

Augmented Intelligence - The New AI - Unleashing Human Capabilities in Knowledge Work

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Abstract—In this paper I describe a novel application of contemplative techniques to software engineering with the goal of augmenting the intellectual capabilities of knowledge workers within the field in four areas: flexibility, attention, creativity, and trust. The augmentation of software engineers’ intellectual capabilities is proposed as a third complement to the traditional focus of methodologies on the process and environmental factors of the software development endeavor. I argue that these capabilities have been shown to be open to improvement through the practices traditionally used in spiritual traditions, but now used increasingly in other fields of knowledge work, such as in the medical profession and the education field. Historically, the intellectual capabilities of software engineers have been treated as a given within any particular software development effort. This is argued to be an aspect ripe for inclusion within software development methodologies.

Keywords—Development Methodologies; Knowledge Workers; Contemplative Practices; Contemplative Techniques; Flexibility; Attention; Creativity; Trust; Awareness; Augmented Intelligence

I. INTRODUCTION

Traditional software development methodologies have focused on imposing structure and procedure on what is, at its heart, a creative human process of practical problem solving. Struggling with the reduced creativity and attenuated responsiveness that such methodologies have historically entailed, various Agile development methods and project management schemes have been advanced. These attempt to re-enable the creativity and productivity that is partially lost under traditional structured methodologies by focusing on the development roles and activities themselves in order to discern patterns of best practices in order to apply them systematically. Calls for various environmental solutions have now come to the fore, notable for their Taoist-like focus on enabling designers and developers to better do their work by removing environmental obstructions and distractions, like ringing telephones and the need to constantly produce status reports for management, that undermine the worker’s creative productivity. These ‘people-side’ solutions emphasize environmental redesign and humanistic work patterns that are believed to result in better focus and an improved opportunity for creativity (and productivity) for developers.

In all these varied attempts at managing, enabling, and better fostering the successful application of knowledge to practical problem solving in software engineering, the capabilities of the human element has been taken as a given, for the most part. The focus has been on the activities and the environment in which software engineering is carried out. This paper suggests that there is a third aspect to knowledge work that can be improved—the knowledge workers themselves. The justification for the proposal suggested by the author is that the inclusion of millennia-old, now scientifically validated, contemplative practices into the software engineering endeavor can enhance the ability of knowledge workers to pay attention, to remain open and flexible in their problem solving approach, to allow each individual to tap into their deep creative potential, and to foster heightened trust between members of software engineering teams. The inclusion of contemplative practices can accomplish these improvements regardless of the development methodology followed, the environment in which it is carried out, or the people involved.

II. BACKGROUND

Contemplative practices, especially mindfulness, which is the ability to pay attention in a particular, non-judgmental, way, have been at the core of religious and spiritual traditions for millennia. While the descriptive language used in each tradition varies, the primary purpose of these practices is to allow the individual to break through their normal preoccupation with their ‘inner dialog’ of thinking about other things and loosen them from their deeply held beliefs, so that they can attend clearly to what is happening, or what they are doing, right in the present moment.

The common view of such practices is that they are directed at the self-enlightenment of the individual, and thus, wouldn’t have much application to the world outside of such spiritual pursuits. But this is not an accurate depiction of the purpose of contemplative arts. These practices are highly refined tools of intellectual augmentation that allow the individual using them to break out of their undisciplined thought processes in such a way as to allow them to see the truth. The implicit justification for the use of such practices in religious and spiritual traditions is the simple observation that if you aren’t paying attention, you will not be able to see the truth when it is right in front of you.

Developers are well aware of a similar phenomenon, which routinely arises as a kind of blindness to the cause of a

problem, or potential problem, in software under development. It is why independent code reviews are a necessary part of software engineering. There are many contributing factors to this blindness that pervades the entire engineering effort, and it is these factors that the author's proposal is attempting to minimize or remove.

Contemplative practices will have other beneficial, well-understood effects on knowledge workers related to the reduction of stress, improved physical health, and the healing of emotional traumas. Such additional benefits, while not the focus of the author's proposal, all certainly will help to improve worker productivity and job satisfaction, while creating a more positive work environment for everyone. These benefits have been independently documented in other venues and there is a large body of scientific evidence to support them. However, they are not the main focus of the author's proposed inclusion of these practices.

III. HOW METHODOLOGIES FAIL US

There are certain aspects of any effort to design a solution to a problem, and implement it, which are inherently dependent upon the capabilities of the people taking part in the endeavor. This is so obvious it is rarely mentioned. Yet, it deserves our attention if, as the author is suggesting, there are practical techniques that can directly improve the capabilities of the people involved in crafting software solutions.

The focus of knowledge work is never theoretical—it is always practical. Yet most of our attempts at improving the performance of these knowledge-based activities focus on the abstract processes involved, or on improving the theoretical environment in which they are performed, rather than focusing on the cognitive capabilities of the specific individuals engaged in the effort and their possible enhancement.

Our underlying assumption seems to be that we can improve a process, or craft an environment more suited to foster productive work, but the individuals involved in the process cannot be improved. Such an attitude is unfortunate because it fails to understand that certain very important human capabilities, central to the conduct of any practical activity, can be taught, can be improved, and can be refined, just like any other human skill, such as dancing, playing sports, or being healthy. One recent finding at UCLA has shown that meditation techniques bring about physical changes in the brain, including the gyrification, or folding, of the cortex, which plays a key role in memory, attention, thought, and consciousness. These changes continue to increase over time, as the techniques are used.^{1,2}

The author has applied many of the techniques under discussion in an ad-hoc fashion as part of development efforts he has led. For example, beginning team meetings with a 5-minute meditation. While the results of these tests cannot be taken as proof of the author's claims, they complement results found in controlled experiments in other fields. Designing similar controlled experiments within an actual development project is a goal for further research.

People are surprising in their ability to overcome difficulties and to work around obstructions, and just as disconcerting, at times, in their ability to undermine the best intentions to foster qualitative work. The author feels that by focusing on the individual's intellectual discipline, dependable improvements can be obtained.

IV. A FACT-BASED CONTEMPLATIVE APPROACH

There are four qualities that are critically important to human problem solving that the application of contemplative techniques can beneficially improve. They are: Flexibility, Attention, Creativity, and Trust (FACT). Let's look at each one.

A. Flexibility

A lack of flexibility is marked by ingrained habits and rigid beliefs about how things must be done regardless of the situation at hand, or an understanding of needs and processes that has become outdated because individuals are not paying attention to changes in the target environment, or a fear of failure if something new is suggested. Each of these inflexibilities can undermine development efforts, as well as our attempts to improve the quality and resilience of delivered solutions. What is needed is for each worker to learn techniques that will enable them to maintain a level of mental equanimity and increased self-awareness to assist them in remaining flexible in matters confronting the development team so that they can more quickly and easily respond to changing requirements, evolving environments, and the added stress imposed by the difficulties that all such efforts are naturally prone to.

The nurturing of equanimity within the individual team member can be accomplished through the use of scientifically validated techniques of guided visualization, such as those used in the practice known as Yoga Nidra. Yoga Nidra is being successfully used in the treatment of PTSD, where its effects help bring about a reintegration of the afflicted individuals through a creative process that overcomes psychic and emotional difficulties.^{7,8} But its applicability is wider than that.

B. Attention

The ability to pay attention—to focus on the activity at hand—is a learned skill that benefits from continuous practice. Mindfulness meditation teaches us how to pay attention in a special, non-judgmental way that allows us to see the 'whole picture'—what is actually present—without preconceived notions that blind us in certain respects, while remaining vigilant for sudden changes in the task at hand that could otherwise be missed if our focus was wandering. It does this by deepening our own self-awareness.^{3,4,5,6}

Mindfulness meditation is widely used in the medical profession as a therapeutic tool. It is increasingly being incorporated in school curriculums as well, because of its obvious effect on student attention in class.

This form of meditation has extremely well documented positive effects on subjects in a wide array of venues.⁹

C. Creativity

Solving problems, designing flexible and reusable software, and meeting customer needs, all require creativity. Creativity is a latent ability in every individual, that is not dependent on some special ‘gift’, and there are techniques to bring out this ability by altering the individual’s mental state while teaching him or her how to unleash their imagination to discover creative solutions. Every great invention starts with an intuition, and it is our intuitive creativity that we can be trained to unleash.

Research scientists have identified a certain conscious state that is normally present when individuals exhibit increased creativity, the Theta brainwave state. This state, it turns out, can be invoked through the use of repetitive rhythmic sounds of certain frequencies. The technique has been used for thousands of years for healing purposes by enabling the application of imaginative visualizations aimed at problem solving, with the aid of various musical instruments, such as drums, rattles, sticks, and rocks.^{10,11}

While the image of software engineers using drumming to assist them in creating cutting-edge solutions may seem comical, like any other human created technology, refinements in the original tools used (drums, for example) are an expected outcome of the scientific discovery of the mechanisms involved in bringing about their observed results. Derived from such scientific research, today there are a plethora of digital recordings that can be used instead of drums, to the same effect.

D. Trust

Trust is not something that can be created by the fiat of management. Whether it is the trust of customers in the products and services of a business, or the trust of team members in each other, trust grows organically only if there is trustworthiness present, and trustworthiness requires transparency, frequent and honest communication, mutual respect, and inclusivity. It takes flexibility, attention, and creativity to ensure that these qualities can flourish in any organized effort. The author was involved in a 3-year project on Trust in Science and Religion at Stony Brook University that brought into focus the need for these factors for the proper development of trust in human relations.

Together, these four qualities reinforce and amplify each other. But what is most attractive about the contemplative practices that can be utilized within the software engineering field is the minimal amount of time necessary to see significant improvements. One-half hour per day, even in 10 minute sessions, leads to quantitatively significant improvements in worker flexibility, focus, and creativity. Increasing these qualities within a team’s members reduces the stress and conflicts that can frequently arise in such environments as that found in the high-pressure field of software engineering, and this reduction can naturally foster the growth of trust between the team members.

An unexpected testimony to the efficacy of contemplative practices was published in the biography of Steve Jobs, who is quoted discussing how important he felt these practices were to his own success:

“If you just sit and observe, you will see how restless your mind is. If you try to calm it, it only makes it worse, but over time it does calm, and when it does, there’s room to hear more subtle things—that’s when your intuition starts to blossom and you start to see things more clearly and be in the present more. Your mind just slows down, and you see a tremendous expanse in the moment. You see so much more than you could see before. It’s a discipline; you have to practice it.”

V. POSSIBLE IMPLEMENTATIONS

Mindfulness meditation is the simplest and most beneficial contemplative practice to implement as part of any development methodology. The technique is simple, yet rich in variety and application. The objective is to direct the attention to a prominent physical phenomenon present in the subject’s awareness, such as the breath, sounds, tastes, and even thoughts, although in a special way. The focus is moved away from our normal immersion in our thoughts, toward the selected phenomenon, with the goal of breaking the whirlpool-like quality of our incessant mental chatter.

When thoughts are used as the focus, it is not on the content of the thought, or what it is about, but on the appearance in the mind of a thought. Thus the thought is not judged or reacted to as normally occurs, but is instead just ‘taken in’ as it arises, as if it had no more content or meaning than taking a breath does. This enables the individual to ‘take a step back’ from their thought process—even anger—in a way that allows them to break free from emotional or mental ‘loops’ that they might otherwise find themselves stuck in, by using these techniques.

Using mindfulness in these ways trains the practitioner to pay attention non-judgmentally. This allows more of the experiential field to be taken in. Normally, because we are constantly reacting to what we experience, we tend to overlook much, while we attend to some selected subset of what is happening. A classic example of the blindness to much of what is actually presented to us at any particular moment is a classic experiment in which the subject is asked to watch a film of two basketball teams passing a ball back and forth between team members as the members move around the court, counting how many times the ball is passed. While the subject is observing the ball being passed around, a man in a black gorilla suit walks slowly and in full view across the court. Few of the subjects ever notice the man in the gorilla suit.

Mindfulness can be practiced for varying lengths of time, anywhere from 30 seconds, known as a ‘breathing space’, to as much as 30 minutes or more. While there are special sitting postures that facilitate remaining alert without any physical discomfort and movement over lengthy periods of time, such as those found in the traditional meditation practices of many spiritual traditions, there is no need to utilize any particular pose. Mindfulness can be practiced while sitting at a desk or on a train, walking down a corridor, lying on a couch or the floor, or even when eating a meal. Research has shown that practicing mindfulness techniques for half an hour per day over the course of only 8 weeks

produces noticeable changes in the brain regions associated with memory, sense of self, empathy and stress.

One technique that the author has used extensively in a group setting is to commence each meeting with a 10-minute mindfulness session using the breath. Starting a meeting with everyone fully ‘present’ has an even bigger impact on the productivity of the meeting than just artificially keeping it short.

Guided visualization, such as used in Yoga Nidra (literally, “the sleep of the yogi”), is best done in a group setting. It also benefits from the kind of enhanced focus that mindfulness meditation develops, and is itself an application of mindfulness techniques with an added dimension of guiding, or directing the attention of the subject, through a series of mental exercises that result in greater self-awareness and a breakdown of physical, emotional, and mental barriers and conflicts that often retard a person’s intellectual performance. This guided practice instills a state of deep relaxation, evidenced by Alpha brain waves in the 7 to 12 Hz range, in which we can begin to access the deep vein of spontaneous creativity that we all share. The author has successfully utilized guided visualization exercises of 10-minutes duration, although 20 minutes to half an hour provide a deeper state of relaxation and creativity.

Finally, the use of repetitive rhythm in the 4-beats/second range, such as fast drumming, has been shown to entrain Theta brainwaves (between 4 and 7 Hz) that synchronize through both hemispheres of the brain. This Theta wave state is indicative of a kind of twilight state between deep sleep and wakefulness. This is the state in which we frequently experience “Aha!” moments of insight, which we all recognize whenever we are stuck with a problem with no discernable solution and decide to “sleep on it.” This practice—think of it as augmented brainstorming—is especially useful in breaking through obstructions that are blocking progress in some aspect of the design or development process.

In the Theta wave state we are in a kind of waking dream during which vivid imagery flashes in our consciousness. In this state we are more open to information that conflicts with our assumptions, and we are more flexible about entertaining possible solutions that might otherwise remain beyond our normal conscious awareness. During the Theta wave state many find they are capable of comprehending advanced concepts and relationships that become incomprehensible when returning to Alpha or Beta states. This state has also been identified as the gateway to learning and memory. Studies have also shown a relationship with increased creativity, enhanced learning, reduced stress and heightened intuitive perception. When the brain is exhibiting Theta waves it appears to balance sodium/potassium ratios that are responsible for the transport of chemicals through brain cell membranes. This appears to play a role in rejuvenating a fatigued brain.

VI. SUMMARY

Every development effort encompasses three broad components: the team members, the environment in which they work (and the broader environment of the organization itself), and the activities that they perform to accomplish the stated goal of their endeavor. Each of these components serves as a primary constituent of the success or failure of the effort. While failure can originate in any one of these components—the people, their environment, or in their actions—success requires committed attention to all three of these components. However, to date, most of the attention of development methodologies has been focused on the process and the full complement of development activities, as well as on the environmental factors, with little attention focused on the specific individuals involved in the effort and the improvement of their particular intellectual abilities. The inclusion of a comprehensive palette of contemplative practices into the development methodology can contribute improvements to any development effort by specifically focusing on the cognitive capabilities of the specific team members involved.

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