Anticipating Serendipity
Preparing for the Unexpected

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ABSTRACT

Serendipity—using "fortunate accidents" for learning or discovery—is a valued if too infrequent route to progress. Although serendipity cannot be scheduled or relied upon, one can develop skills, flexibility and habits of mind that make the recognition and incorporation of serendipitous discoveries more likely. This paper overviews at a high level a program of activities and concepts aimed at preparing modern professionals and communities to leverage the fortunate occurrences they encounter.

Keywords: serendipity, discovery, community, collaboration, improvisation,

1. INTRODUCTION

Serendipity, felicitous acquisition or discovery by a combination of fortune and sagacity, derives from Horace Walpole's correspondence commenting on the fable, The Three Princes of Serendip [33, 36], dating in English from the 18th century. As Walpole states, the three princes were "always making discoveries, by accidents and sagacity, of things which they were not in quest of".

Thus serendipity cannot be a direct goal of a program of discovery, since of course it is impossible to schedule luck, but it is possible to inculcate sagacity, by developing flexibility and an adaptable knowledge base, and fostering openness, wisdom, and judgment.

In the rest of this paper, we look at forms and aspects of serendipity, and suggest an approach for a framework to facilitate it. In particular, we look at the connection of serendipity with improvisation, intuition and analogy.

We then look briefly at a broad variety of applications, and at tools that have been developed for its support. Finally, we provide conclusions and recommendations.

2. FORMS AND ASPECTS

It is possible to recognize three forms (or levels) of serendipity: First, recognition of an unexpected situation or result, as in Goodyear's discovery of vulcanized rubber [10], Fleming's penicillin [37], or Plunkett's Teflon [7]. Second, connections via analogy or linkages, as in Kekulé's (possibly apocryphal) realization of the structure of benzene when he dreamed of a self-devouring snake (the Worm Ouroboros) [35]. And third, the integration of multiple perspectives or disciplines through the formation of groups and communities, where one party's knowledge or approach supplies a missing key to a problem faced by another.

The second, intuitive form, is closely related to the idea of the thought experiment. An interesting example of this form, making totally unexpected connections, occurred in the work of the author. After struggling for months to find an algorithm and complexity analysis for a problem in real-time multi-media scheduling [21], it turned out that the problem was essentially analogous to the line-segment intersection problem [32], which the author had encountered only by taking a course in combinatorial geometry because he found the instructor's approach to teaching appealing.

Dealing with the unexpected is the key to the first two forms. As Isaac Asimov once wrote, "The most exciting phrase to hear in science, the one that heralds new discoveries, is not 'Eureka!' (I found it!) but 'That's funny'" [4]. But to properly deal with the unexpected, one must admit the possibility, and have sufficient mental flexibility, sensory awareness, and "thinking in the background" beyond the immediate task at hand to be able to cope with fortunate surprises.

One must then be able to recognize that something unexpected has occurred, to assess whether the event has the potential to be interesting, and to modify and adapt plans and projects to explore and possibly incorporate the discovery and/or its consequences, and perhaps even changing processes and approaches.

Finally, one must be able to evaluate the result to see if that incorporation was in fact productive, and as necessary to modify and evolve the result, even if it means reverting to the earlier plan or product.

3. THE COLLABORATIVE AND INTERDISCIPLINARY MODE

Collaboration, interdisciplinary ventures, and the community mode in general call not only for such abilities, but also for more group-oriented and communication intensive skills [27]. (Note that "interdisciplinarity" here means more than teams from different disciplines

investigating related problems, or even looking at different facets of a single problem. An interdisciplinary team collaborates as a unit to bring different disciplines to the definition and solution of a problem, development of a product or formation of a community [28]. Such teams can then work with other teams beyond their immediate circle in the pursuit of problem definition and solution.)

First, recognizing opportunities or occurrences requires additional skills: realizing and then fostering a group's potential for positive and creative interaction; picking up on chance but relevant conversations and observations; or making unexpected connections based on conferences, workshops or (formal or informal) publications. An important point, especially for projects complicated by factors such as interdisciplinarity, longevity, complexity or risk, is appreciating unexpected viewpoints and stakeholder perspectives—or sometimes just expected views stated in unexpected ways—which through use of analogy and transformation can produce not only opportunities for integration, but unexpected insights on one's own perspective.

As these connections are made, one finds oneself in a network of overlapping and interacting communities, where "community" can include not only social and governmental units, or enterprises, professional societies or multi-organizational project teams, but also less formal communities of learning, knowledge or practice, as well as "communities of communities", raising the bar from collaborating individuals to collaborating institutions or groups, with a need for both standards and constraints [15].

Preparing to encounter and leverage fortunate occurrences in this mode relies primarily on two factors. After identifying the prospective community or community of communities, the first is creation and maintenance of an environment of communication and trust, which in turn relies on understanding differences in social, institutional, domain/discipline and work cultures [26, 29].

The second is awareness of and openness to the content of communication. Sometimes the most interesting results arise from fortunate misunderstandings, or from attempts by novices (students, interns, participants from outside the discipline) to formulate the principles and issues in a given problem or situation. Once more, the process of analogy, linking disciplines, and pattern matching is important in different ways both for the novice and for the more experienced listener.

In some well-known cases (for example, [3]), the misunderstanding is on the other side, with the novice solving an "impossible" problem by taking a new tack, because he/she did not realize how hard it was or what the traditional approaches had been.

4. A FRAMEWORK

As a structure for organizing the process of being open to serendipity, we propose a framework of six facets: contextual, conceptual, perceptual, effectual, consensual, and eventual. All are valuable, perhaps necessary, for "fortunate discovery", although the perceptual is more valuable in the individual modes, and the consensual in the collaborative modes.

The first three provide core background. The contextual facet is concerned with the acquisition and organization of knowledge [15] — explicit, undocumented implicit knowledge, and tacit, "hand" or "social" knowledge— together with problem analysis (cost-benefit, requirements and risk [23]) and initial problem evaluation—does a prospective approach seem interesting, useful or sufficiently offbeat as to be intriguing?

The conceptual facet entails problem solving and thinking skills: critical thinking, openness and flexibility together with an understanding of agile approaches and processes [2]. In addition, it stresses the understanding and use of analogy [12, 13, 14] and development and use of intuition [8].

While sensory awareness is important to the perceptual facet, the development of a sense of fun with ideas, relationships and communication, and an awareness of physical and social relationships are also important. Improvisation and role-playing [20] are important tools here, especially when the approach emphasizes initial planning and subsequent revision, together with experimentation and exploration of the senses, ideas and relationships. This facet also leads to better communication skills—also valuable in organizing one's own thoughts—listening, organizing information and persuasion, plus a sense of voice, posture and physical presence.

Figure 1. The Serendipity Framework
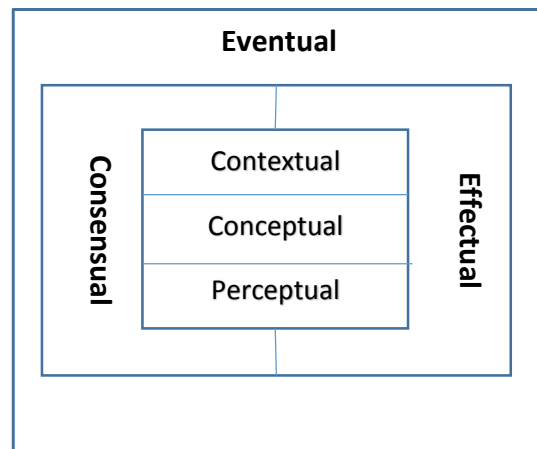
Surrounding these three foundational facets are two facets corresponding to growing ideas. The first is the effectual

facet, concerned with acquiring and integrating information from multiple sources, disciplines, individuals or groups [15, 22, 18], reaching beyond the familiar, and via multiple modes of perception and communication, which provide grist for the processes of abstraction, specialization and generalization, and analogy.

The second is the consensual facet, involved in working with groups, or within communities of knowledge or practice. The seeds of community development and interdisciplinary discoveries lie in recognizing and fostering prospective communities, inculcating communication and trust, and placing a value on benefits to and healthy growth of the community. The consensual facet also presents opportunities to flesh out ideas, using the community as a forum or sounding board, yet at the same time realizing that there are times when it's appropriate to disregard the opinion or preferences of the community and to go one's own way [1]. Preparing for collaboration also calls for revisiting knowledge management, to incorporate knowledge resulting from integrating partner knowledge, or resulting from a collaboratively developed and operated product [9, 22].

Finally, judgment, revision and evolution comprise the eventual facet, where these should be applied not only to problem solutions, but to the modeling of problems, and to our solution processes themselves, and reflection on one's own thought processes. The eventual facet echoes and reinforces the deepest tasks in the others: contextual problem analysis, the conceptual facet's flexibility and agility, the planning and revision of the perceptual facet, the effectual facet's abstraction, analogy and integration, and both the conditional acceptance and justified rejection of community opinion and approach from the consensual facet. For this reason, success in developing the eventual facet is a good measure of success in anticipating serendipity.

5. APPLICATIONS

Serendipity is an obvious important partner to improvisation in the creative arts—theater, dance, music, and the visual arts—as well as fine and decorative artisanship, including pottery, woodworking, glassblowing and metalwork; the preparation for these domains will be in the same spirit but differ in the details from that described above.

As importantly, and more closely in line with the above, improvisation and readiness to use fortunate occurrences are of immense value across the spectrum of teaching and training [1, 9, 11, 19]. They also are of immense use in software development and development of other knowledge-based products [17], as well as in management, especially of knowledge workers—where knowledge can be understood to include tacit, "hand" knowledge. In each case, the ability to read the "class" and to elicit new information, sometimes not yet articulated by its members, is often beneficial.

Science, engineering and technology workers will also gain from both improvisational skills and preparation for serendipity, as indicated by the examples above, and even more so if in collaborative environments, or those in which a complex problem must be defined by multiple stakeholders.

As a final example, this preparation should be recommended for those interested in community planning and development or effective provision of social services, or in collection and curation of oral and artifactual history [18, 30].

6. TOOLS AND SUPPORT

Data mining and visualization are useful discovery tools, although typically limited to information already encoded in the given context. As such, they can be adjuncts, revealing existing patterns and suggesting hypotheses, or suggesting new ones as information is added or modified, but don't themselves add to the context. To promote serendipity, these need to be complemented by tools that make contacts and connections, or that suggest analogies.

Automatic or semi-automatic connection of people with common acquaintances or perceived common background or interests is now common on social media such as Facebook™, LinkedIn™ and others. However, it is both more interesting and more useful (from a research perspective) when those connections are made on the basis of shared knowledge or concerns, or when one appears to have knowledge that will be useful to the other (and hopefully vice-versa), and the results are integrated with enterprise knowledge management.

A number of tools [5, 6, 31] have been developed to support development of a knowledge base with such cross-connections, and the making of connections between people and groups, or between people/groups and topics, using shared technical contacts, publications, projects, and declared interests and memberships to do so. The more sophisticated tools will examine publications and projects to attempt to discover shared techniques, algorithms, concepts, or concerns. Others focus more explicitly on creating a semantic net of concepts labelled with references or artifacts, and notifying interested parties of new connections [34].

An integrated tool for support of collaboration and innovation is presented in [18, 25]. This tool includes both the knowledge and connection base described above, but tools for sharing views of a project across organizations, and robust communication tools. (See also [16, 24], describing a system for software development that integrates project artifacts with collaborator and external information.)

Analogy generating tools are less common, mostly exist in the world of artificial intelligence [13], and are limited both by incomplete context and by a necessarily incomplete analogy-forming rule-base [14]. The author is unaware of any current tool that combines AI-based analogy generation with the sort of connection former described above.

7. CONCLUSIONS

Although one cannot schedule or rely on serendipity, one can develop the flexibility, mental attitudes and skills to improve the likelihood that one will recognize and benefit from fortunate accidents when they occur.

The program of development should include traditional exercises to develop critical thinking and problem solving, together with requirements and risk elicitation and evaluation. These can be specialized to the domain(s) of the participants, with the goal of forming a deeper and more conceptual understanding of its structures. To these can be added study of (general or domain-specific) patterns, the abstraction-generalization-specialization approach, and the use of analogy, and other activities designed to foster intuition, as well possibly as more general surveys of semiotics or visualization.

But these should be supplemented with approaches aimed at fostering communication and creativity, such as improvisation, and with community and group development workshops, and each of these aspects should deal with trust building and differences in cultures, in the broadest sense of that term. Finally, these need to be supplemented with activities that strengthen the analytical facility of the participants as applied to assessing the initial and eventual values of problem, process, and patterns of thought.

The facet structure proposed above will be useful in a broad evaluation of such a program of activities, and may assist in staging, sequencing and refining its activities.

Naturally, large knowledge enterprises and teams involved in multiple complex and interdisciplinary projects will also want a tool suite to facilitate organizing knowledge, making unanticipated connections of both people and information, and evaluating and testing proposed designs or solutions. The combination of preparation, continuing interaction and tool support will facilitate the entire (possibly collaborative) enterprise, and recognition and leveraging of serendipitous occurrences.

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