 1992.

Kenneth Moorman "An approach to the problem of DNA mapping" In *Proceedings of the 29th Annual Southeast Regional ACM Conference*, 1991.

Kenneth Moorman, Paul Poulosky, and Will Gillett, "DNA mapping algorithms: Topological mapping" Washington University, Technical Report WUCS-91-23, 1991.

Selected Student Presentations

‘‘Analysis and Testing of Outer and Middle Ear Models in DSAM.” Megan Kruspe, Bentley Walker, Peggy Shadduck Palombi, and Kenneth Moorman. Paper presented by Ms. Kruspe at the 2001 Kentucky Academy of Science meeting.

‘‘Biologically-inspired Models of the Outer and Middle Ear.” Bentley Walker, Megan Kruspe, Peggy S. Palombi, and Kenneth Moorman. Poster presented by Mr. Walker at the 2001 Kentucky Academy of Science meeting.

‘‘Modifications of a Computer Model of the Auditory Pathway.” Matt Cross, Megan Kruspe, Peggy Shadduck Palombi, and Kenneth Moorman. Poster presented by Mr. Cross at the 2000 Kentucky Academy of Science meeting. Also presented by Mr. Cross at the 2001 AAAS meeting.

‘‘Analysis of Basilar Membrane Models in the LUTEar Library.” Megan Kruspe, Matt Cross, Kenneth Moorman, and Peggy Shadduck Palombi. Poster presented by Ms. Kruspe at the 2000 Kentucky Academy of Science meeting. Also presented by Ms. Kruspe at the 2001 AAAS meeting.

‘‘Analysis of a Functional Digital Model of the Mammalian Basilar Membrane.” Shelly Ferrell, Matthew E. Koger, David Rice, Kenneth Moorman, and Peggy Shadduck Palombi. Poster presented by Mr. Ferrell at the 1999 Kentucky Academy of Science meeting.

‘‘Explanation of the Validity of the Pre-emphasis Filter in an Auditory System Model.” Matthew E. Koger, Shelly Ferrell, David Rice, Kenneth Moorman, and Peggy Shadduck Palombi. Poster presented by Mr. Koger at the 1999 Kentucky Academy of Science meeting.

‘‘Computer Modeling of the Human Auditory System.” David Rice, Peggy Shadduck Palombi, and Kenneth Moorman. Poster presented by Mr. Rice at the 1998 Kentucky Academy of Science meeting.

Reviews

A Computational Story Model Based on Situational Grammar Richard Hall. University of Ballarat in Australia. Served as outside evaluator of the PhD dissertation (2000).

Acted as a paper reviewer of the *Cognitive Science Conference* (1998).

‘‘SIT: A Method for Enhancing Creative Problem Solving in Engineering” Maimon and Horowitz. Submission to IEEE’s *Society, Man, and Cybernetics* (1997).

‘‘How Do Conceptions of Learning Change” Paivi Tynjala. Submission to *The Journal of the Learning Sciences* (1997).

Activities

Member of panel discusion at Lexington Open Source Technology Conference, 2004; topic was the use of open source in education. Search committee, Philosophy (2002–2003).
Parliamentarian (2002–present).
President, KCQRL, Academic Competition League (2002–2004).
Special Award Judge, Intel International Science and Engineering Fair (May 2002).
Who’s Who Among America’s Teachers (2002, 2004).
Judge, Kentucky American Water Company Science Fair (Winter 2002; Winter 2004).
Head Judge, ACM Regional Programming Competition, University of Kentucky (November 2001; November 2002; November 2003).
Vice-president, KCQRL, Academic Competition League (2000–2001).
Committee on Program and Curriculum (2000–2002, Chair 2001–2002).
Judicial Council (1998–2000).
Judge, Lila H. Boyarsky Student Research Award (1999).
Holleian Society President (1998–1999).
Member of the editorial staff of *Alterity* (student-run journal) (1998–2000).
Co-chair (with Ashwin Ram)—FLAIRS-96 Special Track on “Real-World Natural Language Understanding” (May 20-22, 1996).

Courses Taught

Introduction to Computers	Assembly Language	Computer Architecture
Computer Organization	Operating Systems	Artificial Intelligence
Senior Seminar	Object Oriented Programming	Theory of Programming Languages
Discrete Computer Math	University 1111	Foundations of the Liberal Arts I
Robotics	Knowledge Representation and Processing	
Web Design	Foundations of the Liberal Arts II	

The Joy of Penguins: Linux Fundamentals (team taught with M. LeVan)
Artificial Intelligence and Science Fiction (team taught with I. Fields)

Research Interests

Computer modeling of the human auditory system
Social lying
Creativity in the reading process
Small-scale robotics

Memberships

Kentucky Academy of Science
International Reading Association
American Association for Artificial Intelligence
Cognitive Science Society
Holleian Society
Association for Computing Machinery
ACM SIGART (Artificial Intelligence Special Interest Group)
ACM SIGCSE (CS Education Special Interest Group)
Omicron Delta Kappa

Statement of Research

My research is primarily concerned with the computational modeling of various biological processes. ISAAC represents the fork of my work which focuses on creativity in the reading process. LUTEar/DSAM represents the collaborative work I do with Dr. Peggy Shadduck Palombi concerning the mammalian auditory system. In addition to these two research aspects, I have worked on several research projects with various students under the classification of independent study.

ISAAC

Reading is fundamental. Not only is this the slogan of a well-known American reading education program, it also summarizes the core set of beliefs which motivate my reading research. My research interests cover a range of topics related to reading: natural language processing at both the sentence-level and the "real-world" text level; learning, particularly how reading supports the learning process; memory organization and retrieval; and the area of creative behavior, particularly as applied to the act of understanding.

While there are dozens of tasks which go into producing the behavior we call *reading*, these fall into six groups of related task functionality. These groupings of tasks which act toward a common goal are called *supertasks*. For silent reading of written story text, there are six supertasks:

- The *memory* supertask is responsible for the storing and retrieving of information from long-term memory. It is also capable of producing spontaneous remindings, when triggered by incoming concepts.
- The *reasoning* supertask collects the tasks which attempt to "understand" concepts which are presented to the reasoner.
- The *sentence processing* supertask is the set of tasks responsible for transforming English sentences into conceptual representation.
- The *scenario comprehension* supertask builds an internal representation of the events which occur in the story.
- The *story structure comprehension* supertask builds an internal representation of the characters, protagonist, setting, and so forth contained within the story.
- Finally, the *control* supertask is responsible for integrating the other five supertasks. Additionally, it creates an internal representation of the cognitive activity the reasoner undergoes while reading the story.

I have built a system which implements the six supertasks and produces reading behavior. The ISAAC (Integrated Story Analysis And Creativity) system reads published, short science-fiction stories. After finishing such a story, the system can be questioned in order to ascertain its level of comprehension. The stories in question were science fiction tales in order to let me explore the main part of my research—to identify and model the processes by which a reader comprehends a text which contains novel concepts. Science fiction stories tend to contain a great many novel concepts and known concepts used in novel ways, thereby providing a good domain in which to place the research.

The creative understanding process is made up of four tasks: *memory retrieval*, *analogical mapping*, *base-constructive analogy*, and *problem reformulation*. My research has identified these tasks, as well as producing an algorithm describing how they interact. Of particular importance is some way of limiting the process. Otherwise, rather than creative interpretations being developed, only bizarre understanding will result. *Satisfaction* provides one such bound; as soon as an understanding is developed which allows reading to continue is developed, the understanding cycle stops.

The other bound is provided by the use of a principled *ontology*. The knowledge representation system underlying the creative understanding theory organizes all concepts into one of twenty high-level ontological categories. Five domains of knowledge exist: *physical*, *mental*, *social*, *emotional*, and *temporal*. Also, four types of knowledge are represented: *objects*, *agents*, *actions*, and *states*. To achieve the twenty basic categories, one simply crosses these two dimensions of knowledge. Finally, a small set of heuristics exist which describe the permissible ways that concepts may transition around the ontology. For example, concepts may transition in such a way that they are left in the same category. More complex transitions would move the concepts into other categories; for instance, an object may transition to an action by creating an action which captures a function of that object and vice versa.

In addition to the ontology, part of my research effort has been in developing the basic knowledge representation scheme used in the theory. At the top-most level, the concepts within the theory can be seen as being represented in a standard frame-slot-filler style of notation. However, the underlying representation is a conceptual graph form—every frame, every slot, and every filler exists in the knowledge base as specific nodes in the graph. Slots are nodes which act as relationships between other nodes within the knowledge system. In addition to the actual representation, there are certain elements which all concepts share. First, all concepts possess a current function. Second, supporting this is the idea that certain slots represent primary attributes—those features of the concept which allow it to accomplish its function. Finally, the remaining slots represent secondary attributes—features of the concept which are known but which are not currently contributing to the explanation of how it achieves its function.

This knowledge representation system further allows me to precisely define what I meant by "novel" in the earlier paragraph. Think about a black longsword. If you then consider a red longsword, you are reasoning about a concept which is *instantiationally novel (I-Novel)* The function is the same, the primary attributes are the same, but a secondary attribute has been altered. Now, consider a shortsword. While the function has remained the same, the primary attributes have changed. This concept possesses *Evolutionary Novelty (E-Novelty)*. Finally, think for a moment about a light sabre from *Star Wars*. The function remains the same but the primary and secondary attributes have been completely altered. This is an example of a concept which possesses *Revolution Novelty (R-Novelty)* with respect to the original concept, the black longsword.

The instantiated theory, the ISAAC computer model, is capable of reading several short science-fiction stories which have previously been published. It makes use of two other research systems, the COMPERE system for low-level sentence processing and the MOORE system for the functioning of memory. ISAAC is capable of reading and successfully comprehending stories which contain concepts that are novel to the system. As such, it acts as powerful evidence that the theory of creative understanding I have developed is sufficient for explaining the ability to read novel concepts in a text.

Part of the purpose of creating the computer model to instantiate the theory is that it allows me to evaluate the theory by evaluating how well the model accomplishes its task of reading novel texts. Unfortunately, evaluating this form of theory and model is historically difficult; the domain is a so-called "scruffy" one where it is difficult to judge the correctness of a model on a performance task. Rather than rely on the researchers' abilities as reading comprehension evaluators, I made use of a set of experts in the field, mainly high-school English teachers with a long history of teaching reading. These evaluators created question sets for the stories being read by the ISAAC system. Both human participants and ISAAC then read the stories and answered the questions, which were then graded by the teachers.

The theory of creative reading presented here possesses two unique aspects:

- The reading model is able to bootstrap with fewer concepts than previous theories allowed. In particular, it is often possible to define only one core meaning of a concept and allow the model to learn the nexus of associated real-world meanings. For example, if provided with the concept of *robot-as-industrial-tool*, the creative understander can develop associated concepts as needed, such as *intelligent-robot*.

- The model resulting from this theory is more closely related to how humans actually read and comprehend texts. Thus, as a cognitive model, the creative understanding approach is more accurate.[1]

While the ISAAC theory and model have been successful, the research possibilities of this work are by no means at an end. In fact, there are several avenues that my interests and prior research can lead me to. First, I am intrigued by the possibilities of applying the creative understanding algorithm to the area of creative design. Creative invention often makes use of the ability to "see" some object in a new light; it should be possible to use the creative understanding algorithm to provide that functionality. Next, although not a primary focus of my work to date, I am interested in pursuing research into the style of learning which occurs as a result of reading. This is not rote memorization, but rather the ability to link read information into an existing memory of knowledge in such a way that the new information is usable by the reader-learner. Related to this last point, I would like to explore issues of memory storage and retrieval in a more principled fashion than I was able to in my own dissertation research. It is difficult to separate the issues of reading, learning, memory, and creativity; the combination of those abilities provide a wealth of potential research goals.

AGED AUDITORY MODELING

Since coming to Transylvania, I have developed a second major thrust of research. In my first year, Dr. Peggy Palombi (also in her first year) approached me about joining her in a long-range project involving the human auditory system. In particular, she was interested in studying the age-related hearing loss, or *presbycusis*. It is estimated that between 13 and 30 percent of the aged population suffers from this type of hearing loss; as a larger and larger percentage of the population becomes older, the problems associated with decreased hearing will increase. People affected by presbycusis, for example, often withdraw from society as communication grows more difficult.

In the most abstract terms, presbycusis is caused by a slow deterioration of the auditory system. A number of factors influence the disorder—the loss of sensory cells in the cochlea, imbalances in the endolymphatic fluids, structural changes in the peripheral auditory system, alterations in the number or function of the central auditory neurons, and so forth. A great deal of the data which is collected on the deterioration of the aging auditory system is gathered from animal studies, particularly from research involving rats and mice. Human data is difficult to obtain due to the poor fixation of post-mortem tissue and the general inability to perform invasive studies on human participants. Human data does indicate a decrease in neuronal density, swollen neurons, and larger nuclei throughout the auditory nervous system, although there is a great deal of variation across subjects. As a result, any study of presbycusis will need to combine animal studies with known human data, taking care not to overgeneralize other mammalian results to the human system. This means that a variety of results must be combined which is often a difficult task given that experiments will generally have been performed with vastly different goals, making the integration of the result data challenging.

Computer modeling is an approach which can provide this integrative force. Results from a variety of studies can be used to construct a model of the auditory system. This model can then be

[1] Notice that this does not mean that *this* theory of creative understanding is the "correct" one with respect to what humans do—only detailed future evaluation would allow that to be determined. However, the elements of a theory of creative understanding which permitted the reading of novel concepts would be *sufficient* to explain the process, although not necessarily *necessary*.

empirically tested in order to suggest new biological experiments. Rather than recreate existing work, we decided to make use of an existing computational model of the auditory pathway—the DSAM model from Meddis' research group in the United Kingdom. For this approach to be successful, the type of model must allow us as researchers to perform the integration discussed in the previous paragraph. The modeling approach taken in this work is a *functional-computational* one. This means that the model does not attempt to recreate each component of the auditory system. As earlier sections discussed, there is a huge level of complexity to the mammalian auditory system, incorporating structural, neuronal, and chemical aspects. Rather than replicate this detail, the goal is to identify key functions of the systems and to implement those functions in a computational manner. Ultimately, this means that some of the confusion about how to fit different research results together is lessened since we are focusing on the functional level. This approach results in an algorithmic system which will take inputs corresponding to sound data and produce outputs corresponding to the activity of the auditory nervous system. If the identification of the functions of the original system is precise enough, the model will be an accurate reflection of reality.

Given that description of the modeling process, what purpose does the model serve our research interests? Since the model is not a point-by-point implementation of the actual auditory system, is it not possible that the results will be unreliable or useless to us? Many computational models suffer from this possible drawback, particularly those involved with artificial intelligence (AI) research. And, it is in this field that we can find a satisfactory response to the concern. When using a computational model, the focus is not on the model itself. Instead, the model is simply another tool that the researcher possesses. Margaret Boden suggests three *Lovelace questions* be considered any time that a model is being considered for use in a research program; although Boden suggested the questions with respect to creativity research, they can be applied to any area.

The first question is does the model appear to behave the same as the system it is modeling? The second is does the model actually perform the behavior which is being considered? The final question is can the computational model help the researcher understand aspects of the processes under study? Our work focuses on this view of the modeling process. The existence of a model can provide several important elements to a research program. First, it acts as a sufficiency argument, demonstrating that the functions which are implemented are sufficient to produce the desired behavior. Second, it forces the researcher to be extremely precise in their formulation of theories. The act of implementation will often reveal gaps in the theory which are easy to overlook in the abstract but impossible to do so at the modeling level. Next, the model provides the researchers with an entity on which various assumptions can be tested. Physiological studies can be both time consuming and expensive; the model allows a number of ideas to be explored allowing the researcher to discard unpromising ones before embarking on in vivo investigation. Finally, the model allows the researcher to generalize the theory, again without having to resort to more expensive approaches. Interestingly, this discussion is a modification of one that I used in the development and evaluation of the ISAAC model of creative reading; this shows the similarity of thought between two apparently dissimilar avenues of research.

Our research effort had to first identify the ways in which DSAM did sufficiently model the auditory system and the ways (if any) in which it fell short. After a comparison of DSAM's output of various components to the values reported in the literature, we discovered that the model was lacking in a few areas. The main problem was that the model was not designed to permit simple changes due to aging. There were also aspects which were not biologically inspired; for example, the outer ear was being modeled with a bandpass filter. While this worked, it was nearly impossible to associate physical characteristics of the ear with the functioning of the model.

Over the course of several years of research, a number of students have assisted us in modifying the model to better fit what we need. Currently, the DSAM model has a new module representing the outer and middle ear. The model can now easily be altered to account for different mammalian species and for different age groups. Also, the basilar membrane module has been altered to allow the model to reflect changes which occur with aging.

Finally, one of the best parts about this project is the number of Transy students which have been able to be involved in it. These include Matt Koger, Shelley Ferrell, David Rice, Matt Cross, Megan Kruspe, and Bentley Walker. The interdisciplinary nature of the work, the continuing nature of it, and the high student involvement have made the auditory research very enjoyable.

OTHER RESEARCH PURSUITS

During my time at Transy, I have also worked with students on the following research projects:

- B. J. McCreary: A project to make an intelligent front-end to the World Wide Web. The user would type in questions in English which the system would then attempt to answer by doing Web searches. For example, "What's the weather like?" would cause the system to query `www.weather.com` for the current Lexington weather.
- Erik Jessup: A project to work with the CS Lab robot to make it more intelligent with respect to navigation around the BSC building.
- Casey Morton: A project to add wireless networking to the CS Lab robot. The goal was to have the robot transmit back to a base station a representation of where in BSC it was. This would then be displayed as a graphical image. The project allowed Casey to integrate knowledge from *Artificial Intelligence*, *Introduction to Robotics*, and *Graphics*.
- Becca Abney: A project to act as an intelligent spell check mechanism for Web queries. Her hypothesis was that most misspellings result from a finger hitting a wrong key, rather than from a conscious decision to spell a word a particular way. Becca's system tried to find valid English words which were one letter off from the entered word, using knowledge of the keyboard layout to decide which letters to try substituting.
- Charles Erwin: During the summer of 2003, Charles continued a project he began in the winter semester of *Artificial Intelligence*. His goal was to gain a better understanding of the techniques used in computer chess program. He worked on extending the capabilities of an existing program (Crafty) by changing its evaluation technique, by running it on faster hardware, and by running it on 64-bit hardware. He empirically evaluated each version by having his various versions compete with other chess programs and with human players on the Internet.
- Stuart Branham, Darren Carrico, and Matthew Lala: These three students worked on building a 16-node cluster computer for use in the Brown Science Center. Dr. Mike LeVan and I directed the work which involved an extensive literature review to determine what model of computation to pursue, the actual building process, and heavy testing of the cluster. It is currently being used by Dr. LeVan on a problem with two additional faculty working on developing applications for it, with the help of the three students.

Research, Teaching, and Advising Philosophy

Research, teaching, and advising represent an inseparable troika; each define a facet of any professor. Research allows the field to be pushed forward and developed; teaching provides us with the next generation of researchers; advising permits us to hone our mentoring skills. A solid teaching program, then, must interlock with a solid research program, which will support the teaching program. Advising enters into both aspects since we work to advise students about both classwork and research possibilities. At a liberal arts university, the most visible aspect of the three is the classroom.

The undergraduate classroom is one where presentation of information is the paramount issue. This does not mean that classes should be dry lectures. A skilled educator will provide opportunities for active involvement. Participation in classroom discussion activities should be fostered and should act as one element of the evaluation process. Additionally, out-of-class work should make up a large portion of evaluation. Most computer science courses have a significant "hands-on" aspect; this needs to encouraged with both formal lab sessions and independent work.

One natural result of this will be to begin to prepare interested students for further work in research areas. Undergraduates should be exposed to research-style projects, in order to give them some background in that aspect of computer science. Then, interested students can be encouraged to take on additional research projects, as either term projects or independent study. Thus, students with a desire to pursue graduate-level work will begin with a fair amount of background skills.

Since another goal of the undergraduate program is to prepare students for the workplace, one aspect of the curriculum should be group projects. While individual work is important, it is also relevant to future work experience to learn how to work in and contribute to a group effort. While many students will feel uncomfortable with this approach, especially those students used to receiving credit based solely on their own efforts, it is an undeniable fact that many real-world projects are group ones. An additional facet of the group project can be the *self-evaluation*. In this, the group members would agree on a report detailing what contributions each member made to the overall effort. This has the benefit of allowing the instructor to better evaluate each participant as well as providing another opportunity for group interaction skills to develop.

In addition to in-class discussion, lectures, labs, and assignments and projects, it should be possible to teach more advanced courses through a Socratic method. In lower-level courses, a traditional lecture model of instruction is the most effective, with opportunities provided for class discussion. In upper-level courses, student participation should be stressed over being a passive recipient of information. The Socratic method, while unfamiliar to most undergraduates, will encourage this. It will also help to develop strong communication skills and thinking ability.

Whenever possible, a background of interdisciplinary topics should be the foundation of any course. No course stands alone; every one represents an opportunity to demonstrate how a particular field (e.g., computer science) fits into a larger context of learning. This liberal arts approach aids the student by emphasizing learning over simply remembering the facts of a particular field. Once again, the ultimate goal is to produce a general-purpose thinker, one that can go off in the world and never stop learning.

To finish the discussion of the undergraduate classroom, a comment needs to be made on the subject of evaluation: I tend to shy away from extremely objective tests; rather, I prefer essay tests or essay-style tests for undergraduates. Additionally, I feel that extra credit opportunities should be plentiful as motivation is a key aspect of the educational program. It is also important that the students receive timely and adequate feedback regarding their work. No student should ever be "wondering" what their status is in a particular class; they should know. I accomplish this by allowing students to check their grades online and by quickly returning exams and assignments.

To help a student see exactly where they are and where they are going is the key point in the advising process. A lot of this goes on in the classroom, but it has to extend to beyond those borders as well. All students deserve to be handled by effective advisors. This does not, however, mean that the advisor plans everything out for them. One of the goals of an education is to become independent; it is important for the advisor to realize that. Younger students, of course, will need more advice and more explicit guidance. Older students will need advice and the encouragement that you trust them to make good decisions (and gentle help if you realize that they are not).

Outside of the classroom, students need to be advised in more subtler ways as well. For example, numerous opportunities exist for students to participate in clubs and competitions. In addition to offering advice about classwork, I also feel that it is important that I mentor students in these areas as well. For example, at Transylvania, I am involved with both the ACM Competition Team and the Transylvania Academic Competition Club. This gives me another opportunity to interact with the students, teaching and advising them in non-classroom settings.

It is also important for students to receive guidance in research. If a student is planning to attend graduate school, this is extremely important. However, it is also important if a student is not planning to do this—many students are unaware of what research entails. Some students will discover they love it and decide to forgo industry in order to pursue an advanced degree. Others might actually discover that they do not like the research paradigm. A proper advising situation will help the student find this out before investing the time and energy to apply and begin a graduate program.

With regards to the general topic of research, I feel that interdisciplinary work is often the best. My reasoning is two-fold. First, it provides the student with viewpoints removed from their core discipline; the methodology of other research areas will often differ from one's home discipline. Second, multiple disciplines will expose the student researcher to a wider range of basic concepts. Ideally, they will begin to see the same ideas presented over and over again, but with different angles on them, depending on the background discipline.

Students will need to be mentored about one of the most important aspects of research—collaboration. This will be not only between different disciplines but also within the student researcher's own field. This is an extension of the earlier idea of group projects. Little research is performed by the solitary genius, so it is important that student researchers have the experience of working with others on projects. This will be part of the learning of the general methodology of the research field in question.

Also related to the idea of methodology, students need to be taught how to present their ideas to others, both people in the field and to a general audience. It is important to encourage students to attend conferences. First, a local conference as an attendee only might be a good experience. As maturity and presentation skills develop, presenting their work at a local conference is a logical next step. Finally, the student will work their way up being able to present the work at a national conference. If the mentoring has gone well, then the final product will be a confident presentation.

Research is not a passive activity. Nor is it a solitary one. The researcher must exist as a member of a community; the community will support the researcher, who in turn will support the community. And, part of this cycle of support exists in the form of teaching. Teaching provides a new generation of researchers; as such, teaching should not be considered a subsidiary aspect. When done properly, teaching and research, and the advising that accompanies both, will all merge into a single entity, greater than the sum of its parts.