Creating a Media Application to Provoke Process-based Thinking

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Abstract

Open-mindedness and creativity are two key attributes needed to succeed in the world. Without these, we tend to force our opinions on others and fail to understand or negotiate with different views. Some of the most creative inventions and best ideas come from making mistakes, discussing and combining ideas, and straying from a designated goal. The *Emonic Process* (EP) aims to provide an application in which participants can actively focus on the process of creation rather than on the product of the actions in a casual media environment. The users participate in a collaborative exchange similar to improvisation, but with a computer, to change and explore audio sequences. Focus is driven towards the actual performance and exchange rather than the finished product.

This paper addresses the following topics:

- How does one design an application to induce *process-based* thinking?
- How are people best motivated to think about the *process* of the media system rather than a finished *product*?
- How can working in such an environment influence creativity or open-mindedness in other situations?

I discuss the current state of my program as well as the user study I ran and subsequent results gathered to test how well the EP induces process-based thinking rather than product-based thinking. The user study involved 23 MIT students and showed that the EP increases open-mindedness, agreeableness, and creativity. While the EP may still need supplemental instruction to train its users to be open-minded, current observations are encouraging.

Potential uses for the EP could be as a training device for teams to induce more creativity and open-mindedness in meetings or as a learning tool in classrooms to teach children creativity early on. Teaching creativity and open-mindedness to both groups and children can have similar benefits for the world at large: more unique discoveries can be made, decisions can be reached more quickly, and productivity of discussions and disagreements can be increased. The EP serves as a first step in reaching out to this need.

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Project Description

Without open-mindedness and creativity, we tend to want to win arguments instead of listening to and considering alternatives, get directly to goals instead of perusing different directions, or are inflexible or intolerant of opposing opinions or options. However, some of the most creative inventions and best ideas come from making mistakes, discussing and combining ideas, and straying from a designated goal. Although classrooms try to teach creative ways of thinking, brainstorming, and planning, they lack a means to appropriately stress this concept of straying from the norm, being creative, and being open-minded to opposing ideas. Schools rely on creative writing exercises and strong parent and teacher influence to teach creativity and open-mindedness. In the workplace, a similar problem exists. While groups are told to be open-minded and flexible, few mechanisms exist to help people understand this concept.

The *Emonic Process* (EP) aims to provide an application in which participants can actively focus on the *process of creation* rather than on a specific goal or *product*. Similar to improvisation, the users participate in a collaborative exchange with a computer to evolve a media system, focusing on the actual performance and exchange rather than the finished product. A *media system* in the Emonic Environment [2], the parent project for the EP, is a network of media objects that control different aspects of audio, video, or text output. These objects control changes, such as amplification, color ratio, or rhyme, and can be linked together to create unique media outputs. The resulting media exchange should reflect users' ideas on aesthetic media and provide a way for them to be exposed to new and different media systems suggested by the computer. There is no limit to how long a participant can, or suggestions for how long they should, use the EP. There is, additionally, no designated way of keeping a final product created in the EP, thus relieving participants of a possible tension to reach a goal during a session.

PROJECT BACKGROUND

The Emonic Environment, which the EP was inspired by, approaches the problem of the inflexibility of rigid computer-human interactions by providing a means for casual computer-human interaction where both participants contribute equally to a media project. The participant may be working on one level of the media system while the computer is providing further modifications to another level. This environment allows participants to work alongside computers to create improvisational media performances.

Most computer-human interactions involve one-sided computations either by the computer or the human. For example, in editing a movie, the user has complete control over what changes are made to the movie and has to tell the computer what to do at every editing step. In human interactions, however, the exchange is much more double-sided: conversations rely on both people contributing to the topic, sports games involve analyzing the opponent and adjusting your actions appropriately, and improvisation requires flexible input and on-the-spot collaboration from musicians. In simulating the real world, computer programs have lost a sense of reality by separating the different levels of participation existent in most interactions as well as by taking out the actual "interaction" of having both participants contribute to a process.

The Emonic Environment provides many levels of focus, similar to real life, but allows those levels of focus to interact with each other and effect decisions that both the computer and human make. An example of one such level is the genetic algorithms that are used to change the structure of the media system. The genetic algorithms can be run by the computer in the background while the user focuses on other aspects of the system, yet changes made by the computer affect the user's next actions and vice versa. While providing these levels of focus addresses rigid computer-human interaction, I saw the possibility to focus more directly on the evolution choices and the user involvement with these choices. Provoking users to evaluate which media system is the best from a set of options will involve them more in the process of creating an evolving media system rather than having them be observers of the evolution.

Similar to how the Emonic Environment uses a genetic algorithm as a means of internally computed and judged change for the current media system, the EP uses genetic algorithms to provide a set of options for the user to choose from, thus handing over more control to the user. This stronger involvement with the process of creating the media system through evaluation of difference allows the user to participate in and control the process while also having to consider unique and different suggestions from the computer.

THESIS GOALS

One characteristic of an application to enhance process-based thinking rather than product-based thinking should be that it not only involves participants in the process, but also induces participants to *think* about the process. With the EP, giving the user the opportunity to view suggestions for future media systems computed by genetic algorithms will do this. However, attention must be paid to how exactly this is done in order to maximize the user's understanding of the process they are participating in. The user must not only participate in process-based actions, but must also be impacted by these actions.

Additionally, in order to know if the participants are using a method of process-based thinking rather than product-based thinking, an evaluation of the performance of the EP and how it is used should occur. The evaluation involved for the EP was a user study and analysis of the opinions and actions observed from this study.

Some of the questions I propose to address by implementing and evaluating this project are as follows:

- How does one design an application that induces process-based thinking?
- How are people best motivated to think about the process of working with a media system instead of the finished product?
- How can working in such an environment influence creativity or open-mindedness in other situations?

I refer to the ideas of creative thinking, open-mindedness, and process-based thinking often in this paper. I believe that by working with a process-based application such as the

Emonic Process, a person has the opportunity to become more open-minded and creative in their thought. I therefore use these three phrases almost interchangeably.

Related Work

Being open-minded is a concept suggested by leadership development professionals, teachers, and business consultants. There exists a body of literature focused on teaching groups, teams, and leaders how to be open-minded, as well as literature discussing the extent to which people are open-minded. The following sections discuss a sample of this literature to show that there is a need for people to be open-minded. In addition, I will demonstrate that there is an initiative by teachers to try and spark the creativity of children in classrooms. Finally, I will show that there is also an initiative to bring technological learning into the schoolroom, thus making it a reasonable suggestion to bring a project like the Emonic Process into classrooms.

Brin Sharp, a facilitator and leadership development professional, wrote in his article "Open-Mindedness" for the Intersol Media Newsletter [5] that the natural tendency for people in groups is to be defensive and to convince others of their opinion. While this is a common problem in most groups, Sharp reasons that by being open-minded, a group can change disagreement into constructive discussion by replacing the extremity of right vs. wrong with the acceptance of different views. The Emonic Process aims to create open-mindedness such that the user will be more willing to accept media system suggestions that they may not have been able to think of on their own. As Sharp points out, there is a need for people to be open-minded, especially in teams and in decision-making processes.

KidSource.com suggests ways in which parents and teachers can help children learn to be more creative [6]. The types of suggestions cover a broad range of options such as supporting unusual ideas that children may have, holding back on constant evaluation, or providing opportunities for creative exploration. While these suggestions may affect the actions a teacher or parent takes in answering questions or interacting with a child, they do not provide a physical means with which to allow children to practice being creative. The suggestions, instead, create more work for teachers and parents who are already busy as is. The Emonic Process fills this gap.

Due to the growth and improvement of the computer industry and the worldwide trend towards dependence on computers, many projects are focusing on how to bring technology into classrooms. Systems such as the Intelligent Tutoring System [4] present computer tutors to cut down on tutor costs and to provide interactive learning mechanisms. Databases such as MIT's OpenCourseWare [1] spread classroom information around the world to areas that would otherwise not have access to such material. An even more interesting solution provides a means for impersonal distance learning: an online tutoring system for students and teachers to meet interactively at a distance, developed in Hong Kong [3].

While these types of technological contributions to the classroom and to education may improve quality of learning or provide education opportunities where they were lacking, none focus directly on stimulating students to think creatively. Classrooms are beginning to use computers as information sources and complex tutors but fail to focus on using them for abstract concepts such as exploratory thinking. We have seen that open-mindedness is a necessity for successful teamwork throughout life, that there is an initiative to teach creativity to students, and that technology is making its way into the classroom. The Emonic Process builds off these three ideas to represent a program with which musical creativity can be expressed in a non-restrictive manner, thus invoking open-mindedness and process-based thinking.

Methods

The work content of the Emonic Process is two-fold: first the program was designed and written, and second a user study was run to evaluate the impact and initial success of the program. The following two sections describe the two parts and the work involved in each.

PROGRAM DESIGN

The EP is a complex Java program based off of the Emonic Environment. Before writing the program, I had to first understand what such a program would need to include in order to successfully invoke process-based thinking. I did this by exploring various existing aspects of the Emonic Environment to figure out which ideas would work best with my goals. Thus, by working with the Emonic Environment, I was able to better design a program to provoke open-mindedness and process-based thinking.

I then simplified the Emonic Environment into an application workable as a base for the EP. This involved limiting the control given to participants and the complexity of the media systems. I isolated key features that would help induce process-based thinking without creating too much distraction, such as having a simple tempo and audio network instead of involving other types of media as well. Genetic evolution was the only type of interactive control over change that I kept for the EP, yet the algorithms were modified to fit my goals. Genetic algorithms were used by the Emonic Environment to simulate improvisation by slowly evolving the structure of the current media system towards another, user-selected, system. In the EP, genetic algorithms are one of the methods used to provide suggestions for the user during the evolution of a media system. The two genetic algorithm based suggestions run the algorithms for a certain number of generations, allowing the computer to evaluate each set of possible generations and to choose what media system to provide. Judgments are made based on previous selections of the user. Each of these generations created represents a new possible direction that the media system can take such that the overall process may result in a completely different outcome than originally desired. The computer then presents the generation resulting from the evolution to the user, along with the other options as described below, allowing the user to then have final control over the direction of the media system and the overall improvisational exchange.

The set of objects that exist in a media system in the EP can be any of the following. The properties listed are the characteristics of the objects that can be changed in evolution.

- Master Tempo
  - The main source of tempo for the system. It sends a beat to all connected objects at the designated time interval.
  - Properties: tempo.
- Tempo
  - A sub-beat that splits up the main beat into smaller beats, typically connecting the main beat to audio objects. These can also filter out beats to create irregular patterns
  - Properties: tempo, filter pattern.
- Audio
  - A representation of an audio clip. On receiving a beat, this will send its audio clip to the output to be played, if connected. This also controls various aspects of how and when to play the audio clip.
  - Properties: audio file, offset, start cue, stop cue, volume.
- Audio Out
  - An output that plays audio clips.
  - Properties: port.

After modifying the existing system, I designed the application to allow users to choose from four possible media systems created by the computer. Participants can listen to each system and choose one as the basis for the next *round*[1]. When the participant chooses a media system, this system is then used as the basis with which to create the next *generation*[2]. As shown in Figure 1, the four following types of change represent the four suggestions for each generation:

1. Property Changes: Using genetic algorithms, the computer invokes a set of changes involving only the properties of the objects present in the media system, such as the volume of an audio file or the tempo at which the audio will repeat.
2. Object Changes: Using genetic algorithms, the computer invokes a set of changes involving only the objects present in the media system, such as adding or removing tempo objects, audio objects, or connections between objects.
3. Crossover System: The computer adds generated objects to part of the selected system to create a crossover between the chosen system and a randomly created system.
4. Generated System: The computer generates a completely new system with no relation to the selected system.

[1] A "round" consists of the following sequence: having a set of suggestions, listening to and choosing an option, and having the computer create four subsequent options from the selection.
[2] A "generation" consists of a set of options for the user to choose from.

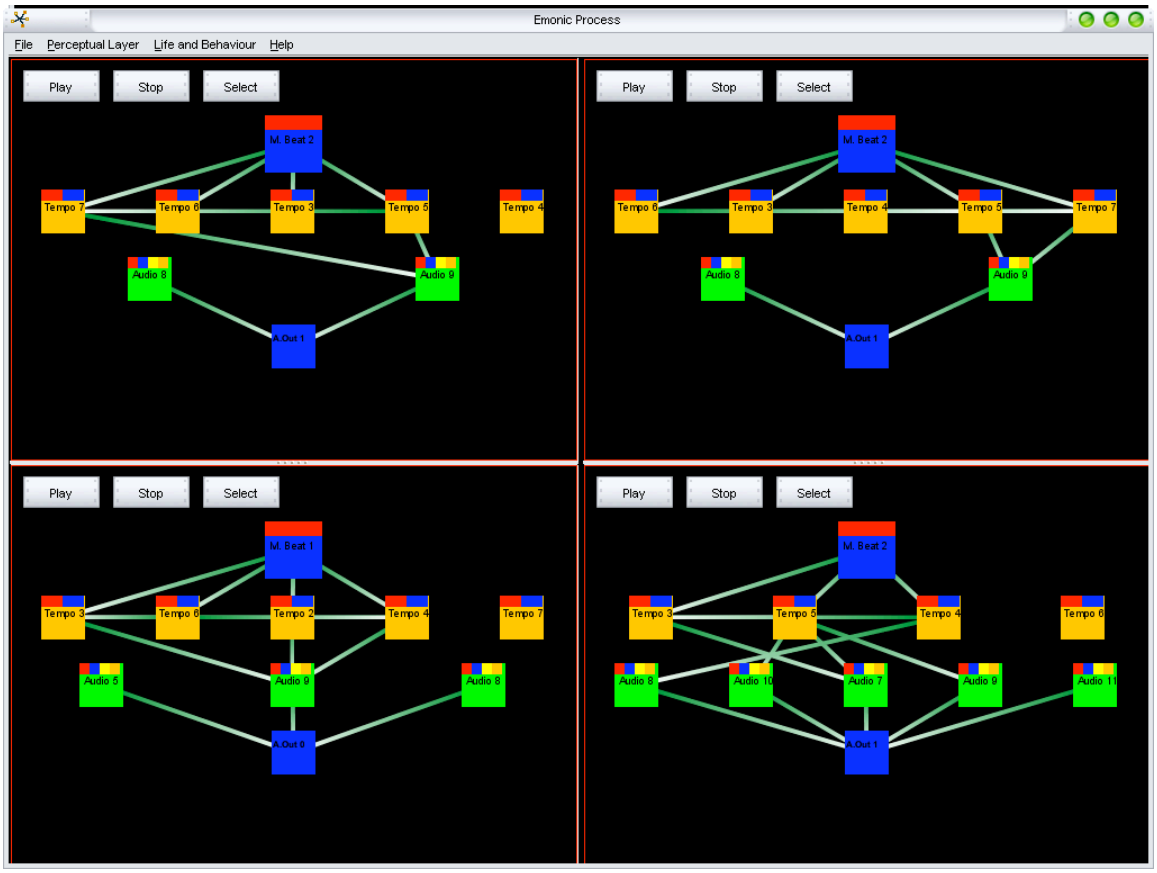

Figure 1: A screen shot of the Emonic Process. Each of the four quadrants contains the following media systems, going clockwise and starting from the upper left-hand quadrant: Object Changes, Property Changes, Generated System, and Crossover System. Each media system has three options for the user to choose: "Play", "Stop", or "Select". "Play" allows the user to listen to the output of a single system. "Stop" silences the system. "Select" chooses that system for the next generation.

These types of change allow a wide range of options for the user to choose from, running from a large change as seen in the Generated System suggestion which has no relation to the selected system at all, to a small change as seen in the Property Change suggestion where only minor aspects of the selected system are changed. By not guiding the user in a particular direction, this should provoke creativity and acceptance of new ideas. There are also no restrictions as to how many times a user can select the media system from a specific quadrant. Figure 2 shows a diagram of the input involved from both the user and computer in order to complete a round.

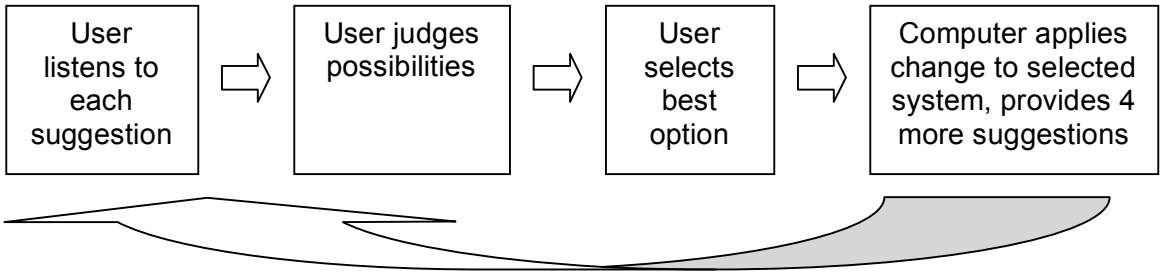

Figure 2: A diagram of actions by the user and computer in a "round".

Overall, the key steps involved in completing this project included:

- Simplifying the Emonic Environment to have only one type of control (genetic algorithms) and few types of objects (master tempos, tempos, audio samples, and audio outputs)
- Redesigning the structure of the class objects to support multiple media systems
- Redesigning the GUI to allow four media systems to be viewed at the same time
- Designing the four types of media systems, implementing those designs, and weaving the use of those designs into the existing structure to be used at each round
- Creating controls to play, stop, and select each media system such that the media systems do not interfere with each other and making the mutation algorithms system-specific
- Redesigning the genetic algorithms to have a predetermined goal of the previously selected media system[3]

The program is designed to give the user control of the overall changes, yet includes participation from the computer as well. The resulting progression of change over the media system ends up being a team effort with input from the computer, which suggests intermediary options, and the participant, who selects which option to use as a basis for the next round. The program can be worked with for an indefinite number of rounds, thus removing the pressure of deadlines or goals that could possibly be set by the computer.

USER STUDIES

After creating the Emonic Process, I ran user studies to observe participant reactions to my system. These studies involved having an MIT student use the EP for ten rounds and answer questionnaires (see Appendices A-C) before the session, after the third and sixth rounds, and after the entire session. The questionnaires aim to answer the following key concepts:

- **Opinion**: How do the subjects view opposing opinions and does this view change over the course of using the Emonic Process?
- **Satisfaction**: How do the subjects qualify the resulting media system? Was it better or worse than the original system? Is it something they could have come up with on their own? Is it unique, different, inspiring, emotional, or reflective of their preferences?
- **Emotional**: For a given set of emotions, are the subjects feeling more or less of that emotion than before the experiment?
- **Goal Oriented**: How much of a goal was used when the subject was deciding which option to choose? If a goal was used, when was it thought up?

[3] The Emonic Environment's genetic algorithms require a starting and ending, or "goal", media system, where random changes are applied to the starting system and each change is evaluated by comparing the change to the goal system. As evolution progresses, choice of change depends more and more upon the success or failure of previous changes, all the while slowly mutating the start system towards the goal sytem.

The questions are mostly range questions in which the subject chooses which of five levels of an answer apply best. The goals are to analyze whether or not this type of learning inspires process-based thinking in a person, whether or not my program actually got this message across, and to what extent the subjects approved of the program. My hypothesis is that this type of application can influence, at least over time, the range of creativity in our everyday thinking and the extent to which people are willing to accept solutions to problems that are different from what they may have thought of on their own.

Results

Having had twenty-three users work with and give feedback on the EP, I have come to the conclusion that the EP is a step in the right direction but additional guidance during usage of the program would be more effective. The following section describes the results in detail.

MEASURABLE COMFORT

After round three, six, and ten, the same set of four questions (see Appendix B and C, questions 1-4) was asked to determine the subjects' comfort and approval of the EP's suggestions at those three points during the experiment. Results are not statistically significant between sequential rounds, however there is a common trend in the progression of average values for each question throughout the experiment. As seen in Figure 3, most subjects became more comfortable with the media system most recently selected, felt that the suggested systems became more relevant, and thought the computer was more intelligent by the end of the experiment. In addition, most subjects felt that the current system continuously became less similar to a system they might have created themselves.

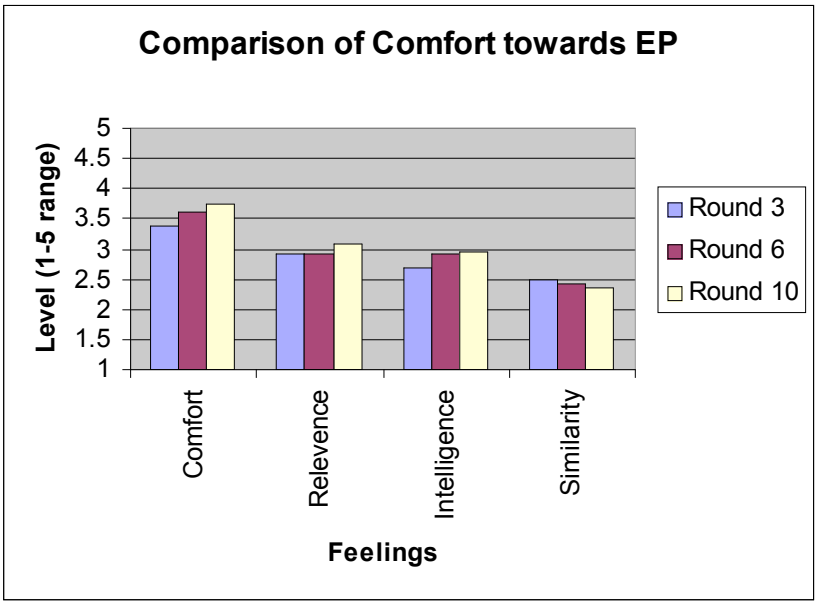

Figure 3: Comparison of the comfort levels of subjects towards the EP at each of three stopping points along the experiment. While not all significant, the common trends are noticeable in every category.

Using a two-tailed T-test on paired samples from responses for round 3 and round 10, the comfort level of subjects increased with a 72% confidence level and opinions on the computer's intelligence increased with a 78% confidence level. While neither of these numbers is significant, they are worth noting. This shows that the EP is providing relatively good solutions for the subjects to choose from. Also, subjects on average did not think that the suggestions provided to them were systems that they themselves might have come up with. The inverse relation between increased comfort levels and decreased similarity to what participants would have created can be interpreted to mean that the participants were gradually becoming more and more comfortable selecting and listening to new media system options.

EMOTIONAL CONNECTION

There were two different ways in which the questionnaires asked about the participants' emotions: one that asked them to circle all relevant emotions from a list and another that asked them to rate whether they felt more or less of certain emotions compared to before the experiment. For the first type of question, the most commonly selected emotions are listed in Table 1 (see Appendix B for the actual questions and options).

	Round 3	*Round 6*
Most common	Open-minded (52%)	Open-minded (35%)
2nd most common	Creative (26%)	Creative (35%)
3rd most common	Passive (26%)	Frustrated (26%)

Table 1: Most commonly selected emotions during rounds three and six with the percentage of subjects that selected each emotion. Subjects were not limited to choosing a single emotion.

Although the number of people who felt that open-mindedness was a relevant emotion decreased, the number of people who felt that creativity was relevant increased. This

may be due to participants who did not like the suggestions they were being given and who became more and more attached to their own goal. This is discussed more in the section about goals and curiosity. Additionally, passivity decreased in popularity and was replaced by frustration; this implies that participants were becoming more involved in the process although they may have disagreed with the options given, hence the increase in reported frustration.

Another interesting point to note about this question is that the option was also given to write-in additional emotions if the subject felt the need. The most commonly added emotion was "Confused". While the number of participants who felt confused was small, this does imply that more guidance was needed to understand what was going on. This may, however, also be a result of the subjects being MIT students. A typical MIT student will desire to know every detail of what they are doing instead of just letting the program direct them.

The second set of emotion related questions were scaled questions asking if participants felt more or less of the named emotions compared to before the experiment. The most significant, as calculated by a two-tailed T-test with paired samples comparing the final levels with an initial level of 3, were "Creative" (almost 100% significance), "Satisfied" (91% significant), "Open-minded" (almost 100% significance), and "Agreeable" (96% significance). These results imply that participants were motivated to become more creative and open-minded than they were initially. In fact, no participant claimed to be less open-minded than initially and only one participant claimed to have dropped in creativity. In addition, most subjects were satisfied with what they had accomplished even though they lacked control over the entire situation and would not have created similar media systems if given full control. As one participant pointed out on his or her questionnaire, "I was spoon fed options; strangely this makes me feel creative."

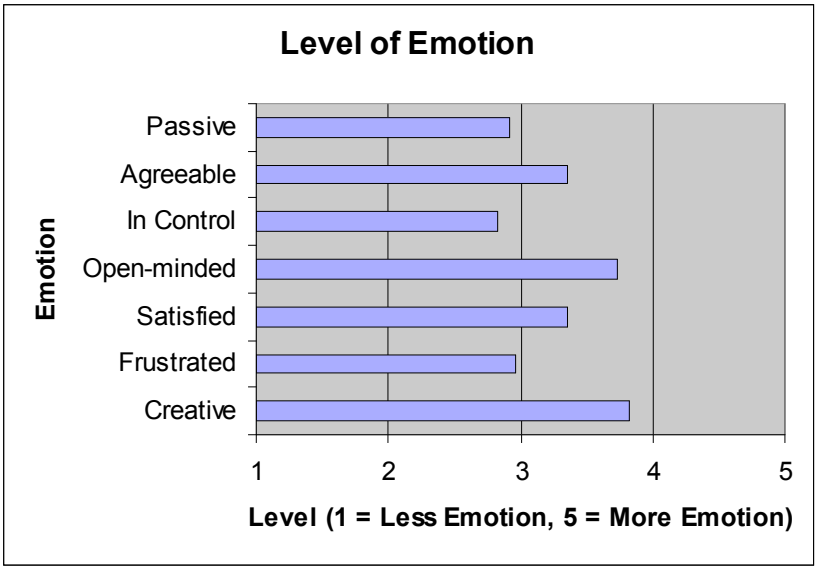

Figure 4: Comparison of the levels of emotions felt by subjects to before the experiment started. The low range was 1 (felt much less than before the experiment) while the high range was 5 (felt much more at the end of the experiment).

Lack of change for the emotions of "Frustrated", "Passive", and "In-control" may have been due to the varying initial reactions of the participants to the EP in general: some participants became very frustrated when the computer changed the media system drastically while others liked these changes. One subject actually exclaimed that the computer had done made a "wrong move". Users who felt this way may have been more frustrated and less in-control than others who felt that they adequately manipulated the computer to make a media system they liked.

GOAL VS. CURIOSITY

One of the main purposes of running this user study and asking questions intermittently was to determine if the subjects were focusing on a goal during the experiment. The question that most directly addressed this was asked in the final questionnaire and asked if the subject was more focused on curiosity (a rating of 1) or on a goal (a rating of 5). The average level selected was 2.3, which is weighted towards curiosity. Only five of the twenty-three subjects claimed to have focused *more* on a goal than on curiosity. However, ten participants named a round at which they began aiming at a goal, which averaged at round 4.35. The surprising thing is that these participants do not directly correlate with the participants who listed that they had focused more on a goal than on curiosity. They may have instead had a dynamically changing goal that changes depending on the suggestions provided. One subject wrote that they started to have a goal at one point and then switched back to curiosity when having a goal became boring.

COLLEAGUE OPEN-MINDEDNESS

The first question before the experiment started and the last question after the experiment ended was the same; it asked how willing the subject was to consider a colleague's opposing views. From a range of 1 to 5, before the experiment the average level of open-mindedness was 3.35 while after the experiment the average was 3.43 with a variance of about 1.1 for each case. This is an insignificant difference. All points are shown in Figure 5. As you can see, most subjects' views did not change throughout the experiment. Four subjects changed their views positively, and three changed them negatively. This lack of change in answers is most likely due to the short length of the experiment. This question would have been better placed in a longitudinal study over a length of time.

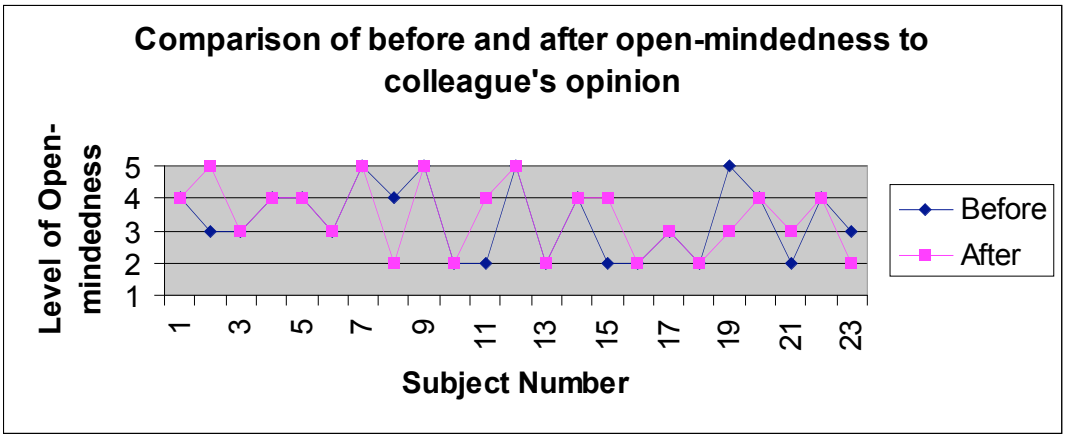

Figure 5: Comparison of before and after open-mindedness to a colleague's opposing opinion. Most points are equal, while 4 subjects increased in approval and 3 subjects decreased.

OBSERVATIONS AND DISCUSSION

While looking at statistical evidence and graphs of questionnaire results is satisfying for those who need physical evidence, I actually found that I learned more from watching and observing participants rather than looking at the data. Most participants felt comfortable enough to discuss what they were going through during the experiment even though I had not told them they could. It seemed that this was a result of either being interested in the media exchange they were participating in or being frustrated with what the computer was suggesting.

From observing participants, I have noticed that there are a few different types of reactions to the EP. The first obvious reaction was one of frustration: some subjects were actively annoyed by the sounds being produced by the computer and went for the option of select the least annoying of the options. These participants seemed to be the least open-minded about listening to what the computer suggested. The second obvious reaction was one of true interest: subjects became very interested in the music, danced to the rhythms, and listened to each option multiple times and for long periods of time. These participants had an innate sense of creativity and truly enjoyed their experience. The contrast between these two types of reactions was so great it was shocking. While there does not seem to be a correlation between the visual reactions and recorded reactions from the questionnaires, it did seem as though people who started off very narrow minded about what they liked and did not like remained that way throughout the experiment. These people may have benefited from additional prompting as to what the experiment was about and what they were supposed to focus on. The subjects who did not fall into either of these extreme categories were passive and did not comment on the experiment.

A possible reason for such different reactions could be that the suggestions for each round and each session were generated on the spot. Every person heard different options even though they had the same amount of control over the process and began with the same media system. However, during some sessions, the computer's suggestions were

continually busy and contained many audio samples playing at once creating a loud, blurred sound that is very rarely approved of. Other times, the changes made by the genetic algorithms were unnoticeable and thus provided very minimal variation. While these types of suggestions are bound to happen given that the EP has both randomly created and genetically evolved media systems, a participant viewing the EP for only ten rounds may not appreciate the possible variety of suggestions if the suggestions they do see are limited or overwhelming.

An interesting influence on participants also may have been their familiarity with the audio samples. Although most samples are from varying uncommon songs or clips of a person talking, one subject understood Spanish and thus tried to select the options with the most Spanish. Another had heard one of the songs before and claimed that because he "knew what it was supposed to sound like," he had a hard time letting other audio samples intrigue him and instead tried to recreate the original song.

A possible solution to this problem is to either allow the users to manually select their own audio samples to use throughout the process or to have the users fill out a questionnaire about media they already enjoy and thus pre-select certain audio samples that they are more likely to approve of in the first place. While this does get rid of some of the opportunity to hear new suggestions from the computer that they may not have originally thought they liked, it does limit the number of times a participant could use a system without ever liking *any* of the suggestions.

Future Work

All in all, watching subjects use the EP was a very intriguing task. Reactions varied so widely that the possibility of creating a system that will cater to every type of person seems impossible. The EP is one step in the right direction towards creating a program that people can use to improve their creativity and open-mindedness, as seen by statistical evidence that most subjects felt more creative and open-minded by the end of their session. Many additions and changes could be implemented in the EP in order to get a better success-rate. Small additions include adding more types of media to the media systems, adding additional suggestions for the user to choose from with an expanded repertoire of changes, or changing the way in which the genetic evolution uses the participant's preferences.

Another change suggested by a fellow student is to have the suggestions reflect different durations of genetic evolution, in which some options have gone through only a few generations while others have gone through twenty or fifty. This would replace the Generated System and Crossover System suggestions and would give the user options that more directly relate to what he or she previously selected.

Time constraints have limited the depth to which I can study the effect of process-based thinking on creativity and open-mindedness. The most important next step would be to observe participants with the EP for longer periods of time to see if their open-

mindedness changes over this period of time. It would be particularly interesting to see if working with the EP has any effect on a participant's work or school related group activities.

In addition, I talked before about bringing the EP into classrooms. To see if this would be worthwhile, user studies with children would have to be run to see if children can benefit from such a program.

Contributions to Society

The Emonic Process can be used as a teaching application to show the benefits of process-based thinking for classrooms, work environments, or simply interested people. It can provide a fun way of evolving media systems that inspire a different way of thinking. This type of learning and thought provocation should be more widely used as a teaching device for negotiation, discussions, and teamwork. Not only can it influence the creativity of children in schools, but it can also influence productivity in the workplace. Having more experience working with process-based activities rather than single-mindedly focusing on results, coworkers faced with understanding each other's proposed ideas may be better equipped to agree on middle ground. Scientists in a lab may be more accepting of experiments going wrong and may be more willing to look for positive results from such mistakes. In general, I believe learning how to understand opposing views and trying different processes to reach a goal is more important at times than learning exactly how to reach a goal. I have designed and implemented the Emonic Process, a program for media exchange with a computer to invoke creativity and open-mindedness in its participants, to serve this purpose.

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Appendix A

Questionnaire to be answered before the subject works with the Emonic Process.

Questionnaire 1

If a colleague's suggested solution to a problem is completely opposite of your own, how likely are you to consider your colleague's solution when discussing what to do?

(Very Unlikely) 1 2 3 4 5 (Very Likely)

Appendix B

Questionnaire to be answered after completion of the third and sixth rounds of the experiment.
The user will be prompted on the screen to do so.

Questionnaire 2

You have now completed the next 3 rounds of the experiment. Please answer the questions with regard to the 3 rounds completed most recently.

1. How comfortable are you with the current sound sequence?

(Not at all) 1 2 3 4 5 (Very Comfortable)

2. How relevant did you think the suggestions were?

(Not at all) 1 2 3 4 5 (Very Relevant)

3. How intelligent do you think the computer is?

(Not at all) 1 2 3 4 5 (Very Intelligent)

4. Would you have done something similar if the computer hadn't been providing suggestions?

(Not at all) 1 2 3 4 5 (Very Similar)

5. Circle any relevant emotions that you are feeling right now (or if none, apply, please write one in).

Open-minded Creative Frustrated Passive Other _____

Appendix C

Questionnaire to be completed at the end of the experiment.

Questionnaire 3

You have now completed the experiment, with a total of 10 rounds. Please answer the following questions about the overall experience.

1. How comfortable are you with the current sound sequence?

(Not at all) 1 2 3 4 5 (Very Comfortable)

2. How relevant did you think the suggestions were?

(Not at all) 1 2 3 4 5 (Very Relevant)

3. How intelligent do you think the computer is?

(Not at all) 1 2 3 4 5 (Very Intelligent)

4. Would you have done something similar if the computer hadn't been providing suggestions?

(Not at all) 1 2 3 4 5 (Very Similar)

5. Were your decisions more based on curiosity or on a final goal?

(Curiosity) 1 2 3 4 5 (Goal)

6. If you did have a goal, at what point did you form this goal? (i.e.: what round) _____

Please compare your feelings now to how they were before the experiment by choosing if you are now less (1) or more (5) of that emotion.

Emotion	**Less than before**		**Same as before**		**More than before**
Creative	1	2	3	4	5
Frustrated	1	2	3	4	5
Satisfied	1	2	3	4	5

Open-minded	1	2	3	4	5
In control	1	2	3	4	5
Agreeable	1	2	3	4	5
Passive	1	2	3	4	5

If a colleague's suggested solution to a problem is completely opposite of your own, how likely are you to consider your colleague's solution when discussing what to do?

(Very Unlikely)	1	2	3	4	5	(Very Likely)