MATURITY MODELS IN SYSTEMS RESEARCH AND PRACTICE

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ABSTRACT

In 2016, a team of scholars met at a gathering sponsored by the International Federation for Systems Research (IFSR), to discuss how systems research could support the increase of systems literacy worldwide. Members of this team developed a conceptual model of the role of systems research in developing such literacy. One consideration this model identified was that people engage with the "systems world" from the vantage point of numerous roles: systems scientist, systems researcher, system engineer, systems philosopher, etc.. Each of these roles demands particular competence with respect to systems theory and practice. Future research must be done to identify a maturity profile for each role – how we can assess the degree to which a person is effectively executing the competencies required to do good systems work.

Maturity models are utilized in several industries, in the attempt to cultivate and evaluate people's ability to effectively execute complex tasks. This paper will examine current thought about the value and pitfalls of maturity models. To further the IFSR's work of promoting world-class systems research, it will identify principles and exemplars that can guide the development of maturity models for the varied roles people take in the systems world.

Keywords: systems research, maturity models, competence

INTRODUCTION

There are many aspects of system science that occupy the minds of its practitioners. Increasing the widespread use of high-quality systems thinking is among them. Enthusiasm for this goal is based on the conviction that thinking systemically and applying systems research to critical issues are of evolutionary significance to our world. Fueled by this conviction, the systems body of knowledge continues to grow, be codified, and evaluated for its progress in occupying a rightful place among other scientific disciplines.

A team of scholars who assembled at the 2016 "Conversation" of the International Federation for Systems Research spent the week engaging in dialogue about the contribution that systems research currently makes, and can potentially make, toward addressing complex problems. The team's position was that individuals are born with a 'systemic sensibility' – an innate sense of the systemic nature of the empirical world. Recent work on 'systemology' is working to formalize this innate knowledge (e.g. Rousseau, Wilby, Billingham, and Blachfellner, 2016; 2018) so that educational efforts can give people "clear concepts and a common language that gives them the capability to articulate and reflect on this innate sensibility, and act upon it in a considered way" (Edson et al, 2017, p. 3). Further, formalization and other efforts to increase the quality of systems knowledge can "enable systems researchers to gain influence in supporting organizations, and through them to better enable systems thinking and acting of individuals and groups, which may (in turn) lead to more quality in how people deal with complex challenges" (Edson et al. 2017, p. 5). At a macro level, the team viewed the systemology initiative as working to identify its maturity as a body of knowledge relative to other scientific disciplines, and to identify key gaps in that body of knowledge. At a micro level, the team discussed how individual people in the systems world inhabit widely varying roles – systems researcher, systems philosopher, systems scientist, systems thinker, and systems practitioner among them. Each of these roles deals with widely varying issues and situations, and therefore faces widely varying technical demands; a great range of systems competencies is required for different roles people play in the systems world. Future research will need to identify the many roles people play in the systems world, to clarify the characteristics of the varied personae required to do systems work. The present paper addresses a different matter: alongside the macro-level work to identify the maturity of the systems body of knowledge, there is a need to assess, at the micro level, the levels of competence required for systems people to do effective work in the varied roles that they play.

In recent decades, there has been rapid increase in the complexity of goods, products, and services that society has come to demand. This has necessitated a corresponding growth in the requirements demanded of organizational processes and people. Understanding these requirements enables organizations a clearer understanding of the ways in which people succeed in meeting the demands they face, and the extent to which their present understanding and actions miss the mark. The competence a person requires to be effective in doing organizational work has become an area of increased interest to scholars and practitioners in many disciplines.

From a "resource-based view of the firm" (Wernerfelt, 1984), the unique competencies of people are a resource as crucial as the bundle of capital, physical, and other tangible resources that make up a human system. Measuring competence levels, it is reasoned, should be as important to an organization as measuring operational efficiency, or financial performance (Rašula, Vukšić, and Štemberger, 2008). In business, things get measured so that focused action can be taken to manage and improve them. Increasingly, this premise is being applied to the degree of maturity that an organization's people exhibit, i.e. the degree to which they are applying the knowledge and behaviours necessary to achieve excellence. Likewise, there is increasing interest in identifying reliable ways of measuring such competence. Without the ability to reliably measure competence, it is difficult to strategically focus organizational attention to things such as "staff development, recruitment and selection, professional registration, training needs, analysis and planning, job descriptions, assessment and an appraisal" (Skulmoski, 2001, p.16). Without this measurement ability, pragmatic action to increase competence maturity is difficult to take.

From the academic standpoint, Rašula, Vukšić, and Štemberger have noted that without reliable ways to measure competence maturity, "a comprehensive theory of knowledge or knowledge assets is very difficult to develop. Consequently, there is no visible progress in the effort to treat knowledge as a variable to be researched, or asset to be managed" (2008, p. 48). The argument here is that maturity assessment is important to developing a common understanding of what comprises concepts such as *knowledge*, *competence*, and *development*. Creating maturity assessments demands "refinement of a general, unified representation" of such concepts across specialties (Kemp et al., 2017, p. 83), which enables consistency in communicating and operationalizing these ideas. These considerations, arising from organizational theory, apply to issues identified by the 2016 IFSR Systems Research Team: namely, without reliable ways to measure the maturity of anyone's systems research competence, it is difficult to develop a theory of systems knowledge. It is difficult to argue for the treatment of systems knowledge as an important asset for an individual, a community, or society, difficult to agree on how to define exactly what is systems knowledge, and difficult to know how to develop it.

Were the systems community to embark on the task of developing a means of assessing systems research maturity, we would be closer to clarifying what comprises systems competence across widely varying subspecialties of systems theory and practice. Identifying unified, disciplined ways of representing systems competence would go far to promote understanding and cohesion among these varied systems schools of thought. Likewise, it could contribute immeasurably to the community's ability to promote the value of systems knowledge in society, and improve the effectiveness of cross-disciplinary dialogue the systems community could have with other scientific disciplines.

Maturity models have emerged in other disciplines: psychology, systems engineering, business processes, project management, and knowledge management among them. In each case, the models have enabled comparison among people, and have had the effect of normalizing specific skills and behaviours deemed important to effectiveness (Domingues, Sampaio, and Arezes, 2016). As such, maturity models have increased in significance to aid those interested in pursuing performance excellence in many realms of human endeavour (van Loy, de Backer, Poels, and Snoeck, 2013). The purpose of this paper is not an exhaustive survey of existing maturity models; rather, it will discuss construct definitions, types of maturity models, critiques, and design considerations with an eye to examining how maturity models could be a useful evaluation tool for the systems research community to consider.

MATURITY MODELS: FUNDAMENTALS

Maturity models are premised on the idea that successful performance is the result of effectively used knowledge, skills, and behaviours. As such, models are useful tools for both practitioners striving for excellence, and for academics working to build developmental theories (Walker and Pitts, 1998). Models have value to individuals[1] and also to groups[2] interested in promoting collective expertise (the capacity to effectively identify, absorb, and apply knowledge [Cohen and Levinthal, 1990; Killen and Hunt, 2013]). The use of specific knowledge, skills, and behaviours is deemed centrally important in the capacity to operate in a competent manner (Skulmoski, 2001), and to also to improve that capacity: "Improvement… require[s] some guidance on what to improve, and in identifying improvement efforts that will provide the most value... Conducting [maturity] assessments provides guidance in terms of current capabilities and identification of performance gaps, helping to identify where improvement is possible, necessary, or desirable" (Mullaly 2014, p.170).

Designers of these evaluative tools imply that the way one uses knowledge, skills, and behaviours reflects one's location on a scale of immaturity-maturity.[3] It is commonly understood (e.g. in popular encyclopedias such as Wikipedia) that maturity involves:

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[1] - such as systems researchers

[2] - such as the International Federation for Systems Research and the International Society for the Systems Sciences

[3] Despite connotations that immaturity involves undesirable deficits (e.g. Kemp et al., 2017), psychologists have proposed that the stage of immaturity is an important time of experimentation

- The ability to appropriately respond to the environment;
- Demonstrated capacity for effective decision making, suitable to context;
- The attainment of sophistication in the flexible use of knowledge and performance of behaviours;
- Appropriate levels of self-reliance and autonomy (in contrast to dependence on the oversight of authority figures);
- The ability to consider options and seek relevant advice, when appropriate; and
- The ability to exercise appropriate temperance and discipline, taking calculated risks without undue impulsivity.

To varying degrees (that is, at various levels of maturity), people exhibit these abilities. The means by which maturity is demonstrated is *competence*, a concept of increasing interest since a seminal publication in the educational testing literature (McClelland, 1973). Since then, it has become a construct of increasing interest in organizational behaviour, popularized by Boyatzis (e.g. 1982) and other theorists. A comprehensive review of competence is beyond the scope of this paper, but for our purposes, in the realm of maturity models, competence has been claimed to encompass a collection of traits, motives, self-image, and perceptions of social norms and behaviour enabling a person or group to direct knowledge and skills in such a way that desired results are consistently achieved (Skulmoski, 2001; Tarhan, Turetken, and Reijers, 2016). The exhibition of "mature" practices is context-specific; that is, any given model conceptualizes immaturity and maturity in specific human systems (i.e. individuals, teams, or groups) operating in a specific application domain (Röglinger, Pöppelbuß, and Becker, 2012).

Maturity models utilize the notion of competence, guided by the assumption that specifically-interlinked collections of competently-used knowledge and skills (Pekkola, Hildén, and Rämö, 2015) comprise comprehensive *levels* or *stages* of maturity. Levels are successively ordered, thereby creating a hierarchical concept-system that enables comparative ranking of different persons (or groups), and models a process of evolution by which a person (or group) can move toward increasingly sophisticated and reliable performance (Domingues, Sampaio, and Arezes, 2016; Röglinger, Pöppelbuß, and Becker, 2012). Different maturity stages are understood to be appropriate for achieving tasks of varying levels of complexity, giving rise to the notion of competence *fit* – another key facet of maturity models. Rather than assuming that the highest possible level of maturity is inherently necessary, adherents of maturity models generally agree that maturity level should be matched to the difficulty of the task at hand, problems to be solved, and environmental context in which one is operating.

Another central assumption of maturity models is that development of mature performance occurs in predictable patterns. This assumption is evident throughout scholarly papers addressing maturity, for example:

- In motivational theory: human drives are arranged from basic to ultimate, each existing as means to subsequent ends (Maslow 1943);
- In management theory: firms evolve in stages along logical, predictable paths (Van de Ven & Poole 1995);

(Bruner 1972) that is valuable to the development of individuals (and the evolution of a field's theoretical understanding of a developmental phenomenon [Gómez, 2015]).

- In agile software development: practices evolve from "ad hoc" to "continuous improvement" (Fontana et al., 2014).

Proponents of maturity models such as these believe that maturity is comprised of "tightly defined, repeatable, and predictable processes [that] directly contribute" to capable behaviour (Pasian, Sankaran, and Boydell, 2012, p. 147). As such, these models can be used to diagnose the current maturity of a person's (or organization's) current practices (i.e. the stage at which practice has stabilized [Pekkola, Hildén, and Rämö, 2015]), in order to understand their current standing relative to benchmarked competitors (Pöppelbuß, Niehaves, Simons, and Becker, 2011; Rašula, Vukšić, and Štemberger, 2008).

The predictability of developmental behaviours enables maturity models to be diagnostic. It also enables the prognostic claim that maturity models can improve the likelihood of success by outlining areas of focus that will progress one toward excellence. This they do by identifying areas of consensually-defined weakness (or "fragility" [Killen and Hunt 2013]) that hinder optimal functioning (Pekkola, Hildén, and Rämö, 2015). As such, maturity models offer the promise of facilitating planning, guidance, and control over future performance by outlining achieved characteristics to be reinforced, and prescribing the characteristics of more mature stages as areas for prioritized development. "Organizations regularly invest in capability development; the capability maturity model aims to provide valuable guidance" in targeting investment (Killen and Hunt, 2013, p. 146), in such a way as to strategically exploit existing capabilities and explore potential ones (March, 1991). Description and prescription lie at the heart of the maturity model's purpose and promise.

VARIETIES OF MATURITY MODEL

A variety of groups have made claim to understanding maturity and codifying it. Carnegie Mellon University, for example, developed a model for the Hewlett-Packard Consulting company's adoption (Rašula, Vukšić, and Štemberger, 2008). Sabre Airlines, an air traffic control and reservation booking technology firm, has developed an in-house maturity model (Fontana et al., 2015). Maturity models have been built based on analyses of human and business processes at work in companies such as Nokia in Finland and British Telecom in the U.K. (Pöppelbuß et al., 2011). In each instance, maturity is defined in terms of a particular application or domain of human activity, ranging from innovation-generating situations such as project management (Pasian, Sankaran, and Boydell, 2012), the collaborative development of new computer software (Pekkola, Hildén, and Rämö, 2015), and the ability to leverage Big Data (Comuzzi and Patel, 2016), to routine organizational operations where effectiveness-enhancing actions such as practices of reflection are said to signify and enhance an organization's functioning (Pekkola, Hildén, and Rämö, 2015). Originating from these different sources, and oriented toward different fields of human endeavor, what all of these maturity models have in common is the intent of formalizing and institutionalizing particular knowledges, skills, behaviours, values, and practices considered fundamental to effective (i.e. mature) modes of operating in a particular context. The different contexts of human activity of interest to maturity modelers gives rise to a variety of characteristics, briefly surveyed below.

Maturity models aim to provide users with conceptual schemas for understanding how maturity is multifaceted in nature. Language used here includes "pillar factors," "dimensions" and "axes" Domingues, Sampaio, and Arezes, 2016), "structural components," "phases," "key agents," and "externalities" (Röglinger, Pöppelbuß, and Becker, 2012), drivers" (Fontana et al, 2014), "input competencies" (Skulmoski 2001), and the use of particular "tools" (Pöppelbuß et al., 2011). Models can vary widely in the granularity with which they conceptualize these elements and their varied permutations. The degree to which models claim to be "tools" seems related to whether or not they portray maturity as a state resulting from tangible, measurable factors conducive to quantitative measurement by Likert scales, or intangible factors better suited to qualitative description (the latter ranging from models using broad-based qualitative descriptions to those utilizing description management theorists would characterize as "thick" or "rich" (Mintzberg, 1979). The ambition of some maturity models is to elucidate differing modes of behaviour with respect to maturity, each useful in their own right. They describe clustered themes of human capabilities and actions enabling users to conceptualize the way they are functioning contrasted with other, qualitatively different ways of functioning.

The ambition of other models is to rank various modes of functioning with greater or lesser value or desirability. Gradations are a feature common to such maturity models. They take on the project of identifying a range of human capabilities and behaviours, and locating each in terms of its proximity to what designers understand as a state of maturity, thus creating a representation of distance and nearness to that state. Such models vary greatly in complicatedness – typically involving four or more levels (depending on whether or not stage zero is accorded any merit [Domingues, Sampaio, and Arezes, 2016]), each model including distinct components, dimensions, behaviours, or capabilities ranging from a few to upwards of 75 (Killen and Hunt, 2013). Such models are said to describe an ordered arrangement of levels, each understood as prerequisite to the next step along a singular evolutionary pathway oriented toward optimal performance/matureness (van Looy, de Backer, Poels, and Snoeck, 2013). Users of these models can identify their location along the path via rating keys, or in some cases, exemplar situations given to represent how behaviour at each stage typically looks.

Developmentally-oriented maturity models have an explicitly forward-moving telos, clarifying the meanings of aspirational states such as *superiority*, *mastery*, and *excellence*.[4] Where forward-moving progress is the aim, maturity models vary in the degree to which they explicitly assist users in advancing their path. Some models focus on within-stage characteristics, clarifying in sometimes great detail each level, they facilitate progress only indirectly by merely naming the subsequent stage to be achieved ("benchmarking models" are examples of this [Pöppelbuß et al., 2011]). Developmentally-oriented models take a more active and direct role in facilitating users' progress, describing specific constraining forces that account for limited functioning (i.e. explaining why one is at a current level of maturity and not a higher one), and conversely naming specific drivers, or enabling factors, that would facilitate movement to each next stage (Fontana et al., 2014).

While maturity models invariably describe different stages of maturity, fewer make claims to have uncovered the mechanisms of movement necessary to ascend between stages. Models differ in the claims they make to be descriptive of different states of maturity, comparative of

[4] Others models focus differently, communicating standards of minimum performance to be achieved in different parts of a human system (Skulmoski, 2001) by articulating gradated meanings of "competence."

modes of maturity exhibited by different people, or prescriptive of what actions to take in order to better one's level of maturity (Röglinger, Pöppelbuß, and Becker, 2012). Thus, maturity models present themselves for two distinctly different purposes of use: (1) understanding how one operates, and (2) directing how to change that in favour of different, more useful ways of operating.

A final variance in existing maturity models is worth repeating. Few models of maturity portray it as context-free. Indeed, maturity itself is generally defined in terms of one's skillful engagement with contextual factors. Hence, most maturity models identify key contextual factors pertinent to users, and provide descriptions of how effective engagement with those factors should look at each level of maturity (Mullaly, 2014). Depending on the model, an array of environmental factors gets highlighted as central to the development and display of maturity, including customers or audience, organizational culture, leadership dynamics (Pasian, Sankaran, and Boydell, 2012). Each are exigencies that demand a person's consideration if one is to perform at mature levels.

CRITICISMS

Fundamental to mental models' raison d'être is the claim that adoption of a maturity model will translate into actual value for individuals or organizations. It is not clear the degree to which these models deliver on that promise (Mullaly, 2014).

For a maturity model to make any claims to efficacy, there must be comprehensible underlying theoretical constructs and mechanisms of action. Central to the matter concerning maturity models is the assertion that concepts called *best practices* exist, and that the assumptions and conditions necessary to attain them are clearly understood. That *maturity* is the state necessary for this attainment is insufficient; models claiming to address maturity should present a well-developed characterization of the construct. Unfortunately, "the central term of maturity is seldom defined explicitly," despite the growing number of entrants into the maturity model field (Röglinger, Pöppelbuß, and Becker, 2012, p. 338). It is unsurprising then, that questions have been raised about how accurately maturity is being codified (Mullaly 2014), how effectively it can be measured (Fontana et al., 2014), and whether the claims of its existence in hierarchical structures are representations of reality that are unneccesarily rigidified (Killen and Hunt, 2013). Undoubtedly, maturity is a complex phenomenon involving many intricately-related factors. As systems science has demonstrated, the interactions among factors is central to understanding complex phenomenon. Theorists and developers of maturity models have been criticized for having "not adequately considered" such interactions in developing the maturity construct and developing models that claim to account for it (Killen and Hunt, p. 137). To *best practices* and *maturity* itself, we can add notions of transformation to the list of under-theorized aspects of maturity models. The allure of these models is the idea that they help a person or organization achieve ever-greater levels of maturity. Models vary in characterizing this transformation as *change*, *development*, or *evolution*. Surprisingly though, the mechanisms of action driving such transformations toward the much-desired maturity goal are little understood. From psychology, for example, "Observed relations between stages of moral development and various forms of social conduct do not establish that the structures of moral reasoning that define stages of moral development exert a significant causal impact on moral behaviour" (Krebs, and Denton, 2006, p. 672). In the field of business process management, dynamics that generate movement among stages seem even less well understood: "All models implicitly expect organizations to eventually reach the top of the maturity ladder" (Röglinger, Pöppelbuß, and Becker, 2012, p. 339), reflecting little understanding of the processes by which this end state is to be reached. Where mechanisms of action that drive the maturation process are described, authors argue that these – and not others – are to be followed. This has the effect of discouraging alternative approaches, and rendering the modes of thinking used by all but a particular "mature") segment of people "deviant and atypical, rather than reasonable and relevant" (Mullaly, 2014, p. 172). For example, this author and others have discussed this in the project management discipline's critique of its own attempts to codify best practice, and the means by which it is to be attained (e.g., Buckle and Thomas, 2003; Thomas and Buckle Henning, 2007; Thomas, George, and Buckle Henning, 2012). Enthusiasm for the idea of maturity models notwithstanding, a slipshod approach to building a solid theoretical infrastructure has left such models open to justified criticism.

Maturity models are particularly vulnerable in this respect: the literature generally agrees that maturity models do a good job of describing various degrees of maturity; but where models claim prescriptive insight, they often fail to meet users' expectations. We see this disappointment in claims that maturity models are oversimplifications of the real-world complexities that users face (Pöppelbuß et al., 2011), presenting optimistic messages that maturity is a state eventually, inevitably reached – yet vague on the details of how this actually occurs (King and Kraemer, 1984). Where such details are forthcoming, maturity models attract criticism that the attention they do give to movement between maturity stages is vague, in the manner of "step-by-step recipes" (Röglinger, Pöppelbuß, and Becker, 2012) that don't work. Conversely, some model designers eager to avoid this criticism develop models so complex that they likewise fail to provide the promised rewards (Killen and Hunt, 2013). Too simple or too complex, if maturity models are to achieve fitness-of-use, the complexity of the frameworks they offer must appropriately reflect the needs of users. Likewise, the prescriptions they offer must fit the resources available to organizations. When models are too costly to adopt relative to the rewards they claim to offer, no one wins. When they rigidify the maturity pathways they espouse, organizations whose problems and environments differ from those envisioned by model designers are left to try force-fitting their way to maturity, usually unsuccessfully, or to customize them in ad hoc ways that may also fail (Killen and Hunt, 2013). Describing levels of maturity is relatively easy. Recommending pathways by which it is to be developed demands considerably greater attention to real-world impediments to mature behaviour, the difficulties involved in overcoming such impediments, and the concrete need for feasible, flexible guidance that works.

"What works" is, of course, a matter of evidentiary support, and here is where the most damning critiques of maturity models focus. The increasing numbers of maturity models suggests growing eagerness for authoritative insight and expertise on how people in widely varying jobs can operate more maturely; this enthusiasm has, however, been unbalanced by actual scientific study to validate such claims. Despite the intuitive appeal of maturity models and anecdotal confirmation that they are useful, research that actually studies their rigor, validity, or usefulness in correlating model prescriptions with actual success is scarce (Tarkan, Turetken, and Reijers, 2016). When enthusiasm outweighs empirical evidence, the value of a particular model, and maturity models in general, is called into question.

The criticisms that maturity models face are fundamental and appropriate. If such models are to achieve what they set out to achieve, academic communities must undertake serious reflection about the characteristics of maturation to replace the vague belief that it is associated with development in a good direction. For this reason, scholars in fields such as information science have called for the development of research standards for model designers (Pöppelbuß et al., 2011). Despite the warranted misgivings, there are models that are believed to be relevant and worthwhile: "Certain maturity and competency models might be robust enough to become the global standard for certification purposes" (Skulmoski, 2001, p. 11). The possibility that maturity models can stand as international standards of how effective functioning can be measured and developed has inspired this brief literature survey. And it is in service to the IFSR's interest in improving and promoting systems research that the potential for a maturity model of systems research competence is under consideration here.

DESIGN CONSIDERATIONS FOR A MATURITY MODEL OF SYSTEMS RESEARCH COMPETENCE (MMSRC)

Were a Maturity Model of Systems Research Competence (MMSRC) to be developed that would be relevant and worthwhile to the international systems research community, we would do well to glean lessons from experienced modelers and theorists, as discussed above. I turn my attention now to highlighting key considerations the IFSR should address in any future initiatives to develop competence models for systems researchers.

Consistent with the move underway to codify the nascent science of systemology (Rousseau et al., 2016; Rousseau et al., 2018), this author agrees with arguments against maturity models which rely solely on anecdotal assertions. As Edson and Metcalf (2017) have written, good systems research responds to the need to marry scientific discernment with lived experience. Any research initiative to establish a model of systems research competence must consider this. Any model that describes levels of maturity solely based on anecdote will fail to meet the rigours of good science, and will run the risk of misleading systems research practitioners who trust them. There is irony in the fact that most maturity models claim that one cannot skip steps on the path to mature standards of competency, while modelers in most disciplines have skipped the crucial step of empirically validating their own models! Without such validation, claims that experts understand the nature of systems research maturity and that the systems community should measure itself by those claims would tread on shaky ground. Thus, the IFSR has a key role to play in advocating for the development of a maturity model with an explicit theoretical base.

From the outset, a maturity model of systems research competence must define central constructs like *maturity* and *maturation*, and must identify observable indicators of the various maturity levels and the characteristics of paths that lay between them (Röglinger, Pöppelbuß, and Becker, 2012). There are theories of human development in cognitive psychology that could inform a theory of systems research competency maturation; educational theories that could inform understanding of systems research skills development; convergence and divergence theories that could help explain path dependencies among maturity levels. van Looy and her colleagues (2013) have pointed out that theories of bounded rationality and information symmetry can inform understanding of how actors at varying levels of maturity make decisions and exert agency in ineffective (i.e. immature) and effective (i.e. maturity-building) ways. Implicit throughout this paper has been the assumption that maturity models focus on the maturity of individuals. Many do. It is also the case that some models focus on the maturity of organizations with respect to their competency in business processes, project management, agile software development, etc..

Were the IFSR to develop a maturity model of collective competency in systems research, organizational theories could be of use in developing maturity models for organizations in which systems research takes place[5] (Pöppelbuß et al., 2011): the resource-based view of the firm (Wernerfelt, 1984) has been mentioned earlier as a theory useful for conceptualizing knowledge and skills as organizational assets; organizational change theory (Van de Ven and Poole, 1995), life cycle theories, and teleological theories of goal formation and implementation (Lee and Kim, 2001) can help in theorizing the development of organizational capabilities in systems research. The systems research community has at its disposal numerous theory candidates that can assist in the development of sound maturity models for both individuals and groups.

Building on a solid theoretical base, all the strategies and methods demanded of good systems research (e.g., Edson et al., 2017), should be applied to any initiative to develop a systems research maturity model. This must include particular care to rigorously differentiating relationships of inference and causality (Edson and Klein, 2017) that can help the systems research community avoid the criticisms leveled at maturity models in other fields, whose claims about what actions can reliably move one to greater maturity rely on scant empirical evidence, or none at all.

In any scientific endeavour, care must be taken to avoid universalization of findings from one instance to all conceivable contexts. Röglinger, Pöppelbuß, and Becker have noted that maturity models often don't translate well in all situational contexts their users face (2012). Maturity models have struggled to account for the idiosyncracies of the problem spaces in which users work. Differences in the size of projects, technical complexity, and organizational culture greatly affect the work people do, and the ways they do or do not develop maturity (Skulmoski, 2001). In particular, work that demands unique processes are hard for maturity modelers to predict and take into account. This makes it difficult to imagine the kinds of skills and behaviours to be called forth from users, which makes it difficult to legitimize certain skills and behaviours as exemplars of maturity (Pasian, Sankaran, and Boydell, 2012). While it is problematic to overstate the number of settings to which a maturity model should apply, so too is it problematic to prescribe qualities – in the name of maturity – that implicitly privilege a too-narrow number of people based on moral typologies (Walker and Pitts, 1998) or gender roles (Wark and Krebs, 1996), etc..

A case can be made that the discipline of systemology is uniquely well-placed to develop frameworks that *can* be generalized in rigorously defensible ways. As Midgley (2000) and others have written, a strength of the systems community is the way it encompasses a very diverse collection of perspectives, priorities, and tools. But since the caution against overgeneralizing applies also to systems science endeavours (W. Varey, personal

[5] I include the academic systems sciences community itself as an organization here.

communication), one could conclude that any initiative to develop maturity measures for systems researchers would require different models for every one of the widely differing systems approaches. Recently, however, Hammond (2017) reminded us about the origins of the modern systems movement as being motivated by the desire to identify patterns common across the boundaries that commonly divide academic inquiry. (A central text in the field does, after all, characterize the movement as a quest for a *general* systems theory [von Bertalanffy, 1968], and the International Society for the Systems Sciences was established "to foster the investigation of the analogy or isomorphy of concepts, laws, and models in various disciplines and professions" [http://iss.org/world/administration/bylaws].) Further, this author has argued that certain perceptual and behavioural competencies are common across all systems research traditions and methodologies (Buckle Henning, 2017). A credible case can be made that a unified maturity model of systems research competency is possible. In its creation, designers should be aided by the important contributions of systems theorists who have contributed to our field by calling for implicit biases to be surfaced and critiqued in systems work (e.g. Stephens, 2015; Ulrich, 1983). For a maturity model of systems research competencies to be ethical and effective, such biases must be a focus of attention.

Other characteristics of good maturity models would serve the systems research community well. User-friendly design is important. Systems researcher operating in different cultures and problem domains should have assessment tools that are accessible and comprehensible. Röglinger, Pöppelbuß, and Becker (2012) have stressed the importance of well-structured and easily applicable self-assessment tools. Netland and Alfnes (2011) have advocated for tests that are "quick." Domingues, Sampaio, and Arezes (2016) have pointed out the usefulness of models that include templates and checklists for users to collect evidence and artifacts of competent activity at each level of maturity. Should the systems research community computerize its maturity model, it should feature intuitive graphical interface and easy report-generating capabilities aligned with principles of good software design (Domingues, Sampaio, and Arezes, 2016). Should the systems community choose to go beyond a descriptive model to evidence-based recommendations on advancing one's level of systems research competency, "relevant drivers and best practices for a roadmap to [increasing] maturity" (Fontana et al., 2014, p. 141) in systems research should be provided in concrete, actionable language that is commensurate with a level of granularity suitable to each maturity level (Röglinger, Pöppelbuß, and Becker, 2012). An emphasis on pragmatic tools, technology, and developmental plans for a maturity model of systems research competence would have the effect of meeting systems researchers in their lived experience, while providing transparency about the qualities and components believed to be indicative of competent skills and behaviours at each stage of systems research maturity (Röglinger, Pöppelbuß, and Becker, 2012).

It is worthwhile to remember critiques that maturity models imply that adhering to particular schemes of behaviour, using uniform techniques, and idealizing certain decision-making strategies can automatize and guarantee sure progress toward maturity (e.g. Krebs and Denton, 2006). This trivializes the situational complexities users face, and would certainly do systems researchers ill service. It is axiomatic that systems researchers grapple with systems that are messy – wicked, even (Churchman, 1967; Rittel and Webber, 1974). The grappling would be no less for those attempting to develop a maturity model for competencies relevant to systems researchers working in complex contexts. Competent systems research cannot be routinized; the very nature of systems work defies this possibility. Mature systems researchers are keenly aware of the ways the systems they study are interdependent with the environment, and aware of the ways in which they themselves are likewise interdependent (VonFoerster, 2003).

The competing forces of unity and plurality that are central to the systems movement are mirrored in the very structure of maturity development evident in existing models. Every model presents its maturity stages as comprised of multiple interacting factors. Those factors include knowledge, skills, and metacognitive abilities (Pekkola, Hildén, and Rämö, 2015); they involve an interplay of cognition, emotional development, moral development, and decision-making capacities able to resolve increasingly difficult psychosocial conflicts (Wikipedia.com - "Maturity"). In other words, any single stage of maturity operates as a system of many interdependent elements. Maturity models argue that people pass between stages of maturity; in other words, that maturity systems are complex, involving dynamic interactions unfolding in ways that can shift a person into progressively more mature levels of functioning – i.e. the development of maturity is a phenomenon involving the emergence of successively higher orders of coherence.

"A static or prescriptive model of maturity cannot hope to provide the level of guidance that organizations require in making effective choices" (Mullaly, 2014, p. 181). Similarly, "The development and refinement of a [theoretical] constructs is an ongoing process that requires attention to clarifying the constructs' definition and parts" (Clark and Watson, 1995). The work of developing a maturity model for competent systems research must be iterative. Research design for the maturity model project should be both rigorously planned and intentionally modified throughout the research life cycle (Sankaran, 2017), acknowledging that systems research is a circular process that builds upon previously obtained knowledge[6] and responds to experience gained through the course of the study (Edson et al., 2017). The project of developing a maturity model for systems researchers ought to proceed as would any sound systems research initiative. Careful attention should be paid to problem structuring (Edson and Klein, 2017). How the research problem is framed should be adjusted as the project unfolds and participants reflect on what they are learning (Mingers and Rosenhead, 2004). Central to the development of a maturity model for systems researchers would be identification of critical success factors – education, knowledge networks, use of systems tools and techniques, conducive organizational climate, and the support of leaders are all factors identified as conducive or obstructive to maturity in other domains of knowledge work (Rašula, Vukšić, and Štemberger, 2008). The relative contribution of these and other factors would need to be evaluated (Skulmoski, 2001), enabling us to clarify the nature of maturity as it pertains to systems research.

CONCLUSIONS

The 2016 Systems Research Team at the IFSR Conversations meeting recognized that if we are to work to develop a more systems-literate world, members of the systems community working in many different roles must participate. In each role, particular systems competencies must be brought to bear, and those competencies will vary in maturity within each person. Learning

[6] The maturity model articles cited throughout this paper provide many good examples of research methods used in developing and refining maturity models in a variety of fields.

theory tells us that experience in doing something does not translate into maturation unless we reflect it against our existing understandings and assumptions (Pekkola, Hildén, and Rämö, 2015). Thousands of intelligent, committed systems researchers have contributed their expertise to pressing world problems for decades now. Are those experiences maturing into increased competence in the practice of systems research? This is a matter for thoughtful consideration, at both individual and community levels.

In several industries and academic disciplines, maturity models have been a way to address the question. A maturity model for competence in systems research would be a difficult undertaking. The number of situational contingencies and mediating factors one typically encounters in systems research is extraordinary to consider. Identifying the competences that actually contribute to research success is no easy matter, as scholars working in other fields have discovered. Navigating the tension between a maturity model's formality and flexibility is a genuine challenge (Killen and Hunt, 2013). Beyond these, engaging in critical self-reflection – which lies at the heart of maturity assessment – opens the very real possibility of unexpected and possibly uncomfortable discoveries (Pekkola, Hildén, and Rämö, 2015). A maturity model for competence in systems research would be a formidable task, but this is not to suggest it ought to be a task left undone.

The task ahead would need to begin by developing clarity about key concepts: What is immature systems research? What does mature systems research look like? What competences contribute to maturity in the systems researcher? By what means could these competences be measured? How do researchers translate systems knowledge into effective systems research skills and behaviours? In what ways do systems research competences stabilize (i.e. what levels of systems research maturity could be said to exist)? How does one develop from one level of maturity to another? What are the relationships between competent use of systems research knowledge and skills and successful research outcomes? Once we develop answers to fundamental questions such as these, the work of clarifying, refining, and enhancing the maturity model would be ongoing – cumulative work that scholars in many disciplines have struggled to do well (Röglinger, Pöppelbuß, and Becker, 2012). Empirical studies to establish the validity and usefulness of the model would be crucial, particularly with regard to its ability to accurately predict and guide ways of increasing maturity to greater levels of effectiveness (Tarkan, Turetken, Reijers, 2016). If a maturity model for systems research competence is to be worthwhile, its accuracy and applicability must gain widespread acceptance among the systems sciences scholarly community and systems practitioners alike.

In all this work, the IFSR's underlying premises for creating a maturity model for systems research must be clarified and kept at the forefront. Those premises are yet to be determined. However, some broad-based possibilities can be mentioned here. Those of us who participate in international systems organizations share a vested interest in contributing to more accurate understanding and effective solutions to systemically complex problems. Systems research, we believe, is central to that aspiration. Systems research involves unique human competencies. The competence people show in conducting systems research varies in maturity. Competence in systems research is a developmental process, and can progress beyond ad hoc approaches typical of new systems researchers. The profession of systems research, and the constituents we serve, would be better served if our community could clarify the competencies and skills universally necessary to doing good systems work. This would legitimize systems research competence and differentiate them from those involved in other kinds of research, enabling recognition of the unique contributions of systems research. In a variety of settings, the particular approaches, intelligences, and knowledge domains associated with systems research would come to be better recognized and valued. With this increased profile, the systems sciences community could, if it so desired, follow the footsteps of systems engineers and systems software designers and form professional associations, with the professional development, standards development, and certification programs such associations can provide (Skulmoski, 2001). The IFSR Systems Research Team set the charge for a maturity model for important reasons – development of the field, increase in the value it can deliver to pressing world problems, and strengthening its legitimacy as a branch of science of equal merit to other established disciplines.

A model of systems research competence could contribute considerably to our understanding of the work we do. Generating such a model would engage the systems community in important dialogue about the sociocultural and political realities that impact effective systems research. The unanalyzed processes of "adaptation and negotiation within organizations" that impact systems research would be surfaced (Pekkola, Hildén, and Rämö, 2015, p. 19). The ways in which competent systems researchers secure budgetary support, the way their research gets measured, and the way they generate lessons for the future would be important areas of discussion in assessing the factors that contribute to the development of systems research competence. The ways in which systems research intellectual capital is or is not transferred to others within organizations and communities would need to be addressed (Rašula, Vukšić, and Štemberger, 2008); the impact of mentor relationships on the maturation of systems research competence could be investigated. A systematic process of collective reflection about factors such as these would clarify important situational contingencies that mediate the development of maturity in systems researchers.

Greater understanding about the work we do as systems researchers cannot be gained in social isolation. A maturity model of systems research competence would make transparent the assumptions underpinning current understandings about what constitutes mature research behaviour in our discipline. It would facilitate the scientific imperative of enabling assumptions underlying a maturity model to be intersubjectively verified by scientists and practitioners. It would mobilize the sharing of interpretations about the research practices our community espouses. A maturity model for systems researchers would become a shared analytical lens through which our community understands and judges the competent use of systems science knowledge, skills, and behaviours. It would, thereby, act as a force for community identity-building, with the potential to substantially affect the impact that systems researchers can make in the future.

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