Project Management Fractals: Position Paper for Curriculum Integration

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Abstract: This position piece, based on 30 years of teaching, argues for incorporating the notion of fractals into project management education to create business-ready graduates who can tailor a project process method to the project. By looking at the project in smaller pieces (fractals) and the relationship between those pieces, practitioners can achieve a deeper understanding of the project without being overwhelmed by its complexity. Project management pairs well with fractals because of its interdisciplinary nature—the idea of fractals in project management incorporates application of numerous business disciplines, creating graduates who are comfortable with both theory and practice.

1 INTRODUCTION

This paper is an opinion piece based on 30 years of teaching project management to executives, professionals in the discipline, and graduate and undergraduate students. During this time, we have worked with the different project methods and followed the PMBOK by PMI as it transitioned from a skills-based platform to a seminal certification of practitioners. The central narrative has been to define methods such as the process-based method (Waterfall) and other methods under the Agile umbrella (SCRUM, KANBAN, Extreme Project Management, etc.). Three of these methods—Waterfall, SCRUM and KANBAN—are the primary methods used in curriculums to teach project management. They all teach project management as a system, but we believe that they do not get at the common fractal and interconnectivity by which

students can understand the commonality of all the methods and thus be better prepared for its implementation in business. We believe this method of a project management fractal builds all versions and methods of project management clearly and simply, making them more accessible for business curriculum integration.[1]

2 DEFINITION

A fractal is a geometric figure wherein each part of the whole has the same characteristics in a never-ending pattern of various size (Oxford, n.d.). These patterns are common in natural systems (e.g., snowflakes and tree branches) and can be extrapolated into organizational processes. The fractal we are working with in this paper is the relation of a task and its predecessor relationships.

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[1] This position paper is intended for practitioners training new recruits and for instructors in business schools preparing graduates to be team players and future practitioners of outcome-based business applications. Although not a research paper, the piece addresses the

notions mentioned in the keywords and complements the research classified below. JEL Classification: F60; G31 and G41; M11 and M16

Knowing some simple rules, we can build even the most complex projects and define the right project management approach.

The narrative of fractals becomes important to the field of project management because the Project Management Institute has put forth its concept of project tailoring in the newly released Project Management Book of Knowledge (PMBOK 7) in the fall of 2021. Tailoring is the act of the project manager and team assessing the right methodology for the project solution. We agree with PMI that tailoring is key to project success, but we believe it must be done at the lower level of project design. This does not mean the project must be totally fleshed out; however, it does mean the practitioners must consider time, risk, constraints, and cost at the task and predecessor level. The execution of these elements drives the project methodology.

3 POSITION

Our observation is that most students and unsophisticated practitioners do not fully understand the need to proactively manage a project method or process. Most of their experience has been approaching projects as a loose set of actions, where they do not see the impact of the project on the programs, cost/revenue effort, and client satisfaction. Often, the established way of teaching a project system does not fully appreciate the effort to implement a project, and upon completing the course, many attendees may fall back into their old ways of control and working a series of tasks rather than a system of outcomes. Our position is that fractals will alter and improve the established way of teaching by defining micro actions—task analysis—that help identify congruences between tasks, and the connection between a task and its predecessor. We believe this will allow project management students more clearly grasp what they are trying to execute.

Most instructors define curriculum by focusing on the set of outcomes projects are to deliver. The basic process of deconstructing the problem or requested delivery tends to revolve around setting a definition for the scope of work, identifying who will be doing the work, defining a timeline, assessing a cost, then managing a team and the associated risks. The pros for this method are 1) project managers try to lay out the whole ecosystem of the project so participants clearly understand their charge and role to create a successful set of deliverables, and 2) the process leads to well-defined statements of what needs to be done. The cons for this method are 1) it takes time to create

well-defined actions to execute and has become costly and cumbersome, particularly in a venue where time is a factor in getting to clients before your competitor, and 2) the lack of clarity causes risk and liability through errors.

We propose that instructions go down to the task level to talk about what is common to all methods and how that basic process is tweaked to create the different project management approaches. The element of the basic fractal is the notion of a dependent task and its predecessor task and some constraints that must be understood to grasp the different approaches to project design. In the recently released PMBOK 7 (pgs. 131-152), PMI calls this "tailoring." We believe the PMBOK does not get into what is tailored at the elemental level. We feel that some constraints of our fractal narrative need assessing time, relationships between the dependent and predecessor task, and the associated risks that emerge as time and dependencies change. We will use the Waterfall and SCRUM methods to show how the project fractal can help practitioners and students work in a task-oriented way to build their comfort with project systems and methods, and how to choose (tailor) their project process more comfortably for the desired outcomes.

Focusing on the task level of the project minimizes oversimplicity and ambiguity. When dealing with projects, having a goal to complete a system or series of processes drives practitioners to be uncomfortable. Yet, the reach of understanding what is happening on a task level and how it happens is digestible. Allowing practitioners to focus on a subsection and its viability allows them to put the pieces together into a larger whole. As they pull the project subtasks together, they can again look at how a subcomponent relates to other subcomponents for internal consistency. This induction of fractal relationships makes the deduction of projects from summary task to subtask to lower-level subtask produce congruency between project methodology and project viability. Knowing the structure of the relationships at the lower level of the project plan based on time, resourcing, and constraints can change the level of effort to plan and design the project process.

Based on teaching experience, we will provide evidence "discipline by discipline" for how to apply fractals as a tool for curriculum integration. This will allow educators of different expertise to focus on how their subject matter can be taught and integrated into the project process plan.

4 SECTION 1

4.1 The Interdisciplinary Attributes of a Course in Project Management

Most programs have an interdisciplinary capstone course that brings together siloed topics (Rhee et al., 2014; Magnanti & Natarajan, 2018; Munroe, 2016), but a review of literature revealed that the concept is rarely found bringing together the various disciplines within business. The purpose of an interdisciplinary course design in Project Management specifically is two-fold: it is a useful tool for students to combine their knowledge of business disciplines, and it brings theory into practice (Mazzetto, 2016). Calling upon the interdisciplinary subjects in business education, projects can be thought of as planning and executing problem solutions. Once the project is successfully executed and the deliverable emerges, the project ends, though the deliverable can continue. The dominant way project management is taught is through a Waterfall or Agile (SCRUM) model. We are going to drill down into the Waterfall and Agile methods to show how fractals can be used.
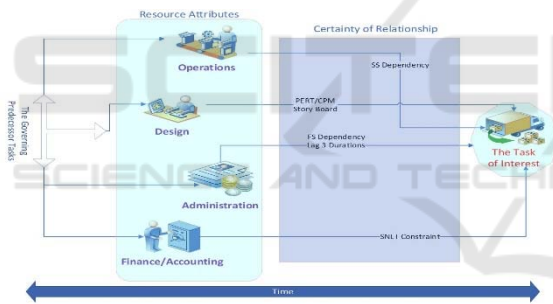

Figure 1: Basic Fractal of Project Management.

Time can be a major indicator of whether the project methodology should be Waterfall or Agile. Waterfall allows more time to explore the relationships between tasks, meaning more time to comprehend potential setbacks and risk in the project design. Understanding these relationships between tasks can provide stakeholders and clients with more comfort that the outcome is well understood, and the project is quite deterministic.

Should the PM need to execute the project swiftly ("ready, fire, aim" syndrome) and not dwell on the accuracy of the relationships between tasks, recursive or Agile project planning may be the best approach. The focus is to get moving and fail fast (Accardi-Petersen, 2011), then redefine the next set of actions or tasks based on the interim learning. This presupposes that cost is not a major driver; rather,

strategic impact and the imperative to get something done are the key criteria. With Agile, connection between tasks is not well understood or is very fluid, so clarity in the task relationships is not essential. Essentially, perception of motion and action is preferred over plotting and planning. Watching someone plan does not leave participants feeling the work is getting done. Actual physical motion and engagement of stakeholders produces the feeling that time is being spent productively.

The KANBAN method is very useful in helping students understand the relationship between task and the completeness of work being planned. Students, sponsors, and faculty can work on a simple high-level understanding of the project work while also learning the potential relationship between a task and its predecessor. While exploring the basic level of task relationships, the KANBAN method allows for group interaction to occur in defining the relationships of task with potential predecessor tasks.

Figure 2: KANBAN - Project Status Tool.

KANBAN is great for a project icebreaker in that students can start thinking about project definition without spending much time on the complexity of the relationships, scheduling, and resourcing. We have observed good team-building moments as the students work together orally and spatially trying to convince each other what is being requested. The natural flow is towards a much richer effort using the Waterfall or SCRUM methodology.

The Waterfall fractal approach begins with a plan and a good idea of the end goal. The essence of the project's logic is the basic relationship between the desired project conclusion and the summary task (top level) required to execute the project based on the process approach. The practitioner studies and constructs how the predecessor summary task feeds into the final project outcome to produce with greater certainty the desired deliverables. Looking at each summary task, defining what summary task proceeds it, and identifying the relationship between the tasks clarifies the appropriate way to succeed at the project

outcome. Interactions between task dependencies, task constraints, calendar scheduling, unit costing, and risk assessment produce an in-depth understanding of how the predecessor task influences the task of interest. The more certainty of this relationship required, the more the time constraint expands. It requires the team to spend time investigating the internal connections between the tasks, and if you are traveling from the earth to mars, those internal relationships are crucial. If human lives are at stake, you want clarity in the outcome, not quickness to completion.

Figure 3: Process Based Approach – A Waterfall Approach.

Agile, becoming extremely popular, experiences far more changes in the process to the deliverable and encourages a fail-fast mindset (Accardi-Petersen, 2011). Agile is useful in military campaigns because soldiers train to navigate a variety of scenarios because the outcome is not clear. Business examples of Agile are software development, medical devices, bioengineering, and many areas of cutting-edge technology.

The Agile method can be incorporated into the curriculum to demonstrate the impact of uncertainty and continual changes in requirements on the project and practitioners. The fractal elements are the same as in Waterfall, but the focus is on the ability to redefine the task of interest as the predecessor task changes based on changing requirements from the stakeholders in the project. Because the requirements are fluid, so are the relationships between tasks. Therefore, focusing on relationships is an inefficient use of time. Agile's guiding force is the willingness to iterate the project task until a minimal viable outcome emerges that all the stakeholders feel suffices as success. Focusing on outcome flexibility removes the constraint on cost, resources, and schedule and introduces a different type of risk—a lack of flexibility to modify. Should the internal relationships become more important than the ability to change, Agile becomes less attractive. The notion of the daily scrum allows flexibility to change the predecessor task, thereby redefining the project into very small-time increments. The project team must be very comfortable with uncertainty, which most students and practitioners are not good with. So, teaching Agile is teaching not just failing fast but also

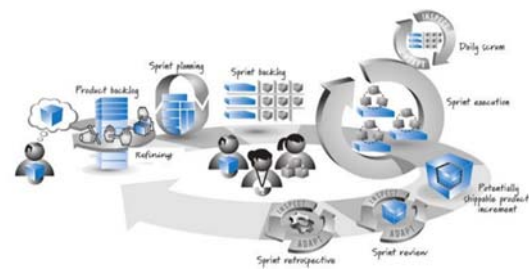the unnatural behaviour of working without clear direction.

Figure 4: Agile (SCRUM) Methodology – Iterative.

Core to the two methods above is the tacit knowledge that all methods of project management are grounded in a basic fractal. The ways these fractals are netted together create different methodologies and, hence, different project culture. Project participants' understanding of the project management fractal will help the classroom deconstruct the work content of the project and will provide an inductive way to ensure the project process method can create a successful set of deliverables.

5 SECTION 2

5.1 Integration of Established Business Disciplines with the Attributes of Project Management

Now that the attributes of a project management course are laid out, let us see how certain established disciplines of the business curriculum connect with these attributes to educate business-ready candidates. In Section 2, we will provide examples of integrating the processes of project management from Section 1 with the disciplines of marketing, finance/accounting, operations, human resources, organizational behaviour, and leadership. This list is by no means exhaustive. It is a starting point for further, more meaningful possibilities of integration.

5.1.1 Marketing

The focus of marketing is customer need, customer expectation, and a successful response to the same. In project management, that focus is identifying the stakeholders—the customers to be served within the project—and understanding their impacts on the project design and outcomes.

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The marketing fractal focuses students on the role of the client or customer in the task effort. If the customer is clearly defined or crucial to the success of the activity, practitioners should spend time understanding the customer impact, needs, wants, and ability to influence the project outcome. However, if the customer is unclear and ambiguous, Agile may require less focus on needs planned and more focus on needs discovered during the project exercise.

5.1.2 Accounting/Pro Forma Analysis

Although successful in their class work, simply stated, most fresh business graduates do not know the importance of planning ahead using accounting and pro forma analysis.

The accounting fractal bears down on the cost and budgeting effort of the task. Should the task and the relationships between the tasks be crucial to the budgeting exercise or the cost control, practitioners should spend more time and effort discerning the go or no-go decision based on budgeting concerns. Should the cost not even be penultimate to the project design, then the focus on cost should be relegated to a concern but should not delay the project based on specificity. Cost can be assigned as the project is built and reiterated.

5.1.3 Organization Behavior and Leadership

The charter, a post pro forma document, is the authorization tool that states the assembled project is coherent, ready for kick-off, and validated by the organization leadership and sponsor. The charter contains commentary on the project's feasibility, initial team assembly, stated definition, scope to date, high-level cost, and leadership signoff. Here, students of management and leadership will learn that not all projects are valid. An in-depth fractal narrative of what is being done and where it's being done will help with organizational retention and use of project learning. Project validity and clarity up front will drive a Waterfall design and capture knowledge that can be used in project and post-project audits. If speed to execution and constant changing requirements are desired, then there will be less capture of the behaviors and leadership stories from an Agile method. Agile teams require practitioners who can work with lack of clarity in tasks and hold more tacit knowledge of the relationship between tasks; hence, this fractal design will need a more seasoned self-reliant implementor.

5.1.4 Operations Management

How do we effectively and efficiently deliver products or services? At the fractal level, this question manifests as an understanding of the constraints and assumption of how the task relate to each other. Must the task be executed at the same time? Do we have conditionality based on a best, most likely, or worst-case scenario? Elements of project management aid in learning to analyse and improve all types of processes, and they also show how to leverage statistics and technology to make informed operational decisions. The Waterfall fractal enriches the ability to discern the depth of relationships and dependencies between the tasks. Should the task be constrained to a lunar or financial constraint? Or does Agile assume the defined work can be done based on an organization's intellect and the process's ability to change? The more accuracy required in the task, the more we will default to a Waterfall approach. Agile presupposes those requirements are dynamic and will flow freely as we approach the daily scrum of the sprint cycle. Using Agile will heavily depend on insights into the relations, resources, and constraints amongst the tasks that will not be present in nascent practitioners.

5.1.5 Finance

The three main pillars of project management are scheduling, cost, and resources, and all three tie together. An impact on one affects all three. The fractal narrative around cost flows from the impacts of controlling and budgeting the project budget and defining their ROI annually. This is a constant battle between great predictions and uninformed cost entries from project participants to the cost control efforts. When a firm needs to focus on how well it is doing, plans that derive good cost from well-defined elements in the planning cycle matter. Waterfall works to clearly define the interactions between task and the drivers of cost that enable and hinder a good ROI. Because agility focuses on dynamic iterative changes in requirements and the relationships between those requirements, cost controls can only be best described as top-down in accuracy.

5.1.6 Risk

Risk is present, regardless of method. It comes in many forms, but there are three key forms of project management risk, cost, schedule, and resources. Teasing out relationships and dependencies as you craft the project introduces high potential for unknown relationships between tasks to emerge. Not

managing risk on the front-end means having to manage risk later. Using a Waterfall approach and identifying risk up front lowers the likelihoods of large pay-outs, cost exposers, resource misalignments, and missing customer expectations, thereby reducing significant potential penalties. For example, in a project that is putting out a computer, there is little cost to defining and mediating risk at the beginning of the project; however, letting that machine go to the client's shelf with unknown operational, reputational, and financial issues will exacerbate potential penalties. Risk is not a question of *if* but *when*.[2]

Risk management is a great example of the interdisciplinary aspects of the approach. The more we define the dependencies between the task, the clearer risks present themselves and the more we are likely to use the Waterfall fractal approach. Thus, teaching risk management is a far-reaching interdisciplinary web.

5.2 Soft Skills in the Project Fractal

5.2.1 Stakeholder Relationships between the Task Owners

Project managers need to understand their stakeholders' perspectives (Ewin, Chugh, Muurlink, Jarvis, Luck, 2021) so they can have clarity between the task definitions and the predecessor task relationships. The DEI (Dunn, 2020) influencers of organizational roles along with stakeholder ethnicity, age, gender, sexual orientation etc. can cause a misalignment between the task owners and their task outcomes. We have observed students culturally in conflict with their sponsors on task activities due to language, expressions, and perceived authority inherent in social norms and implicit bias. In some cases, students have incorrectly assumed a task definition due to their lack of work experience, yet they still challenged their sponsor ability due to social miscues. By focusing in on individual project fractals, the faculty, sponsor, and student can audit or explore their assumption whether they are sharing the same story or narrative between the task, thereby knitting a tight story through the project schedule.

5.2.2 Communications

How the dependencies and relations are communicated may also influence the dynamics between the task and its predecessors. Poor communication (Muszyńska, Marx, 2019) between team members via lack of documentation, poor software usage, or poor note taking may yield inaccurate task relationships and durations, thereby generating a misunderstanding of deliverables or project outcomes. When this poor communication is due to different student or sponsor needs for in-depth participation, we have seen a lack of trust in outcomes and quality of work. Teams with good communication skills, whether on face-to-face, Zoom, or phone, create a better sense of trust and responsiveness for a shared outcome and ownership in a quality learning experience. Students more effectively negotiate their roles and produce the desired level of work when they know how their parts make the task-predecessor relationship work.

5.2.3 Resilience

Understanding stakeholder emotions and their own needs, students have been observed struggling with critique and criticism of their work. This critique has frustrated and challenged their resilience (Magano et al., 2020). We have observed that students who understood the needs of other students working on a predecessor task felt more comfortable in their own work and seemed less stressed. Even when things went wrong in the relationships, schedule, or definition or work between the tasks, student seemed less frustrated or bothered when they understood what the other task impacts where on other students. Robust communications between the team members, sponsors, and faculty seemed to create more commitment to a good project outcome and less angst.

6 CONCLUSIONS

The notion of fractals, a simple and easy methodology, is available for curriculum integration. In today's business context, an interdisciplinary course design is imperative. In this piece, we have stated that a course on project management

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[2] This is the concept of "Pay Me Now or Pay Me Later," so the company either pays preventative money (costs associated with activities specifically designed to prevent poor quality in products) or appraisal money (costs associates with activities specifically designed to measure, inspect, evaluate, or audit products to assure conformance to quality requirements [CQE Academy, n.d.]).

incorporating fractals may well serve as one vehicle for interdisciplinary teaching. We found this to be successfully received through teaching at the University of St. Thomas in St. Paul and at the University of Bergamo in Italy.

Feedback from our prospective student employers reminds us that omitting a course like this in business education is encouraging failure by default—the program is not setting students up for success in both theory and application in the industry. Also, not clearly stating that project management requires tailoring the method to the project culture and design will create a systems approach not readily understood by the student, sponsors, and instructors.

We conclude the project fractal narrative will give students a tangible way to understand the content and help them see that integration at a lower level. When choosing the process method, students should know whether they are executing a well-defined, highly structured set of deliverables (Waterfall); whether the outcome is much less defined (SCRUM); or whether to use simple tools to show task completion (KANBAN). These methods are not in competition, but they are three different tools to complete a successful project, based on the ecosystem of the project. Instructors can create a curriculum based on an individual with seasoned project experience, or instruction can be knitted together with faculty of different disciplines doing their part and explaining how the project fractals work from their expertise.

We welcome contributions and suggestions from colleagues to demonstrate other possible courses that also can be a good vehicle for integrated course offerings to make our students business ready. Our next effort currently underway is to survey the students and sponsors about the value of project management and whether they perceive a difference in systemic project teaching versus fractal project teaching. We are using Likert scale questions and essay questions for this next step.

REFERENCES

Accardi-Petersen, M. (2011). *Agile marketing* (2011). Apress, 1st edition, 113–171. https://doi.org/10.1007/978-1-4302-3316-9

CQE Academy (n.d). *The cost of quality*, CQE Academy, www.cqeacademy.com/cqe-body-of-knowledge/quality-system/cost-of-quality/

Dunn, L. (2020). *What is diversity, equity & inclusion (DEI)?* InclusionHub. Retrieved March 3, 2022 from https://www.inclusionhub.com/articles/what-is-dei

Ewin, N., Chugh, R., Muurlink, O., Jarvis, J., Luck. J. (2021). Empathy of project management students and why it matters, *Procedia Computer Science*, *181*, 503-510. https://doi.org/10.1016/j.procs.2021.01.196

Magnanti, T. L., & Natarajan, K. (2018). Allocating students to multidisciplinary capstone projects using discrete optimization. *Interfaces*, *48*(3), 204–16. https://doi:10.1287/inte.2017.0940.

Magano, J., Silva, C., Figueiredo, C., Vitoria, A., Nogueira, T., Alzira Pimenta Dinis, M. (2020). Generation Z: Fitting project management soft skills competencies—A mixed-method approach, *Education Sciences*, *10*(7), 187. https://doi.org/10.3390/educsci10070187

Mazzetto, S. (2016). Practice experience and multidisciplinary collaboration in project management: a case study. In *Integrated solutions for infrastructure development, conference proceedings of ASEA-SEC-3,* ISEC Press, 1–6.

Munroe, D. (2016). Interdisciplinary community-connected capstone courses: A model for engaging undergraduates with public policy. *Council on Undergraduate Research Quarterly*, *36*(3), Council on Undergraduate Research. https://doi:10.18833/curq/36/3/2

Muszyńska, K. & Marx, S. (2019). Communication management practices in international projects in Polish and German higher education institutions, *Procedia Computer Science*, *164*, 329–336. https://doi.org/10.1016/j.procs.2019.12.190

Oxford. (n.d.). *Fractal*. Lexico Dictionaries. Retrieved January 27, 2022, from https://www.lexico.com/en/definition/fractal

PMI. Tailoring. *PMBOK Guide*. PMI, 7th edition.

Rhee, J., Oyamot, R. J. C. M., Speer, L., Parent, D. W., Basu, A., Gerston, L. N. (2014). A case study of a co-instructed multidisciplinary senior capstone project in sustainability. *Advances in Engineering Education*, *4*(2), 29.