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Positive Deviance Approach for Identifying Next-Generation System Engineering Best Practices

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Abstract

Systems Engineering practices, methods, and processes are rapidly evolving to keep pace with the accelerated advances occurring in complex systems development. Often, Systems Engineering curricula reflect methods and processes proven over time and as such don't necessarily convey the changes occurring at the forefront of complex system development. This paper explores an alternative approach - Positive Deviance - for researching and identifying next-generation Systems Engineering best practices at this knowledge horizon. Positive Deviance has over two decades of proven use in social sciences disciplines as a means of identifying behavioral patterns. The intent of this paper is to demonstrate a method for maintaining a continuously refreshed repertoire of leading edge best practices to supplement traditional training curricula in Systems Engineering. This paper presents a proposed model (DISCO Model) for the integration of the Positive Deviance approach into current knowledge elicitation processes used to capture Systems Engineering best practices. This paper focuses on providing an exploratory discussion of useful steps and guidelines that prospective educators could use to capture next-generation Systems Engineering best practices for inclusion in their training and education curricula.

Keywords: Systems Engineering; Positive Deviance; Complex Systems, Education and Training: Knowledge Capture and Management.

1. Introduction

Systems Engineering (SE) practices, methods, and processes are rapidly evolving to keep pace with the accelerated advances occurring in complex systems development. Often, SE curricula reflect methods and processes proven over time and as such don't necessarily convey the changes occurring at the forefront of complex system development. For example, Systems-of-Systems Systems Engineering activities go beyond traditional SE methods and practices; and it has taken time for those extensions to be incorporated into the SE body of knowledge. This changing knowledge horizon presents a challenge for educators to effectively identify emerging behaviors that may be next-generation best practices, particularly as the volume and velocity of change continues to accelerate. The DISCO Model proposed in this paper may offer a new method for addressing this challenge. The DISCO Model

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incorporates Positive Deviance (PD) that has shown to be effective in social sciences. More recently, Rebovich and DeRosa [1], have applied PD to SE research.

The intent of this research is to provide an approach that can supplement current methods of identifying next-generation best practices; thereby allowing Systems Engineers to be knowledgeable of the latest SE advances earlier in their evolution. By identifying best practices earlier in their evolution, it affords educators time to better understand the method or process in question, better integrate it into existing curricula, and mature training offerings quicker. Additionally as Sage [2] noted for the practitioner, engineering education can be more than a professional pursuit, it can also be an intellectual stimulus. The DISCO approach can broaden the opportunities for the practical and intellectual pursuit by providing insight into nascent methodologies and techniques earlier in their evolution; and it may provide the catalyst for further research by a larger field of researchers.

1.1 Positive Deviance Background

Deviance for most of history has had a negative connotation as in a negative deviation from expected norms. In the 1970s, the concept of PD entered the social sciences lexicon. The PD approach offers us an alternate method – one of replicating behavior that has a positive impact on outcomes instead of identifying problems and systematically mitigating each one. Rebovich and DeRosa [1] noted in their research that when things go wrong the spotlight is often shown on the problems, and causes, and very little is noted about replicating success. In the last twenty years, PD as an approach has shown itself to be a viable means of improving individual, organizational, and community performance by replicating success instead of analyzing why things are wrong. PD is best suited for problems that require behavioral and social change especially where complex social systems, engineering or organizational cultures make the adoption of change difficult. PD is particularly useful in overcoming social norm stasis. In essence, PD offers a means of finding unrecognized patterns that have grown organically from within.

The positive perspective of behavior although discussed in the 1960s didn't take form until Wishik and van Der Vynckt [3] applied the idea to nutritional analysis in the 1970s. They described positive deviants as families whose children showed better nutritional health as compared to the norm for comparable families under suppressed socio-economic conditions. Zeitlin [4] built upon Wishik's and van Der Vynckt's research and more fully structured a PD approach and an elementary description of a positive deviant. She extended Wishik's and van Der Vynckt's research by noting that PD can be seen as a form of social, behavioral, and physiological adaptability to stress.

Jerry and Monique Sternin [5] pioneered the use of PD as an approach as opposed to a label affixed after research. In the late 1980s, they were operating a program to reduce malnutrition in Vietnamese villages. The program was struggling in that it followed the norms of the day, i.e., bringing in outside experts. The Sternin's, looking for a better alternative, leveraged Wishik's, van Der Vynckt's and Zeitlin's respective research and realized the value was in finding success from within the community and replicating it versus using external expert opinion. They used the PD approach to work with locals to identify the best nourished children among the villagers – the positive deviants. Positive deviants are individuals that exhibit PD behavior. The Sternin's then visited the mothers of the well-nourished children to understand what they were doing differently. Surprisingly, many villagers weren't aware that some in their community were well nourished and moreover that the children's mothers' approach contradicted accepted wisdom. The Sternin's shared the PD approaches they had uncovered with other villagers. Malnutrition was significantly reduced in rural areas in which the Sternin's spread the PD driven approaches. The Sternin's [6] later updated their early definition to a generalized form which described PD as "Identifying individuals with better outcome than their peers (positive deviance) and enabling communities to adopt the behaviors that explain the improved outcome are powerful methods of producing change." Others such as Seidman and McCauley [7, 8] and Spreitzer & Sonenshein [9] built upon their Sternin's work and extended it into other disciplines. Rebovich, DeRosa, and Norman [8] using case studies showed how PD could be used to improve SE practices. Their work demonstrated how PD can support an evolutionary improvement in identifying next generation best practices in SE by looking from the inside out versus a top-down driven approach. More recently, Rebovich's and DeRosa's [1] presentation at the Conference for Systems Engineering Research (CSER) 2012 titled Patterns of Success in Systems Engineering of IT-Intensive Government Systems which demonstrated that success patterns in SE can be discovered using the PD approach.

2. Proposed Method

Identifying programs where success is predicated upon PD approaches and identifying individuals or groups of individuals (positive deviants) responsible for devising and implementing these PD approaches can be challenging. An even more daunting task is the identification of PD instances in which the work appears to have long term value and can be institutionalized to benefit a larger community. The following is a proposed 5–step method for identifying and integrating PD activity into education and training curricula development to address this challenge.

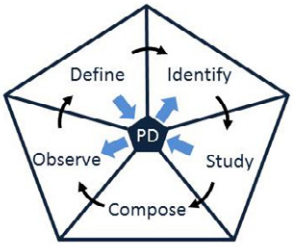

Figure 1. Proposed DISCO Method

The DISCO Method incorporates PD as expressed in prior work by Pascale [10] and Sternin [10] [11]. It also relies upon the PDCA/PDSA cycle, popularized by Deming, and the Six Sigma DMAIC improvement process. The proposed method contains 5 steps: Define; Identify; Study; Compose; and Observe (DISCO Method) as shown in *Figure 1*. The causal map shown in *Figure* 2 notionally demonstrates how the DISCO process augments the current educational development approach; and it demonstrates the relationships between each activity with the DISCO Steps.

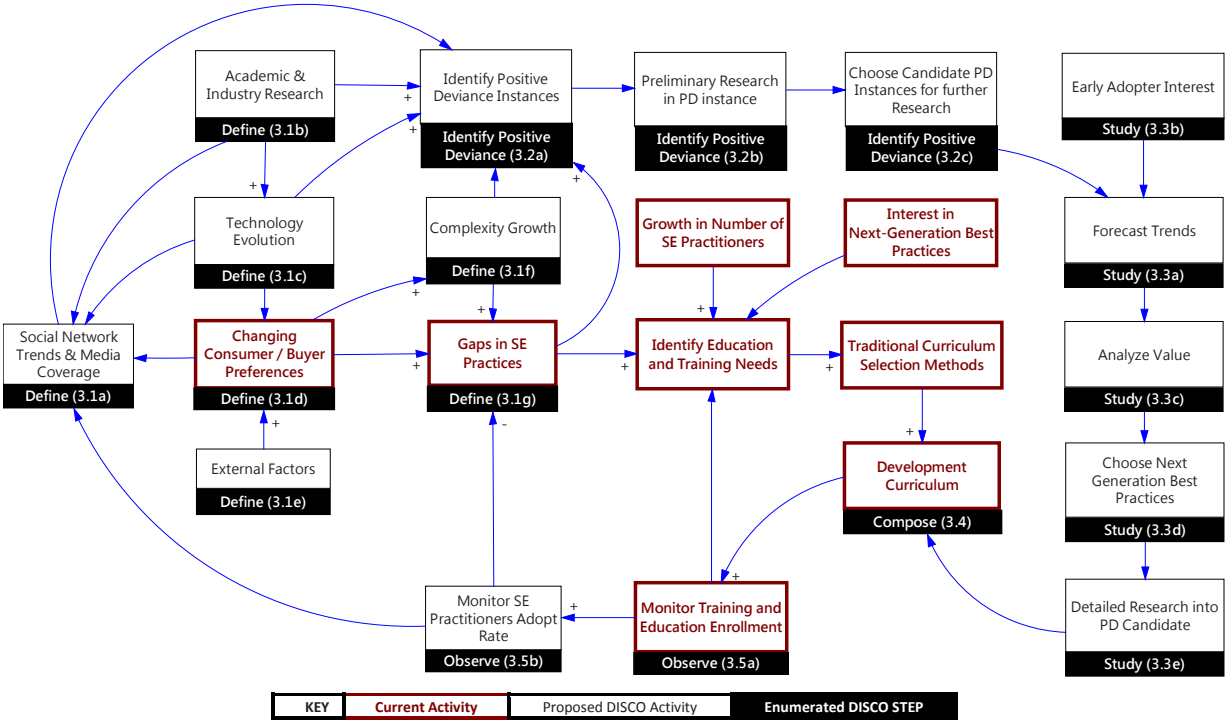

Figure 2. DISCO Implementation Causal Map

Each step is described in further detail below. The intent of the DISCO approach is to use information sources, data analysis techniques and field research to predict likely next generation best practice candidates versus reacting once sufficient adoption of a best practice has coalesced in industry and research. As such, it differs from traditional methods in that it relies heavily on monitoring and mining social and traditional media to identify trends to identify instances where individuals or organizations have improved performance through a new or unique approach, e.g. possible best practice. Although difficult to accomplish, the DISCO Method also relies heavily on measuring the rate of adoption as new best practice methods are taught and disseminated throughout industry and academia. Together, this approach creates a continuous feedback loop to constantly identify individuals or organizations that are demonstrating better outcomes than their peers where better outcomes are: higher quality; reduced program or product risk; greater efficiencies; greater interoperability; and greater operational effectiveness. It is envisioned that the DISCO Method can aide in identifying next-generation best practices for more expedient inclusion in the SE body of knowledge; and conversely the DISCO Method can provide determination through data-driven insight to quickly discard poorly received practices and move to the next candidate best practice.

3.1 Define

The initial step in the proposed DISCO Method is to identify and define gaps in the SE body of knowledge where the desired outcomes of organizations are not being achieved consistently or effectively; or where challenges and constraints impede program performance. *Figure 3* shows the activities within this step. The outputs of these activities are a series of data sets that can be mined and analyzed to identify trends in practices that appear to be outperforming peer implementations.

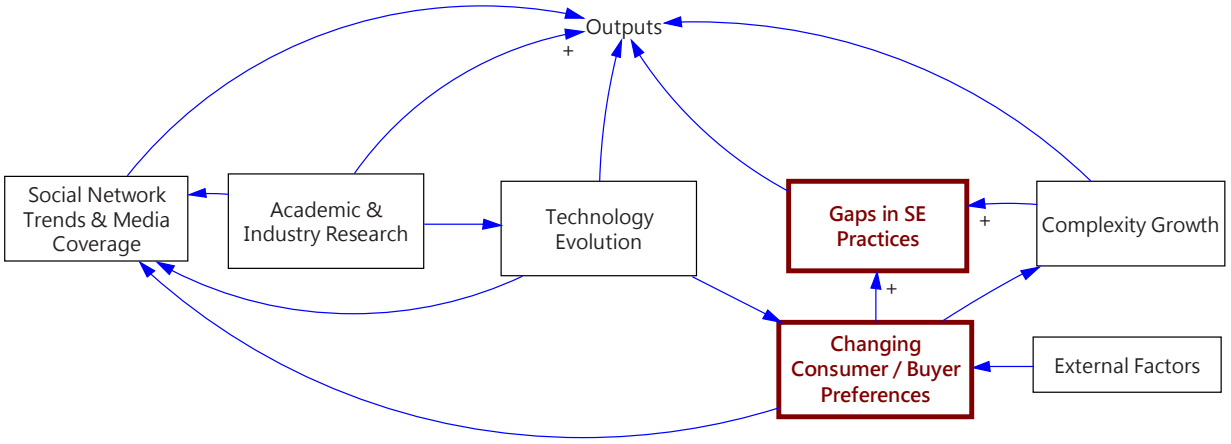

Figure 3. Process Flow for Design Step

Identifying and defining SE body of knowledge gaps is a continuous activity. One in which a learning organization must continually monitor academia and industry. Educators should development problem statements that detail the deficiencies in the current training curricula and clarify with facts. To define these statements, educators should monitor market trends and use surveys and other instruments to gauge interests and concerns of the target audiences. Defining gaps in SE practices and identifying PD instances to resolve those gaps revolves around understanding the changing consumer and buyer preferences. Understanding consumer and buyer preferences requires continuous monitoring of relevant social networks, media and research activity. Additionally, social networks provide insight innovative techniques where information about the techniques are shared across organizational boundaries [12]. Technology evolution can also have subtle and profound impacts [13] on preferences which can drive changes in SE practices. Monitoring other external factors, such as regulatory and economic conditions, can provide insight on changes that may influence customer and buyer behavior which in turn can affect changes in SE practices. Often, societal needs and consumer preferences change which in turn increase system complexity or drives change in performance expectations. Complexity driven by consumer and buyers needs may also create gaps in SE practices.

2.2 Identify

A top down, logic driven approach quite often delivers satisfactory result and is an effective option in solving many challenges [10]. Alternatively, PD addresses a certain class of challenges, namely those that require individuals and organizations to respond by implementing changes counterintuitive to prevailing norms. Awareness of PD traits prior to identifying positive deviants and programs exhibiting PD traits may help identify PD behavior that could be overlooked when viewing behavior through the lens of traditional norms.

A hallmark indicator of PD presence is individuals or organizations outperforming their peers with the similar resources and operating environment. By applying resources or new processes in counterintuitive ways, positive deviants may significantly outperform their peers by focusing on action instead of justification of their reasoning. Enterprise Architecture and the Agile development process, in their nascent stages, could have been considered a product of PD. Tanner and Sternin [14] compiled a set of insightful ideas, shown in *Table 1*, that provides insight into how PD and traditional approaches differ when addressing change.

Table 1. Traditional vs. Positive Deviance Approach to Change

Traditional Approach to Change	Positive Deviance Approach to Change
Leadership as Path Breaker	**Leadership as inquiry**
Primary ownership and momentum for change come from above.	Leadership facilitates search; community takes ownership of the quest for change.
Outside In	**Inside Out**
Experts identify and disseminate best practices	Community identifies preexisting solutions and amplifies them.
Deficit Based	**Asset Based**
Leaders deconstruct common problems and recommend best practice solutions. Implication: "why aren't you as good as your peers?"	Community leverages preexisting solutions practices by those who succeed against the odds.
Logic Driven	**Learning Driven**
Participants think into a new way of acting.	Participants act into a new way of thinking.
Vulnerable to Transplant Rejection	**Open to Self-replication**
Resistance arises from ideas imported or imposed by others.	Latent wisdom is tapped within a community to circumvent the social system's reaction.
Flows from Problem Solving to Solution Identification	**Flows from Solution Identification to Problem Solving**
Best practices are applied to problems defined within the context of existing parameters	Solution space is expanded through the discovery of new parameters.
Focused on the Protagonists	**Focused on Enlarging the Network**
Engages stakeholders who would be conventionally associated with the problem.	Identifies stakeholders beyond those directly involved with the problem.

Source: [14]

Other PD traits that can be used to identify positive deviants are [10]:

- The same individuals are integral to the problem and the solution;
- The individual or group is often considered the guru;
- Solutions are innovative;
- Solutions exhibit elegance through simplicity;
- Results are consistently better than peers; and
- Results are sometimes doubted by others within the organization.

Initially, others within the organization may not be aware that their peers are doing things differently; but once recognized, and if it is not too radical, it becomes the new norm. Using the knowledge challenges identified in the

previous step along with the data sets gathered, educators will need to identify instances where an individual or organization is outperforming peers. Within an organization it may require multiple inquiries to identify responsible individuals. Once identified, preliminary research should be conducted to learn more about the PD instance. This first round of research is to capture insight about the approach and its relative value so that a determination can be made of its worthiness for inclusion in educational curricula.

Figure 4 shows the activities of this step. It is tempting to consider using a framework for structuring interviews and observations for preliminary research, but it is preferable to allow the flow of conversation to lead to discovery given that PD behavior and practices deviate from expected norms. But as PD behavior is identified, it can be very valuable to use a reference framework to categorize and compare PD behavior and practices against common practices. Two candidates of the many published frameworks are the Systems Engineering Body of Knowledge (SEBoK) published by the International Council of Systems Engineering (INCOSE) and available through their Systems Engineering Handbook [16] and recently released SEBoKWiki [17]; or ISO/IEC 15288 - Life Cycle Management - System Life Cycle Processes [18]. Both provide suitable frameworks that encompass the life cycle of a system and are can be used in any applications field or level of systems complexity.

Outcomes of this step are a list of PD candidates with detailed information about each including basic descriptive information and information about how the candidate approach outperforms other approaches within similar peer groups.

Figure 4. Process Flow for Identify Step

2.3 Study

As part of studying the candidate PD instances, educators should consider the impact of the best practice if adopted by industry as well as the value to their organization as an educational asset. Understanding trends and the behavior of early adopters can provide insight and should be a key factor when forecasting trends. *Figure 5* shows the activities within this step. To ensure that the identified PD practices are truly influencing the outcome, educators should use quantitative methods to statistically demonstrate the behaviors of the individual or organizations contribute to overachievement in comparison to peers [15]. Practices that demonstrate the characteristics of PD and can be statistically proven to positively influence performance outcomes can then be chosen as subjects for detailed research.

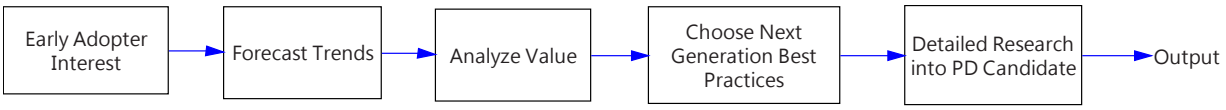

Figure 5. Process Flow for DISCO Study Step

PD, as next-generation thinking, often is exhibited through behavioral changes that have not settled into documented and institutionalized processes. As such, educators should use interviews and observation as a primary means of discovering PD patterns, i.e. uncovering uncommon practices and underlying behavior exhibited by positive deviants. Next, educators need to thoroughly understand the PD practices, methods, processes, and behaviors that set it apart from prevailing norms. Educators should document the practices and behavior, collect artifacts and data [15] that support the changes in practice from norms, and corroborate findings through analysis of control groups that do not exhibit PD. Understanding the differences will provide valuable insight and context for the next step in the DISCO process. The outcomes of this step include detailed documentation of all aspects of the practice or method under review.

2.4 Compose

PD practices tend to be behavioral-based and are often counterintuitive in nature, which means acceptance by a wider audience can take time to occur. When integrating PD-driven practices and behaviors into educational curricula, educators should consider socialization as the first step of integrating a new practice into the SE body of knowledge, i.e. the first two stages of Rogers' innovation adoption framework, awareness and understanding, as shown in *Figure 8*.

As noted, culture and operating norms may initially slow the rate of adoption. As awareness rises across targeted communities, it is likely that its acceptance as a viable practice will grow. As momentum is gained in industry, then fuller training can be developed. Educators should integrate this new source of training insight into their current curriculum development processes so that it is a regular and consistent part of their operations.

2.5 Observe

Educators should monitor the progression of knowledge diffusion for each PD practice by analysing how knowledge diffusion is changing over time as shown in *Figure 7*. Educators can discern the value of specific curricula and continuously improve value through their current feedback and quality assurance mechanisms. Other mechanisms that can provide insight into knowledge diffusion are social media sites, government procurement activity, and job banks. Educators should consider a systems thinking view in which resolving gaps in SE practices is linked to and influenced by other elements in an overall system as depicted in *Figure 2*.

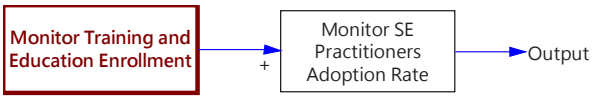

Figure 6. Process Flow for DISCO Observe Step

When monitoring the adoption rate, albeit a difficult task, educators may wish to consider the following approach which is based on work by Rogers and Bass. The publishing of Everett Rogers' [19] *Diffusion of Innovations* in 1962 began the research journey of seeking to explain how and why ideas and technology spread through segments of society. A key element of this work was to provide descriptions of the stages of product adoption. Bass [20] built upon this model by providing a measurable means of understanding the diffusion of knowledge which has many similarities to Rogers' product adoption model. The Bass Innovation Model, often referred to as the S-curve model, has its statistical roots in the gamma and shifted Gompertz distributions which are specific variations of the cumulative distribution function. By doing so, Bass provided a statistically sounded and repeatable means of forecasting societal adoption of innovations, e.g. knowledge in this instance. It has been successfully applied within many disciples since its inception. As such, it can be easily extended to analyzing the value of expediting the diffusion of knowledge through training and education [21]. In particular, it can demonstrate the value of using the PD approach as a means of early identification of relevant knowledge which, in turn, accelerates knowledge diffusion across a given societal segment. Adapting Bass' original equation to generate a density function for use in knowledge diffusion over time, we have:

$$Y(T) = m\int_0^T f(t)dt$$

where m is the total diffusion population and f(t) is the likelihood of knowledge adoption.

Figure 7 provides a notional example of Bass' model with the inclusion of Roger's stages to demonstrate the expected impact of PD on training and educational curriculum development.

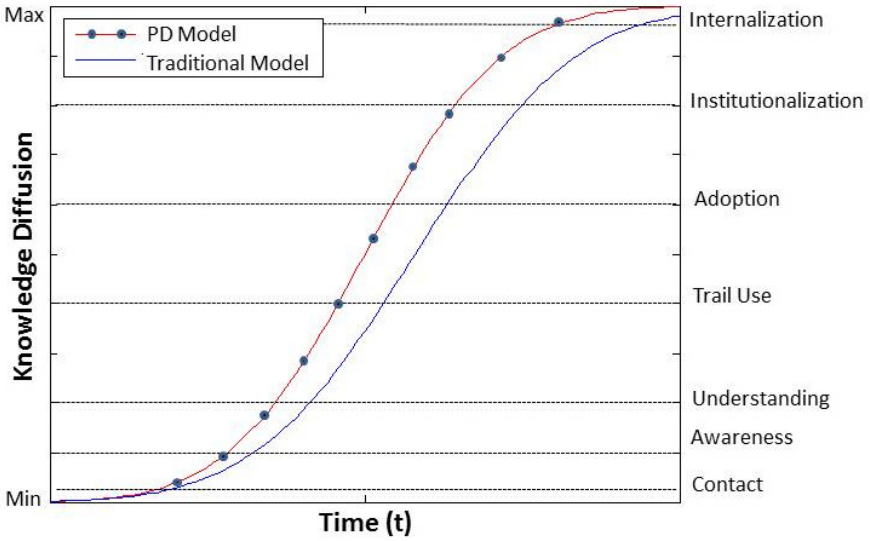

Figure 7. S-Curve Model for Knowledge Diffusion

By employing PD, it is postulated that there will be an increase in the rate of knowledge diffusion over time. In essence, measuring knowledge diffusion provides a means for demonstrating that SE practitioners knowledgeable in newer techniques and process allow for quicker uptake of ideas into the SE community, i.e., moving from first contact to trial usage quicker. Accelerated knowledge diffusion may also strengthen the feedback loop from 'trial users' to concept developers thereby allowing for constructive feedback into fledging concepts at a faster rate. Output from this step can be used as an additional input into the first DISCO step.

3. Exploratory and Future Research

This research is in its exploratory stage and further research is needed to validate the DISCO Method. At the time of publishing initial testing of the method is underway within a large corporation. Anecdotally, initial research has shown that the DISCO Method requires:

- A change in the way an organization thinks;
- Additional manpower and effort over current methods; and
- A certain amount of risk taking not present in traditional reactive methods of defining educational curricula.

Some initial benefits that have been anecdotally identified are:

- Information learned from monitoring has value understanding trends in current curricula;
- Valuable additions to current curricula can be uncovered as part of the monitoring; and
- The additional research and monitoring of trends allow staff to be more knowledgeable of the state of the art and can better respond to inquiries about new and cutting edge practices with a more comprehensive and informed response.

4. Conclusion

Government, industry and academia have collectively invested immeasurable time into evolving SE, Systems of Systems and most recently Systems of Systems Engineering practices. Through this progression, new methods and approaches, as well as the codification of heuristics for common challenges, have continually been integrated into the collective body of SE knowledge.

It is hoped that this research extends that body of SE knowledge by integrating tried methods from other disciplines into the field of SE research. Further, it is hoped that using the PD approach and proposed DISCO Method will provide a sustainable means of identifying process and behavior innovations for earlier inclusion in training and education curricula [17]. For educators, this approach can provide early awareness of emerging trends that can then be monitored and assessed for inclusion in training curricula. It may allow educators to tailor their curricula for competitive advantage versus reacting to market pressures. For industry, in the classic sense of supply and demand, it can mean that skills are available when the demand arises. Better balanced supply and demand can also mean that scarce skills are not procured at a premium. Earlier availability of innovative processes and methods provides an opportunity for implementers to remain competitive in a fast changing environment. Collectively the integration of this approach may accelerate acceptance of new methods and processes which in turn can accelerate innovation.

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