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AGILE–STAGE GATE MANAGEMENT (ASGM): NPD IMPLEMENTATION PRACTICES FROM GLOBAL FIRMS DEVELOPING COMPLEX, PHYSICAL PRODUCTS

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AGILE–STAGE GATE MANAGEMENT (ASGM): NPD IMPLEMENTATION PRACTICES FROM GLOBAL FIRMS DEVELOPING COMPLEX, PHYSICAL PRODUCTS

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3 AUTHOR CONTRIBUTION STATEMENT

There are three figures used in this dissertation created by other authors, permission has been grated for their republication:

- Figure 7.3 - Generic Scrum Process Model (Softway 2012)
  - See APPENDIX D - COPYRIGHT PERMISSION Figure 10.4
- Figure 10.5 – Industrial Scrum Model (Sommer, Hedegaard et al. 2015)
  - See APPENDIX C - COPYRIGHT PERMISSION Figure 10.5
- Figure 10.8 - Popular ASGM Model (Cooper 2016)
  - See APPENDIX E – COPYRIGHT PERMISSION Figure 10.8

The inclusion of these figures is simply to illustrate the current thinking of researchers and practitioners of Agile, Scrum, and ASGM techniques.

4 ACKNOWLEDGEMENTS

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5 ABSTRACT

Stage Gate Management (SGM) has been used successfully by global organizations to direct the New Product Development process (NPD) for years, recently a new variant of this venerable approach has emerged. Researchers and firms have begun to intersperse elements of Agile, as popularized for the development of software, to create an Agile – Stage Gate Management (ASGM) hybrid NPD framework. Agile practitioners believe in process waste reduction, an intense focus on customers, and the creation of nimble entrepreneurial project teams, which, for software products, has positively impacted development time to market, resource utilization, and market success, more generally, improved business outcomes. For NPD professionals responsible for physical products, not solely software, do these Agile tenets continue to produce results? With minimal available research, a Grounded Theory study was conducted to inductively create theory from the implementation of ASGM, specifically for firms that design, develop, and manufacture physical products. Twenty-nine experienced industry professionals were interviewed from four global companies which represented five distinct Business Units (BU) which competed in a variety of markets and industries around the world. From these interviews, a Content Analysis approach was employed to organize primary and secondary themes which illustrated NPD team practices. Additionally, a comparative multi-case study method further developed specific Agile/Scrum techniques implemented, the measures of business success realized, as well as, a new ASGM model for like firms. From this research, firms which developed physical products did not implement all Agile practices, only Team Interface, Product Demonstrations, and Specification Flexibility were uncovered. The cases did, however, subjectively realize an improved time to market, as well as, greater product success for projects commercialized using ASGM. Lastly, a new framework emerged which highlighted the unique practice of Agile behaviors earlier in the development process, but rigid, or SGM-like, activities closer towards product launch.

6 INTRODUCTION

The focal phenomenon for this study is the management of New Product Development (NPD) within firms that design, develop, and manufacture physical products using a relatively new hybrid framework, Agile – Stage Gate Management (ASGM). Recently, experienced researchers have begun to broach this methodology (Goetvert, Lindner et al. 2018) which is based upon integrating elements of Agile/Scrum techniques (Alliance 2001) (Schwaber 2004) that have long been used with success (Rigby, Berez et al. 2015) in the Software and IT development domains (Karlstrom and Runeson 2005) with a more traditional gate review style framework, which it's track record by companies creating physical products (Cooper 2016) (Sommer, Hedegaard et al. 2015). Organizations developing tangible or physical products, such as automobiles, appliances, or medical devices, that are electro-mechanical in nature, with extensive development and tooling cycles, have also begun using ASGM frameworks to manage complex NPD projects.

Investments into NPD can be sizeable, global annual Research & Development (R&D) spending is approximately $1T USD, roughly half is spent in the United States (Boroush 2016). Individual project product development costs can run into the millions (Meyer and Marion 2010) or $1B USD for very complex electro-mechanical programs such as automobiles (Mol 2001). Development of new products, or simply new features, can be the lifeblood of an organization, where new offerings may allow firms to reach new customers or create new markets. Global competition does not cease, easy access to clients a world away, efficient logistical systems, and an abundance of data, have made the world a smaller place. Reaching intended markets quickly, or more importantly before other competitors, and leveraging development resources in the most efficient manner possible seem like critical endeavors for organizations. The methods used to manage product development are important to the success of NPD projects, these frameworks are critical tools for businesses, practitioners, and managers to organize the bounded chaos that is innovation (Rochford and Rudelius 1997). With significant costs on the line and organizational viability at stake, developing a clear understanding of ASGM implementations, that combine two pre-eminent methods for managing NPD, could be very valuable for industry practitioners and businesses alike.

6.1 RESEARCH QUESTIONS & MOTIVATION

Stage Gate Management (SGM) is a well-known process framework used by large and small companies alike for managing NPD with documented successes and criticisms. A Stage Gate example, shown in Figure 6.1, sub-divides the development process into distinct sections with status check reviews at defined intervals in an attempt to organize the uncertainty of product development (Cooper 1990) (Cooper 2008).

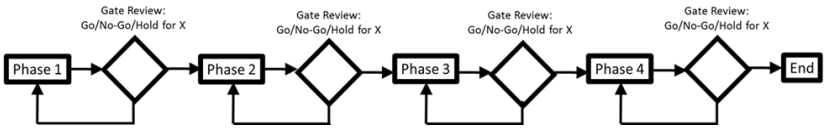


Figure 6.1 - Generic Form of SGM

Firms, such as those of interest to this study, have long used SGM to manage NPD, much has been written about the importance of methods used to commercialize products along with the business benefits of executing product development. Delivering new products to market supports a firm's growth and viability if executed properly, the manner in which companies undertake product development is essential (Cooper and Kleinschmidt 1991).

Large organizations often have complex portfolios to manage, consisting of many project opportunities, often good ideas outstrip the available resources needed to commercialize these interesting ideas (Cooper and Edgett 2006). Product development for firms designing physical products can include long testing cycles and significant resource investments, such as people and capital. Advancing the 'right' project within a broad portfolio by scarce resources is crucial, user needs must be continually evaluated and refined throughout the development process to ultimately align with expected customer value to, in turn, deliver market success.

Two research questions are framed for this Grounded Theory study:

- How do firms that design, develop, and manufacture physical products implement the techniques of Agile/Scrum in their ASGM framework to manage NPD?
- What outcomes do these firms encounter from the adoption of ASGM when managing NPD?

The motivation for this research is framed by over twenty-five years of professional experience, in many industries and geographic regions, to locate the optimal development method, if one truly exists. Specifically, for large firms with complex, often distributed teams, the processes used by R&D teams are increasingly important for senior leaders to ensure these NPD investments are managed wisely.

The results of this research will assist developers of physical products to understand how specific Agile techniques were implemented and if these ASGM methods delivered value.

6.2 THEORETICAL PERSPECTIVE

The theoretical perspective used for this study is based upon Grounded Theory, where the researcher inductively develops theory and insights based upon the collection of data, in this case, from interviews that used a series of prompting, yet open ended questions (Glaser 1998). The results were theoretical insights into the

practices of firms that have employed an ASGM approach for managing NPD, in other words, the goal is development of theory, not to quantitatively test theory. In this case, theoretical sampling was used since the selected cases fell within the intent of the study, again, global firms that design and develop physical products with experienced practitioners of ASGM and were suitable to highlight and articulate practices and methods employed. With a set of tightly defined research questions that build upon recent research, qualitative data methods are a scientifically recognizable approach to understand the insights of such a complex process that is NPD (Eisenhardt and Graebner 2004, Eisenhardt and Graebner 2007). The theory-building process occurs through iterative 'cycling' though the case data, where well-done theory building from cases is 'objective' since the closeness to the data keeps researchers honest (Eisenhardt and Graebner 2007). Theory building using cases has been historically leveraged to answer the 'how' and 'why' in unexplored research areas (Edmondson and McManus 2007). Simply, grounded theory is what is, not what should, could, or ought to be (Glaser 1999). Live interviews with numerous highly knowledgeable participants are an efficient way to gather rich, empirical data, furthermore, leveraging different hierarchical levels, functional areas, groups, and geographies, limits participant bias (Eisenhardt and Graebner 2007).

6.3 PREVIEW OF RESULTS

Twenty-nine separate experienced industry professionals were interviewed from four global firms, representing five distinct Business Units (BU). Each unit was either responsible for a significant portion of the development process, such as research and technology scouting, or was responsible for the entire NPD process for a specific product line, family, or platform. All BU's developed physical, electro-mechanical products, with complex mechanical, hardware, and software sub-systems, meeting the requirements of this study. The participant interviews were transcribed using professional services, and coded, using a Content Analysis methodology, where themes were extracted and organized after several iterations. Furthermore, each of the BU's were developed into case studies and cross compared to find similarities and differences. The classical techniques of Agile and Scrum were largely implemented by these global producers of complex products in a very similar manner as software or IT products with some notable exceptions. Deployment models were developed to describe the unique nature of firms developing physical products. Study participants felt ASGM benefits were also clear with a reduced time to market and greater levels of market success.

Section 6 offers background details, inspirations, and summary of the study. Section 7 describes the literature review executed to illustrate the current landscape of SGM knowledge and to highlight gaps in understanding or practice. Section 7.1 extends the findings from the SGM literature review, and specifically, highlights the

foundational elements of Agile/Scrum along with recent research of ASGM. Section 8 outlines the methodology employed for this study. Section 8.2 reviews the study samples used, Section 8.3 discusses the industries represented within this study, where Section 9 highlights the multi-case approach employed. Section 9.2 through Section 9.6 describes the case studies completed, how they were organized, and the cross-comparisons. Section 10 and Section 10.5 reveals the overall results, including cross-case analysis, flexible techniques implemented, measures of success realized, and a potential new ASGM framework. Section 11 through Section 14 are organized into several sub-sections discussing the study contributions, implications, limitations, opportunities, and lastly, conclusions.

7 LITERATURE REVIEW

Real world challenges and recent journal activity indicate a need to investigate, or modernize, SGM methods. This study leveraged a structured approach to create a baseline of existing SGM knowledge, as well as, highlighting gaps in the extant literature (Tranfield 2003). A review methodology was created for journal article identification using selected key words and two popular scientific databases. The databases retrieved articles aligned with the search criteria, and using 'fuzzy logic', were 'ruled in or ruled out' by reviewing the abstract, article titles, and authors to ensure a broad sweep was conducted to capture relevant articles. Journal quality was also considered as a screening element defined by the Australian Business Deans Council (ABDC). A content analysis approach was employed to extract relevant information about the articles included in the review and to organize the themes presented (Krippendorf 1989). Several iterations of groupings were created, and recreated, to reach the final structure, the result was over one hundred relevant, prominent articles, published between 1991 and 2016. The findings were organized into three main themes and further deconstructed into twelve Secondary themes, see Figure 7.1.

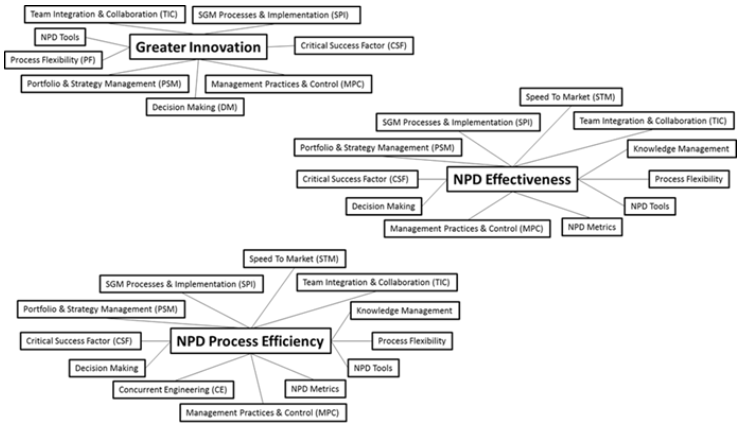


Figure 7.1 - Primary and Secondary Themes from Content Analysis of SGM

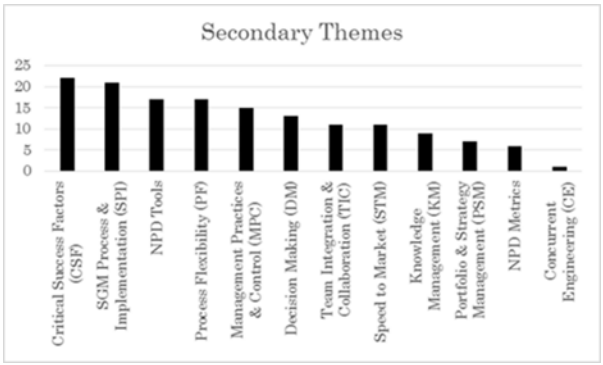


Figure 7.2 - Pareto of Secondary Themes from Content Analysis of SGM

Based upon this literature review, Critical Success Factors, SGM Processes & Implementation, Process Flexibility, and Management Practices & Control were the top themes as shown in Figure 7.2.

The literature review specifically considered papers applicable to large, multi-national organizations that developed physical products utilizing SGM to manage NPD. The articles within scope were further analyzed for future research areas called for by individual authors, these calls were organized to develop a map of literature inadequacies, which led to the following:

- Universal NPD success factors – Keys for successful product development across markets and geographic boundaries
- Stage Gate process flexibility – Updates to make SGM applicable to more project types and responsive to emerging customer needs
- Development process management practices – Management methods for optimal NPD success and efficiency

Based on the findings from the literature review, gaps articulated, and real world challenges, a refined set criticism emerged of SGM (Hutchins and Muller 2012) (Bers, Dismukes et al. 2014) (Sommer, Hedegaard et al. 2015) (Cohen, Kamienski et al. 1998):

- Does not fit non-traditional projects
- Cannot accommodate all project types
- Not scalable to ensure 'right' amount of flexibility
- Not fluid enough for late specification freeze
- Forces organizations towards incremental projects
- Drives more resource utilization
- Projects take longer due to rigidity

Agile techniques integrated into SGM to create an ASGM framework were designed to improve project flexibility, foster continuous learning, and ensure customer alignment (Cooper 2016) (Rubin 2013, Sommer, Hedegaard et al. 2015). SGM literature for years has investigated modifications for the decades old gate review methodology. The understanding of ASGM and its use for the development of physical products is inadequate and incomplete. The literature fails to take a broader and deeper look into the practices of ASGM at global firms that design, develop, and manufacture physical products.

7.1 AGILE/SCRUM BACKGROUND

The intersection of Agile and SGM is the foundation for this study, both approaches have been extensively leveraged, with positive results, for years, and have significant quantities of available research, however, the particular nexus of interest is the implementation of ASGM with firms that develop physical products. The previous section articulated the results of a systematic literature review of SGM methods, highlighting knowledge gaps and criticisms, along with real world observations, research has proposed that the combination of Agile and SGM, hence the ASGM descriptor, could be beneficial for NPD practitioners. Sections 6 and 7 highlighted several important points about SGM and Agile, however, a deeper retrospective into Agile and Scrum would be beneficial at this point to build on the SGM review conducted.

Agile has been described as a well-developed, highly effective, holistic system engineered to overcome common barriers of successful innovation, where Agile methods have boosted average success rates to 39% from 11% for software based products (Rigby, Berez et al. 2015). Planning and prioritization, communication and follow-up, customer interaction, and management support are other key findings from a comprehensive case study of software development projects for products such as industrial controllers, radar control tracking systems, and consumer electronics (Karlstrom and Runeson 2005). Simply, Agile techniques delivered more powerful tools for micro-planning, day-to-day work control, and progress reporting as compared to SGM, conversely, the Stage Gate model gave Agile a means to coordinate with other development teams and to communicate with functions such as marketing and senior management (Karlstrom and Runeson 2005).

The Agile/Scrum label, for purposes of this study, combine several different thought processes used in industry today, such as Agile and Scrum themselves, with elements from Lean Product Development, Kanban, Crystal, and Extreme Programming (XP). The two major sources of ASGM hybridization particularly stem from Agile and Scrum, which represent flexibility of the NPD process, and SGM. Both Agile and Scrum, as mentioned, are strongly rooted in the software

development world, where change is constant, and flexibility, in terms of responding to new stimuli, is paramount.

Specifically, Scrum methodology assumes development activities are not completely defined, systems are assumed to be complicated and complex, as such, control mechanisms are instituted to improve process flexibility, simply, the primary difference between Scrum and traditional SGM or Waterfall is that Scrum assumes the analysis, design, and development processes during defined Sprints are unpredictable (Schwaber 2004). The main characteristics of Scrum methodology are linear planning and closure phases that have inputs and outputs well defined, time bounded Sprints which contain unidentified or uncontrolled activities designed to maximize flexibility, where these nonlinear Sprints require explicit process knowledge to evolve the final product, and lastly, a closure phase where the project remains open to change, including competitive, time, quality, and financial pressures (Schwaber 2004). Figure 7.3 illustrates a generic Scrum process model (Softway 2012).

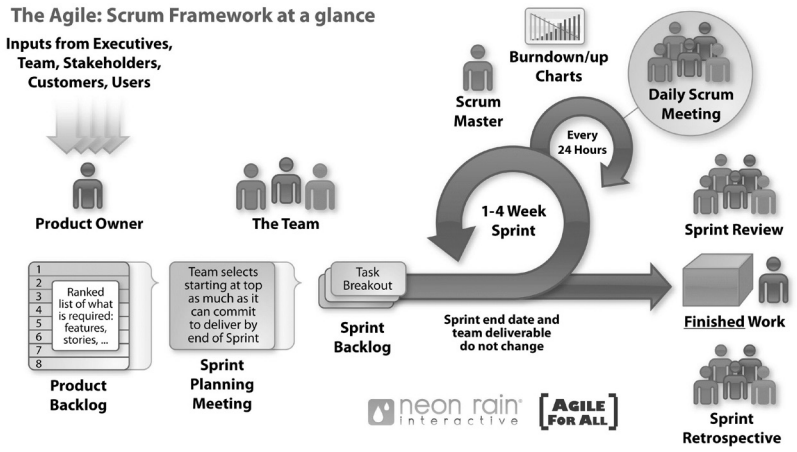


Figure 7.3 - Generic Scrum Process Model (Softway 2012)

Agile has often been defined simply by the Agile Manifesto, this vision statement summarizes a deep desire for lightweight processes to manage software development. The manifesto has four main elements: Individuals and interactions over processes and tools; Working software over comprehensive documentation; Customer collaboration over contract negotiation; and Responding to change over following a plan (Alliance 2001). ASGM, as previously defined, is largely the integration of both Agile/Scrum into an SGM style over-arching framework. Researchers have investigated examples of physical product development within a variety of firms to search for applicability (Cooper 2016) (Cooper and Sommer 2016). An example of an experimental automotive development project, which never achieved commercialization, was centered on the fast creation of a small, 100 MPG,

efficient vehicle, where the team leveraged Agile methods to create a road going prototype with manufacturing environment considerations (Denning 2012). Important characteristics that emerged from this case study, were practices such as modular design methods, test driven development, distributed collaborative teams, and pairwise work designed to share knowledge (Denning 2012).

Researchers have also observed Scrum with physical products such as aerospace, where feedback loops are valued, however, the development cadence could be longer to account for physical fabrication time but the benefits of updating product understanding and market needs holds true (Brown and Ford 2016). Elements of Agile practices have been observed to deliver positive project benefits within a variety of different firms and products, Agile interspersed with SGM methods, such as IT projects in India (Kulkarni, Padmanabham et al. 2017), and an innovative German on-demand bread maker (Lindemann, Bohmer et al. 2017). ASGM hybrid product development framework has also delivered project and product development performance, such as, information accuracy, team commitment, and leadership (Conforto and Amaral 2016)

Alternatively, regulatory restrictions, or the perception of restrictions, have often made companies skittish of Agile methods, 'compliance' in terms of FDA, SOX or other, appear to be singularly defined, however, this mindset should be challenged to understand the exact concerns and illustrate misperceptions of the methodology (Stuart, Beede et al. 2011). Two studies in particular, utilizing qualitative survey methods, with significant sample sizes, have illustrated some of the Agile practices being implemented across many different market sectors and firms (Komus 2017) (Goetvert, Lindner et al. 2018).

8 METHODOLOGY

The methodology used for this study has several classic elements such as research context, data collection, and data analysis, these well-known research guideposts, employed within a Grounded Theory approach, establish a known framework for the organization of information in a consistent manner (Glaser 1999) (Edmondson and McManus 2007). Qualitative research rigor is based upon a method that stands independently to afford another researcher the opportunity to analyze the same data and arrive at similar conclusions and to produce plausible and coherent explanations for the phenomenon under scrutiny (Mays and Pope 1995).

8.1 RESEARCH PROCESS

To answer the research questions, several sources of data and methods, such as an extant literature review, a qualitative field study, professional experience, and other publicly available information were employed through a step-wise process (Eisenhardt 1989) (Pratt 2008) (Homburg, Wilczek et al. 2014). A structured

approach was employed for this study consisting of the steps as shown in Figure 8.1. This study leveraged a classical approach towards grounded theory creation (Eisenhardt 1989) (Homburg, Wilczek et al. 2014) of how developers design and manufacture new physical products using Agile, Scrum, or other 'flexible' techniques.

Figure 8.1 - Steps of Research Process

8.1.1 DATA COLLECTION

The study data was collected by initially locating professional contacts from firms that met the search criteria, then identifying participants, conducting interviews, and gathering secondary data. Several avenues were taken to locate potential firms, a 'snowballing' technique was employed to traverse from an initial contact to a valuable lead. Searches included:

- Web search – Google/Yahoo, etc using 'fuzzy logic' for 'like' firms with Agile and/or Scrum
- CEB search – Industry database, Conference Executive Board (CEB), researches business topics
- Agile User Groups/Conferences – Global user groups, consultancy firms, Seminars, and Conferences
- Professional Contacts – Leveraged personal/professional contacts for practitioners and firms
- LinkedIn – Reached out to firms/individuals, using a 'fuzzy logic', such as, 'Research & Development' AND 'Agile'

Ultimately, the study enrolled five distinct Business Units (BU) from four global firms, with development sites across the globe. Each BU also had some form of additional geographic dispersion beyond the main development sites, such as supporting software design work in India or manufacturing in Mexico.

8.1.2 STUDY PARTICIPANTS

Each study participant was required to be a current industry professional with greater than five years of commensurate experience, who had either led, managed, or been a part of NPD teams that used flexible development methods, such as ASGM, to manage a new physical product development project. These individuals delivered significant, detailed insights into the intricacies of ASGM utilization within their respective BU's. See APPENDIX B – RECRUITMENT FLYER for the Recruitment Flyer used.

The study sought to diversify responses and to create depth of discussion in two ways:

- Leverage participants from varying groups within an organization such as engineering, marketing, sales, quality, and manufacturing functions
- Ensure differing levels of the organizational structure, such as, Project Team, Project/Program Management, and Executive Leadership were canvased

Utilizing different organizational hierarchical levels, as well as, different functional groups was designed to minimize retrospective sense-making (Eisenhardt and Graebner 2007).

The hierarchal structure, defined as organizational roles, was established as:

- Individual Contributor: Personnel engaged or performing day to day design activities
- Project/Program Management: Staff which acted as traditional Project Managers guiding and directing overall team activities
- Leadership: People managers or directors that provided strategic direction for NPD activities

As intended, participants covered technical functions, such as design, engineering, quality, and manufacturing, as well as, sales and marketing groups, and held organizational titles such as R&D Program Manager, Principle Engineer, Product Manager, Innovation Director, Regulatory Engineer, and Quality Manager.

8.1.3 INTERVIEW STRUCTURE

Field data collection was accomplished through live interviews of participants using web streaming voice services, such as WebEx and Skype, and often lasted between 30 to 75 minutes. Each interview was transcribed using a professional transcription service to ensure the nuances from each participant were captured, then organized with a unique numbering scheme to ensure traceability. Interviews are regarded as a reliable method of efficiently collecting empirical data (Eisenhardt and Graebner 2007), from this data, multiple case studies were developed to build a stronger argument for theory creation (Yin 1999).

Interviews were conducted in English, using a semi-structured approach with an interview guide that featured starter questions that were open ended in nature, but pointed enough to probe deeply (Roulston, deMarrias et al. 2003). General areas of discussion for the interviews were:

- Importance of New Product Development (NPD)
- Challenges with current NPD process framework
- Updates to NPD framework to address concerns
- Benefits realized from NPD framework updates
- NPD framework "Do's and Don'ts" based on participant experience
- Insights into existing gate reviews in use today
- Customer role within the NPD process

A complete list of interview guide questions can be found in APPENDIX A – INTERVIEW GUIDE.

Demographic data for each participant and firm was also collected to help identify moderating factors, see Table 8.1 and Table 8.2 below.

Table 8.1- Participant Demographics

Participant Demographic Variable	Factor Description
Duration of Professional Employment	Number of years of professional experience
Educational Background	Educational discipline(s), such as, Mechanical Engineering or Marketing
Organizational Level	Hierarchal level within the BU, such as, Project Manager or Individual Contributor
Discipline	Discipline the participant currently represents, such as, Resource Manager – Software or Quality Assurance Engineer

Table 8.2 - Business Unit (BU) Demographic Variables

BU Demographic Variables	Factor Description
Region	Geographical location of main NPD activity
Sector	Market sector where the BU competes
Industry	Main industry where the BU competes
Sub-Industry	Sub-Industry where the BU competes

8.1.4 SECONDARY DATA

Since most of the firms that participated in the study were publicly held organizations, a significant amount of information was available from annual reports, firm web-sites, product brochures, or regulatory filings. This secondary source of information, which was found independent of the study participants, included financial and other macro-level organizational data, such as, stock price, R&D spend, revenue margins, employment levels, and strategic plans or other corporate level initiatives disclosed to share-holders and market analysts. This secondary data was used to augment the interview discussions, which provided additional depth of the firm and BU perspectives.

8.1.5 DATA ANALYSIS

The interview transcriptions were analyzed and coded for themes using a systematic Content Analysis approach that reviewed data within a specific context to build a method that is replicable, making valid inferences from data (Krippendorf 1989).

Employment of this methodology enabled the planning, execution, communication, reproduction, and evaluation of the analyses possible (Krippendorf 2004).

The software package Nvivo Version 11 was utilized, along with Excel, to perform coding and theme organization. Three levels of coding were conducted to ensure a robust thematic set (Homburg, Wilczek et al. 2014):

1) Open coding was employed, to identify concepts and their properties and dimensions within the data (Strauss and Corbin 1998). Through a line-by-line analysis of the interview transcripts, the relevant forms and activities, outcomes, and practices of ASGM were identified.

2) Axial coding results were analyzed in an iterative manner and organized based on common wording and associations. After the main themes were organized, axial coding was employed to link sub-themes to create relational statements at a conceptual level (Strauss and Corbin 1998).

3) Selective coding, defined as the integration and refinement of the theory, was conducted (Strauss and Corbin 1998). Figure 9.1 illustrates the primary and Secondary themes.

ASGM implementation practices were uniquely configured into eight tenets that capture the core beliefs of Agile and Scrum. Since Agile and Scrum are closely related and often interspersed in practice, or confused by practitioners, their principles were merged together as 'Agile' methods used in the hybrid approach of ASGM (Rubin 2013) (Alliance 2001). In a similar fashion, the participants were asked about the benefits of ASGM, or how they perceived that ASGM would, will, or have impacted their business performance. Here however, the ASGM benefits were organized into three distinct areas: Improved Speed to Market, Greater Market Success, and Reduced Consumption of NPD Resources.

After coding was organized, participant interview transcripts were again reviewed, this time for relevant quotes that were used to either support or refute the research questions. If a participant, during the interview, mentioned, as an example, that their BU believed that ASGM has helped their R&D teams to become faster to market for NPD projects, the passage from the participant interview was highlighted and aligned as positive support for the benefit of ASGM. The participant quotes were lightly edited to ensure the quote represented the participants original intent and the context under which it was said to adequately contextualize the discussion (Sandelowski 1994).

8.2 RESEARCH SAMPLE

The research context for this study was a real-world setting of industry professionals employed by global R&D organizations who had greater than five years of

commensurate experience, leading, managing, or working within an NPD team that had used flexible SGM methods, such as Agile, to organize new product development projects. The global companies in scope were those that designed, developed, and manufactured electro-mechanical, physical products, further articulated as products with mechanisms, hardware, and software, all coming together to deliver a tangible product or a platform that was further integrated into a final product. The participants were from varying disciplines such as engineering, marketing, sourcing, quality, and manufacturing functions, along with an assortment of levels within the organizational structure, such as individual contributors (e.g., Design Engineer), project or program managers, and leadership. Since many organizations practiced broad cross functional approaches to deliver new products, understanding the behaviors of all supporting elements was deemed important.

All participants verbally consented to the study, no participant information was included in the study data. The research was focused on how firms implemented ASGM as a part of the NPD process, as such, the scope of this research will not place participants at risk for criminal or civil liability or be damaging to their financial standing, employability, insurability, or reputation or be stigmatizing. Confidentially requirements stem from historically significant documents such as the Belmont Report, which described the ethical principles that were followed with respect of persons, beneficence, and justice (Department of Health 1979). The US Code of Federal Regulations (CFR) described the authority and responsibility of Institutional Review Boards (IRBs) in protecting human subjects during research (US Department of Health and Human Services 2009). With privacy and confidentially in mind, the specific firms, BU's, or individuals will not be revealed, they were to simply provide rich insightful information, which is the goal of any study. A macro level analysis was conducted that will reveal the industries, sub-industries, sector major competitors, and high-level, indiscernible characteristics of study participants, such as organizational role and education field of study.

8.2.1 INDIVIDUAL PARTICIPANTS

In total, twenty-nine discrete interviews were conducted. The total number of samples is adequate for this type of theory development, where the cases have been selected to illuminate and extend relationships, as well as, highlight logic among constructs (Eisenhardt and Graebner 2007). The study participants were experienced NPD professionals of varying backgrounds, experiences, and organizational roles, all were active participants within an NPD project using an ASGM framework, and all have been a part of NPD using other methodologies as well, such as Waterfall or Stage Gate. Table 8.3 summarizes the specifics of each study participant while protecting identities, such as the case study grouping, years of professional experience, organizational role, and other information.

Table 8.3 - Participant Information

Case #	BU	ID #	Male or Female	Actual Title	Organizational Role	Scope	Team Function	Education	Experience
1	NA Technology Discovery and Implementation	1	M	Director	Leadership	Technology Assessment	Design	Business	36
		5	M	Manager	Program Management	Innovation Incubation	Project Management	Mechanical Engineering	32
		10	M	Manager	Program Management	Innovation Process	Agile Coach	Industrial & Systems Engineering	21
2	Global NPD of Railway Technologies	2	M	Program Manager	Leadership	Scrum Master & Product Owner	Project Management	Electrical Engineering	24
		4	M	Principle Engineer	Individual Contributor	Control Hardware Engineering	Design	Electrical Engineering	10
		6	M	Manager & Lean PD Coach	Resource Manager	Team Manager – Electrical & Mechanical Engineers	Agile Coach	Electrical Engineering	11
		17	M	Quality Manager	Resource Manager	Software Quality Manager & Scrum Master	Agile Coach	Mechanical Engineering	28
		21	M	Marketing	Individual Contributor	Product Owner	Business	Software Engineering	20
3	Global NPD of Industrial Automation Process Monitoring Equipment	3	M	Project and Systems Engineer	Individual Contributor	Systems Engineering, Requirements Management, PM, Scrum Master	Agile Coach	Electrical Engineering	19
		7	M	Program Management	Program Leadership	NPD R&D Project Manager	Project Management	Mechanical Engineering	19
		8	M	Software Architect / Developer	Individual Contributor	Software Developer & Engineer R&D NPD	Design	Software Engineering	21
		9	M	Software Group Manager	Resource Manager	Team Leader Software Engineering & Agile Coach	Agile Coach	Computer Engineering	14

4	NPD and Manufacturing of Perimeter Access Products	11	M	VP Engineering	Senior Leadership	Executive Leadership	Business	Mechanical Engineering	28
		12	M	Engineering Manager	Resource Manager	Resource Manager	Agile Coach	Electrical Engineering	19
		13	F	Product Manager	Individual Contributor	Marketing Leader	Business	Business	19
		14	M	Director of NPD	Senior Leadership	BU Engineering Leader	Project Management	Mechanical Engineering	22
		15	M	Director of Engineering	Senior Leadership	Program Leadership	Project Management	Mechanical Engineering	22
		16	F	Regulatory Engineer	Individual Contributor	Regulatory/Project Compliance	Design	Mechanical Engineering	31
		19	M	R&D Manager	Resource Manager	Manufacturing Project Leader	Design	Industrial & Systems Engineering	40
		20	M	Quality Director	Senior Leadership	Business Unit Engineering Leader	Business	Mechanical Engineering	29
		22	F	Mechanical Engineer	Individual Contributor	Mechanical Design Engineer	Design	Mechanical Engineering	28
		23	M	Manager, EE & RF Engineering	Resource Manager	Electrical Design Engineer	Design	Computer Engineering	22
		24	F	Sourcing Agent	Individual Contributor	NPD Sourcing Activities - Purchasing	Business	Business	10
5	NPD and Manufacturing of Medical Devices	25	M	Project Manager	Project Manager	Scrum Master	Agile Coach	Electrical Engineering	21
		26	M	Program Manager	Program Leadership	System Engineering Lead	Design	Computer Engineering	26
		27	M	Mechanical Engineer	Individual Contributor	Mechanical Design Engineer	Design	Mechanical Engineering	8
		28	M	Software Engineer	Individual Contributor	Software Design Engineer	Design	Electrical Engineering	6
		29	M	Systems Engineer	Individual Contributor	System Engineer	Design	Biomedical Engineering	6
		30	M	Systems Engineer	Individual Contributor	Principle Engineer	Design	Mechanical Engineering	15

Leveraging Table 8.3, the participant data can be organized to highlight geographies, organizational roles, and industries/sub-industries, where Table 8.4 discloses the number of interviews by characteristic to help illustrate the breadth and scope of this study. Industry/Sub-Industry where the BU competes, Organizational roles were high-level descriptors for the levels of the BU team structure, and geography was simply the central location of the BU. For the different organizational roles, the hierarchal structure was established as:

- Individual Contributor: Personnel engaged or performing the day to day design activities
- Program Management: Staff acted as traditional project/program managers guiding and directing overall project team activities
- Leadership: Executives that provided strategic direction for NPD activities
- Resource Manager: People managers that organize specific resource sets and mentor employees

Table 8.4 - Participant Summary

Characteristic		# of Interviews
Industry/Sub-Industry	Consumer Discretionary/Perimeter Access	11
	Transportation & Logistics/Railway Technology	5
	Hardware/Process Monitoring	4
	Healthcare/Medical Devices	6
	Automotive/Auto Parts	3
	Sub-Total	29
Organizational Role	Leadership	2
	Individual Contributor	12
	Resource Manager	6
	Program Management	9
	Sub-Total	29
Geography	NA - US	14
	NA - Canada	4
	EU - #1	6
	EU - #2	5
	Sub-Total	29

From Figure 8.2, the participants represented different skill-sets, various backgrounds, and industry experiences providing a richness and depth to the study, foundationally, however, their education largely came from a technical point of view, overwhelmingly, degrees such as Mechanical, Electrical, or Software Engineering were observed, although several went onto obtain advanced degrees (e.g., MBA) or professional certificates (e.g., Project Management), however, several participants

more recently operate functioned in contrasting roles within their NPD teams (e.g., Scrum Master or Product Owner). The most observed educational discipline was Mechanical Engineering, followed by Electrical Engineering, and, lastly, Business.

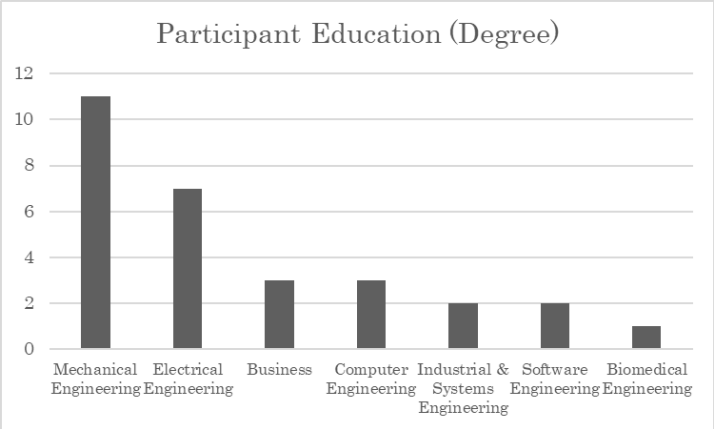


Figure 8.2 - Participant Education

The study participants were further categorized along another axis, education was straight forward to discern, as was organizational role, but team function was an insight pursued to create a deeper understanding of the actual responsibilities of the participants. From Figure 8.3, most of the interviewees were understood as responsible for the product design (e.g., Mechanical Design, Electrical Design, Software Design), meaning these professionals were designing the actual product under development. The second most observed team function was Agile Coach, someone who was responsible for elements or techniques associated with Agile or Scrum, where Business and Project Management functions completed the categories. Furthermore, the roles and responsibilities were defined as:

- Design: Personnel, at any organization level, that either performed actual design activities or managed design activities
- Program Management: As stated earlier, staff acted as traditional project/program managers guiding and directing overall project team activities
- Agile Coach: Personnel, at any organizational level, that fulfilled the roles of Agile Coach, Agile Process Champion, or Scrum Master
- Business: Personnel, at any organizational level, that managed the financial, marketing, or business aspects of the project team

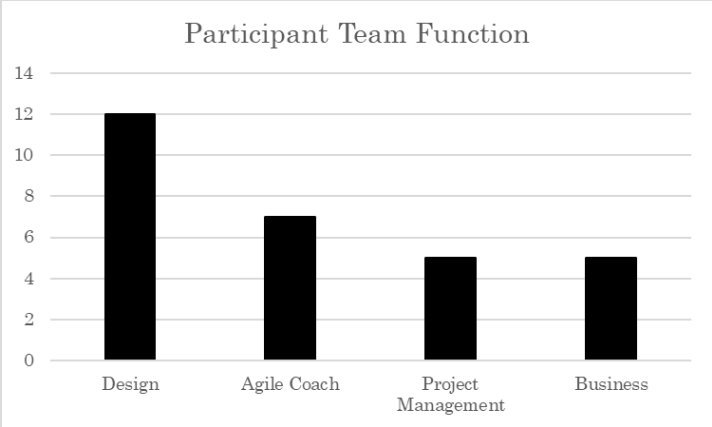


Figure 8.3 - Participant Team Functions

The study required NPD professionals with a minimum of five years of professional and ASGM experience. The twenty-nine participants had experience levels evenly distributed across the spectrum, from six to forty years as seen in Figure 8.4 following a normal bell curve shape lending credence to the participant sample collected.

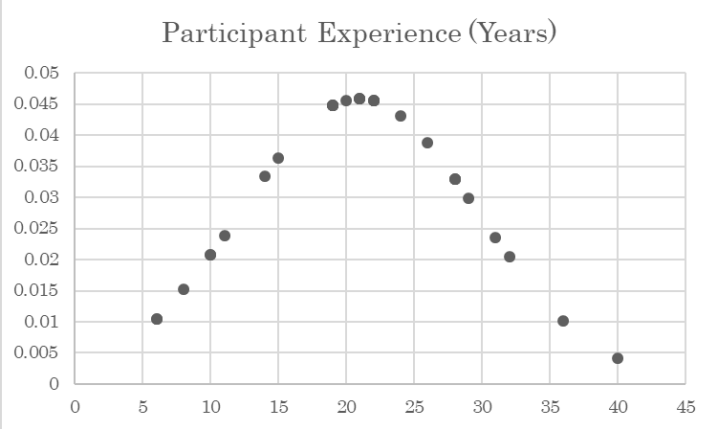


Figure 8.4 - Distribution of Participant Experience in Years

The study participants and firms engaged in the study, as intended, were from a variety of industries, geographies, disciplines, and organizational levels and all were experienced with ASGM for NPD.

8.3 INDUSTRIES ANALYZED

Five case studies, which were an outgrowth of the distinct Business Units (BU) interviewed, came from four global firms, representing the Automotive, Transportation & Logistics, Hardware, Consumer Discretionary, and Healthcare industries. All five BU's were leaders within their sub-industry segments, such as Automotive Components, Railway Technology, Process Monitoring, Perimeter

Access, and Medical Devices. Each BU represented significant portions of their firms which were not inconsequential companies.

To illustrate the gravity of the study participants and to protect the identities of the firms, businesses, and personnel that supported this ground-breaking effort, an analysis for each industry that broached history, macro-economic trends, along with a listing of the top companies within each market was developed. A more detailed description of the major players within each sub-industry followed, and lastly, an analysis of the twenty-nine professionals that delivered insights and richness to the study. The intent of this information was to frame the overall environment under which these established firms were operating and to deliver depth towards the case study and cross-case analyses.

8.3.1 BACKGROUND OF AUTO COMPONENTS SUB-INDUSTRY

History - The history of the automobile played a significant role within the economy and left an indelible impact on society, considering humble beginnings, in 1895 there were only four cars officially registered in the United State, in 1909 a Ford cost $825 and the company sold 10,000 of them, to 1916 over three million vehicles were registered (Davis 2018).

Ford produced the Model T from 1908 to 1927, billed as the first affordable car for most Americans, it was known as the "Tin Lizzie" for its durability and versatility. Following Ford's invention of the moving assembly line, roughly half of all cars in the U.S. were Model T's by 1918. Henry Ford's manufacturing innovations decreased the amount of time it took to build a car from twelve hours to two and a half, which dramatically lowered the cost of the Model T between 1908 and 1926 for, arguably, a much-improved model (Biography.com Editors 2014). In 1914, Ford introduced the $5 wage for an eight-hour workday, more than double the average wage at the time and became renowned for his automobiles as well as steady wages (Biography.com Editors 2014).

The automobile transitioned to a necessity from a luxury item, by 1948 the American auto industry rolled out its 100 millionth car, however, a decade later the grip American producers had on the U.S. market was lost when Japanese-made automobiles were imported into the country for the first time (Davis 2018). In 1973, foreign-made, fuel-efficient cars surged into the U.S. during and after the oil embargo. Throughout the twentieth century the automotive industry was a reliable indicator of the U.S. economy (Davis 2018). After the recession of 2007-2008, new car sales declined dramatically as consumer confidence and spending evaporated.

Today - The current economic environment has been positive for several years for automakers, however U.S. vehicle demand trended lower year over year for the first half of 2018, along with a continued evolution away from sedans toward trucks and

utility vehicles, full year 2018 U.S. light vehicle sales are expected to decline by 1.9% to 16.8 million units, however, global demand is expected to rise, driven by China (Levy and Goon 2018). North America, which was once the largest auto market in the world, has lost its clout to the Asia Pacific region where the population continues to aspire towards vehicle ownership, making China the largest auto market in the world.

Industry Role - Auto parts manufacturers produce components and accessories for new vehicles in an ever-important manner where automakers design and market vehicles but outsource production of major components to relatively large external manufacturers. While automakers grant suppliers specific targets for cost, quality, performance, timing, and product features, they tend to leave component suppliers to their own devices to create appropriate solutions (Davis 2018). Parts producers enable automakers to accelerate new product introduction by taking on increased responsibilities for product testing and systems integration, where "full-service" suppliers strive for early involvement in the product development process, potentially delivering cost reductions and new innovative features, all against a backdrop of design simplification as automakers reduce the number of vehicle platforms, but expand product offerings (Davis 2018).

Market - The automotive market globally, is in the midst of truly disruptive times for vehicle producers and component sources with increasing vehicle electrification, combined with ride-sharing and ride-hailing services dramatically changing how the industry and consumers behave. Both traditional and non-traditional manufacturers have announced plans to develop and produce fully Autonomous Vehicles (AV) in the near future. The rapid advancement of technology has allowed automakers to add more features, especially new propulsion systems, such as Electric Vehicles (EV), either fully electric or plug-in's, as well as, AV's. Fuel efficiency is expected no matter the vehicle segment, as are many other technologies, such as back up cameras, adaptive cruise control, infotainment, and smart braking systems. EV technology is already on the market in expanding numbers, both EV and AV offerings are expected to rise steadily and rapidly over the next several years. Part manufactures are expected to face cost pressures on legacy or commodity components which places additional business emphasis on newer technologies to support market mega trends (Levy and Goon 2018). Traditional auto manufacturers such as Ford, GM, Daimler, FCA, and VW are chasing an upstart Tesla in the EV race, but have been joined in the AV quest by off-shoots of "technology" companies such as Waymo, Uber, Huawei, Vodafone, and others, along with parts manufacturers Continental, Denso, Aisin Seiki, to deliver communication pathways between vehicles to enable autonomous driving which is intended to make driving more safe (Levy and Goon 2018).

8.3.2 BACKGROUND OF RAILWAY TECHNOLOGY SUB-INDUSTRY

History - Passenger rail service in Europe has been a part of the fabric of the continent since the nineteenth century, the speed at which these trains travelled relied on sophisticated engineering from advanced economies. Early *Rocket* engines reached 50 km/h speeds in 1829, others achieved 100 km/h by 1850, 130 km/h by 1854, and an incredible 200 km/h by the early 1900's (UIC 2015). Train top speeds continued to climb as the twentieth century rolled forward where velocities over 330 km/h were achieved in 1955. By the mid 1960's, Japan had modernized its infrastructure with its high-speed *Shinkansen* operation, globally, advancements continued, particularly in France, Germany, and the U.K. in the 1970's and 1980's where public investments funded railroads of the future (UIC 2015).

High speed rail continued to advance with new technologies along nationalized lines leveraging home grown engineering, however, new or revamped players joined the high speed market, Italy and Germany in 1988, Spain in 1992, Belgium in 1997, the U.K. in 2003, and the Netherlands in 2009, and the trend is expected to grow to 80,000 kilometers of high speed track globally by 2035 (UIC 2015).

Market Forces - The rail industry has been slow to adopt many of technological changes seen in consumer oriented markets, such as integrated real-time sharing of data and efficiency improvements, however in 2018, a shift appears underway, where the rail industry is embracing the Internet of Things (IoT), cloud computing, and big data analytics (Stazzone 2018). Furthermore, smart cities and smart transportation have appeared across the globe with increased government support for railways driving growth of intelligent railways. Urban migration, where young people are shunning the suburbia of their parents, for hip, culturally diverse, dense environments, have increased safety concerns among city dwellers (Grandview Research 2013). These smart railway systems are instrumented and interconnected, built from devices and components with integrated solutions and services that help rail companies collect information needed to monitor operations (Grandview Research 2013). Information integration, data analytics, and data modeling help with operational decision making, as well as facilitating the sharing of information with different partners including passengers, rail operators, component providers, system integrators, and governmental agencies (Grandview Research 2013).

Market - The market clearly sees integrated networks as a management priority, however, connected mobility is also a big story for passengers, where rail operators seek to connect passengers during their commutes with other data such as real-time travel information, entertainment, or e-commerce sites. Climate change, as felt within the automotive industry, has led to greener forms of rail transport, alternatives to diesel trains are being developed, technologies such as hydrogen fuel

cells, battery-power, and natural gas, plan to create zero or reduced emission offerings (Bombardier 2017).

Obstacle detection and driver assistance systems support operators in critical situations by detecting and tracking impediments, warning drivers about risks increasing the safety of all involved. Avoiding accidents and their subsequent costs, obstacle detection assistance systems also increase the availability of trains (Bombardier 2017). Unfortunately, smaller operators have struggled to implement these safety systems due to the financial and technical hurdles (Grandview Research 2013).

8.3.3 BACKGROUND OF PROCESS MONITORING SUB-INDUSTRY

History - Global manufacturers continue to innovate, searching for the next market changing product is important for business longevity, however, close attention to the production of existing products is also critical. There are many industrial automation or process monitoring products on the market to help control critical processes to ensure the highest levels of quality, these include a variety of analytical tools and systems. Manufacturing, as currently structured, with product inspections to ensure quality, started with Great Britain in the eighteenth century, and later grew into the Industrial Revolution of the nineteenth century. After the U.S. entered World War II, quality became a critical component of the war effort, virtually every product was inspected, however, to simplify the approach without sacrificing safety, the American military began to use sampling techniques for process control (ASQ - American Society for Quality 2018). The birth of total quality within the U.S. came as a direct response to the quality revolution in Japan following World War II, where the Japanese welcomed Americans Joseph M. Juran and W. Edwards Deming, who, rather than concentrating on inspection, focused on improving organizational processes (ASQ - American Society for Quality 2018). By the 1970's the U.S. automobile industry, in particular, was viewed as inferior to Japanese imports. To combat quality shortcomings, American auto manufactures adopted a different approach, called Total Quality Management (TQM), this further evolved from the foundations of Deming, Juran, and the early Japanese practitioners, whereby quality moved beyond simply manufacturing, but into service, healthcare, education and government sectors (ASQ - American Society for Quality 2018).

Industry – The best manufacturers not only inspect finished goods, but raw materials that go into completed products. Manufacturers often check the composition of solids, liquids, or gases, depending on the product, looking for unknown contaminants and confirmation of proper specifications, seeking fine discrimination between materials (ABB 2018). Microanalysis of materials to

identify contaminants, analysis of thin films and coatings, and smokestack emissions are examples of industrial automation process controls that support manufacturing as well as the environment to monitor air quality, water quality, and soils (Thermo Fisher Scientific 2018). Food manufacturers use similar process monitoring tools to support food labeling requirements, these methods can also be used by police departments to identify illegal drugs, process crime scene evidence, as well as assisting pharmaceutical laboratories with regulatory requirements, simply put, these tools are used for both routine quality control analysis and analytical investigations (Thermo Fisher Scientific 2018).

Market - The market for instrumentation and process monitoring products is expected to enjoy positive growth, driven by new plant construction primarily in emerging markets such as China, India, Middle East, South and Central America, but also in western economies as regulations to improve plant safety, environmental performance, and manufacturing productivity intensify (ABB 2006). Going forward, the industry of automation and process monitoring will be focused on more effective management of assets, through increased use of wireless networks, remote monitoring and diagnostics, with the help of low-power sensors, battery chemistry, communication protocols, and improved utilization of existing data (ABB 2006). Simply put, manufacturers will continue to focus on improving the efficiency of critical methods, and process monitoring will play a major role, specifically, the usage of robots, however, decreasing human labor and scarcity of investment for many companies could be major restraints (MarketWatch Inc 2018). The Asia Pacific region dominates the industrial automation market introducing advancements in technology and system integrations, whereas, North America is the second largest market due to the high demand for semiconductor products and general manufacturing, and Europe showing positive growth with the adoption of automated control systems for the automotive and power generation sectors (MarketWatch Inc 2018).

8.3.4 BACKGROUND OF PERIMETER ACCESS SUB-INDUSTRY

History - The "American Dream" has been loosely defined since the early nineteenth century as a belief that opportunity and prosperity exist for all, regardless of class or circumstance, that with hard work, upward mobility can be achieved in the U.S. A central part of this thinking has been homeownership since most experts believe that owning your own is central to wealth building. With home ownership comes home improvement, an essential component of today's economy in the U.S. and Canada, where the physical landscape is dotted with big box retailers selling billions of dollars of goods, along with the virtual landscape of cable television, where home improvement shows can be watched by millions (Randl 2015). In the 1920's, middle

class Americans simply did not view home ownership as a key component of prosperity, however, manual laborers and immigrants did, as a sign of progress and a hedge against unemployment, with homes often being constructed by owners themselves using mail-order home kits (Randl 2015).

After World War II, returning servicemen with employment in the private sector, sought suburbia, creating a wave of migration away from congested city centers, looking for open spaces with large yards in pre-planned neighborhoods. These housing developments were the fuel for a primed and ready home improvement market. The home improvement boom can be attributed, in some part, to amateur improvers, the "handymen", and the recognition by retailers of their growing spending power, as well as, older and even recently constructed houses with unfinished basements or attics ready for remodeling (Randl 2015). In the 1960's and 1970's, home improvement became ubiquitous, with a tremendous number of customers, and a housing shortage in some parts of the U.S., do-it-yourself projects became an imperative, however, other economic factors also supported the trend such as increasing levels of discretionary income, shifting gender norms, availability of credit, and the rise of a generic consumer focused society (Isenstadt 2013).

Market - With the build-up of wealth, homeowners began to purchase more modern technologies such as appliances, televisions, telephones, radios, and to protect another large family investment, the automobile, garages and garage door openers, and security systems. As the overall security situation changed in the late twentieth and early twenty-first centuries, new perimeter access solutions to address growing levels of angst were developed. Electronic fencing with sensors, integrated fiber-optic detection systems, and video surveillance, along with remote access to homes and data anywhere in the world, are some of the current perimeter access technologies on the market.

Rising confidence in the economy and higher incomes have enabled households to make larger purchases, this increased disposable income is expected to drive an increased demand for housing starts but will also drive more home improvement projects boosting industry revenue growth (IBISWorld 2017). New technologies will also drive segment growth as manufacturers look to create more advanced products to boost profit margins where the integration of systems will provide the user with more accurate information and enhanced decision-making power (IBISWorld 2017).

Other market mega trends today include increased urban infrastructure, migration of young people from suburbia to cities, overall technological advancements, data collection and analytics, this will help drive next-generation perimeter access solution market growth (Reuters 2017). These systems will create a wall of protection around property, ready to alarm at the presence of an intruder through

connected products which are able to profile specific locations, as well as, biometrics-based electronic locks and sensor-based alarm systems (Reuters 2017).

8.3.5 BACKGROUND OF MEDICAL DEVICES SUB-INDUSTRY

History - The creation of nationalized healthcare systems has taken contrasting paths throughout the world, the model developed in the U.S. is distinctly different than that one that has emerged from Europe. The U.S. system can be traced back to the end of the nineteenth century and the Industrial Revolution where precarious and dangerous steel mill jobs led to a rise in workplace injuries (Griffin 2017). U.S. healthcare costs came into focus in 1910 when the first pre-paid health insurance plan became available, by 1929 enrollment in these plans grew to three million (Blue Cross Blue Shield 2012). The influential American Medical Association (AMA) was founded in 1847, focused on scientific advancement, medical education, and improving public health, the organization was ingrained deeply with government to bring change to the healthcare landscape (AMA 2018).

The back and forth of a nationalized U.S. health care system continued, several attempts failed, however, tangential legislation was passed. The Social Security Act of 1935 created a system of benefits for the elderly, disabled, and/or unemployed, along with the Stabilization Act of 1942, authored to combat inflation by limiting wage increases (Griffin 2017). The Act of 1942 incentivized companies to offer employer sponsored health insurance for the first time as a means to attract and retain employees (Griffin 2017). Cost concerns went unabated, the price of hospital care doubled in the 1950's, again a comprehensive solution could not be found, however, the Social Security Act of 1965 was signed into law by President Truman that essentially created the Medicare and Medicaid benefit programs (Griffin 2017). Other significant legislation related to healthcare such as the Social Security Amendment of 1972, the Health Maintenance Organization Act of 1973 (HMO), the Health Insurance Portability and Accountability Act (HIPAA) of 1996, and more recently in 2013, the Patient Protection and Affordable Care Act (PPACA), have changed the U.S. healthcare system (Griffin 2017).

Regardless of the healthcare framework, populations of many lands have benefitted from numerous medical innovations, from care practices, treatments, vaccines, drugs, and devices. In 1854, British troops suffered immensely from cholera and diarrhea, Florence Nightingale, was dispatched and subsequently developed care practices that reduced illness rates such as overcrowding rules, ventilation provisions, and disinfecting of latrines (Sheingold and Hahn 2014). Building upon this during the U.S. Civil War, a sanitary commission was created for the Union Army, where Clara Barton led inspections of living conditions and habits, ultimately, she organized diet kitchens, made bandages, and conducted door to door

"blanket raids" to prevent soldiers from sleeping on the ground (Sheingold and Hahn 2014).

In the 1860's, Louis Pasteur, a French chemist, discovered that disease was caused by microorganisms, this led to the adoption of antiseptic practices by physicians and hospitals. In 1879, Charles Chamberland, a French physician and biologist who was influenced by journal entries from the year 1679, invented the first auto-clave for sterilization (Sheingold and Hahn 2014). In 1895, Wilhelm Rontgen, whilst researching cathode rays, found that under controlled conditions, a plate covered on one side with barium platinocyanide placed in the path of rays became fluorescent (Nobel Media AB 2018). Rontgen later placed the hand of his wife in the path of the rays where after development of the photographic plate, an image of her hand appeared which showed shadows of the bones, a ring she was wearing, and surrounded by the penumbra of flesh (Nobel Media AB 2018).

Market - Medical technology certainly has evolved but opportunities for innovation remain plentiful. The broader market for devices is expected to have a positive outlook going forward due to governmental spending across the world, especially in emerging and developing markets, also, people, generically, are living longer. The impact and capabilities of technology has led to increased development and interest in wearable medical devices, such as the Apple smart watch that also functions as a heart rate monitor, Fitbit's Sano startup that is developing watches that track blood-sugar levels, and Google's Verily division working on a contact lens that can also monitor blood-sugar levels (Huang and Choong 2018).

These innovative wearable devices are expected to drive a shift from treatment to prevention with a goal of reducing the escalating costs of health care. The proliferation of data and artificial intelligence has enabled devices that can provide increasingly useful insights, however, usability and demonstration of true clinical value for the data presented, along with cybersecurity concerns have to be answered. Although the trends look favorable, the threat of disruptive technologies remains ever-present for individual firms, where industry leaders cannot be certain of their futures based on the pace of technological change (Huang and Choong 2018).

Industry - The health care equipment and supplies industry, of which medical devices are a component, has one of the highest sector Gross Margins (GM), for 2017, the average GM for the S&P Composite 1500 Health Care Equipment index was 59.4%, much higher than the broader S&P 500 rate of 30.6% and 32.7% for the health care sector (Huang and Choong 2018). Innovative health care equipment & supplies companies charge premium prices for their products to recuperate the high costs of development, along with FDA approval, whereas, companies that sell

commoditized products typically have little pricing power and low margins (Huang and Choong 2018).

8.3.6 TOP INDUSTRY COMPETITORS

To maintain secrecy of the firms and BU's enrolled within this study, a brief overview of the top firms within each particular sub-industry follows, this overview, does indeed include the actual firms involved, however, they simply will not be divulged:

Automotive (Industry) – Automotive Components (Sub-Industry):

Major competitors within the global Automotive Components sub-industry include Aisin Seiki, Continental, Denso, Faurecia, Magna, Robert Bosch, and ZF (Stastista 2018). Table 8.5 summarizes several details of these top sub-industry competitors, the 'Main Businesses' section describes key areas where each firm competes, specifically, the types of components produced, along with a section entitled 'Of Note', which highlights future business focus areas (Aisin 2018) (Continental 2018) (Denso 2018) (Bosch 2018) (Faurecia 2018) (Magna 2018) (ZF 2018).

Table 8.5 - Prominent Automotive Component Firms

Name	Aisin Seiki Co LTD	Continental Corporation	Denso Corporation	Faurecia Corporation	Magna International	Robert Bosch GmbH	ZF Friedrichshafen AG
Headquarters	Kariya, Japan	Hanover, Germany	Kariya, Japan	Nanterre, France	Aurora, Ontario	Gerlingen, Germany	Friedrichshafen, Germany
Web Address	www.aisin.com	www.continental-corporation.com	www.globaldenso.com	www.faurecia.com	www.magna.com	www.bosch.com	www.zf.com
Main Businesses	Transmissions, clutches, disc brakes, suspensions, oil pumps, power windows, and power door locks	Tires, brakes, interior electronics, automotive safety, powertrain and chassis components, tachographs	Air conditioners, air bags, ignition systems, generators, power steering systems, spark plugs, and communication equipment	Seating, interior systems, and emissions control technologies. #1 supplier of seat frames, emissions control, and interiors, #3 supplier of complete seat systems	Exterior systems, seating, closure systems, vision systems, powertrain, electronic systems, body/ chassis systems, hybrid & electric vehicle systems, and contract assembly	Mobility solutions, consumer goods, industrial technology, and energy/building. Mobility includes brakes, traction control systems, body electronics, oxygen sensors, injectors, fuel pumps, spark plugs, wiper blades, and	Automotive, Rail, Marine, Defense, and Aviation – Auto Parts are transmission systems, steering, axles, chassis technology
Employees	~100,000	~235,000	~170,000	~100,000	~160,000	~400,000	~130,000
Sales	3.9T JPY ($35.2B)	44.6B Euro ($51.4B)	4.5T JPY ($40.5B)	17B Euro ($19.6B)	$39B	78B Euro ($90B)	35.2B Euro ($40.6B)
Of Note	Product Development areas of focus: Zero emissions, Automated Driving, and Connected Cars	# 6 Strategic Dimension - Technological balance – combination of established and pioneering technologies; #4 largest tire manufacturer	Innovating with its technology of "Mobility" and "MONOZUKURI" to solve social issues. Innovation for Mobility, Electrification, Automated Driving, and Artificial Intelligence	Innovation areas: Smart Life on Board and Sustainable Mobility	Mobility For Everyone™ - Magna is a mobility technology company—the only automotive supplier with deep systems knowledge and expertise across the entire vehicle	New impulse for electromobility - Less weight, greater range, and more efficiency: The eAxle; Connected Mobility, Automated Mobility, Powertrain Systems and Electrified Mobility	Megatrends in mobility include maximum efficiency, highest safety levels, autonomous driving, emission-free e-mobility and consistent digitalization

*using exchange rate as of August 9, 2018

Transportation & Logistics (Industry) - Railway Technology (Sub-Industry):

Major competitors in the global Railway Technology market include ABB, Alstom, Bombardier, General Electric, Hitachi, and Siemens (Grandview Research 2013). Table 8.6 summarizes several details of these top sub-industry competitors, the 'Main Businesses' section describes key areas such as where each firm competes, specifically, the types of components produced, along with a section entitled 'Of Note', which highlights future business focus areas (ABB 2018) (Alstom 2018) (Bombardier 2018) (GE 2018) (Hitachi 2018) (Siemens 2018).

Table 8.6 - Prominent Railway Technology Firms

Name	ABB Ltd	Alstom	Bombardier Inc	General Electric	Hitachi	Siemens
Headquarters	Zurich, Switzerland	Saint-Ouen, France	Montréal, Canada	Boston, Massachusetts	Tokyo, Japan	Berlin, Germany
Web Address	www.abb.com	www.alstom.com	www.bombardier.com	www.ge.com	www.hitachi.com	www.siemens.com
Main Businesses	Robotics, power, heavy electrical equipment and automation technology areas	Rail transport including passenger transportation, signaling, and locomotives. High-speed, suburban, regional, and metro trains	Transport – Aircraft and Passenger Trains	Aviation; Healthcare; Power, renewable energy; Digital; Additive manufacturing; Venture capital and finance; Lighting; Transportation; Oil and Gas	Information & Telecom; Materials; Power Systems; Electronic Systems; Automotive Systems; Railway Systems; Construction Machinery	Industry, Energy, Healthcare, and Infrastructure & Cities; Prominent maker of medical diagnostics equipment which generates about 12% of sales
Employees	~140,000	~34,000	~70,000	~300,000	~300,000	~370,000
Sales	$34.1B	7B Euro ($8.1B)	16.2B CAD ($12.2B)	$122B	9.3T JPY ($83.3B)	83B Euro ($96.1B)
Of Note	1)ABB Ability: Combines all digital products and services 2) Innovations across product spectrum to create a safer, greener, productive, collaborative efficient world. 3) Sustainable mobility - energy-efficient products for global transportation sustainability	Sustainable mobility; transport solutions that help decrease greenhouse gas emissions, congestion, pollution and improve public health; access to transport is an essential factor of social progress; support transition towards global sustainable transport systems that are inclusive, environmentally friendly, safe and efficient	Building the future of mobility by: Creating better ways to move the world; Capturing global growth opportunities; Strengthening customer focused excellence	Creating standalone Healthcare company; BHGE separation; Substantially complete on dispositions; Materially shrink GE Capital balance sheet; Structural cost reductions; move to decentralized model	Accelerate collaborative creation with customers and partners through the advanced Social Innovation business with a focus on the trend towards digitalization; Leverage three strengths Operational, IT, and Products and Systems	Positions along the electrification value chain – which covers the transformation, intelligent transmission and distribution of energy as well as its efficient utilization. With its pronounced strengths in the automation field, the company is well placed to face the future in general and the digital age in particular.

*using exchange rate as of September 5, 2018

Hardware (Industry) – Process Monitoring (Sub-Industry):

The major competitors within the Industrial Automation market are: ABB, Emerson Electric, Schneider Electric, Honeywell International, Yokogawa Electric, Rockwell Automation, and Fanuc (MarketWatch Inc 2018). Table 8.7 summarizes several details of these top sub-industry competitors, the 'Main Businesses' section describes key areas such as where each firm competes, specifically, the types of components produced, along with a section entitled 'Of Note', which emphasizes future areas of business opportunity or strategic imperatives (ABB 2018) (Emerson 2018) (Schneider 2018) (Honeywell 2018) (Fanuc 2018) (Rockwell 2018) (Yokogawa 2018).

Table 8.7 - Prominent Process Monitoring Firms

Name	ABB	Emerson Electric	Fanuc	Honeywell International	Rockwell Automation	Schneider Electric	Yokogawa Electric
Headquarters	Zurich, Switzerland	Ferguson, Missouri	Oshino-mura, Japan	Morris Plains, New Jersey	Milwaukee, Wisconsin	Rueil-Malmaison, France	Tokyo, Japan
Web Address	www.abb.com	www.emerson.com	www.fanuc.co.jp	www.honeywell.com	www.rockwellautomation.com	www.schneider-electric.com	www.yokogawa.com
Main Businesses	Robotics, power, heavy electrical equipment and automation technology areas	Two Businesses: Automation and Commercial & Residential Solutions	Three Business Divisions: FA (NC and Servo), Robot, and Robo-machine	Aerospace; Home and Building Technologies; Safety and Productivity Solutions; Honeywell Performance Materials and Technologies	Control systems; Industrial control components; Information software; Motor control devices; Sensing devices; Network technology; Safety technology; Industrial security	Energy management; Automation solutions; Spanning hardware; Software, and services. Parent company of Square D, Pelco, APC brands	Industrial Automation; Test and Measurement Business; Aviation and Other
Employees	~140,000	~75,000	~6,000	~130,000	~22,000	~144,000	~20,000
Sales	$34.1B	$15.3B	537B JPY ($4.8B)	$40.5B	$6.3B	24.7B Euro ($28.6B)	407B JPY ($11.8B)
Of Note	ABB Ability: Combines all digital products and services; Innovations across product spectrum to create a safer, greener, productive, collaborative efficient world; Sustainable mobility - energy-efficient products for global transportation sustainability	Constantly striving to be more connected, forward-looking and customer-focused. Company values serve as our foundation, informing every decision we make. They are part of a shared vision that keeps us grounded as a company, moving forward together even as the industries we serve continue to shift and transform.	FANUC develops high quality products featuring "intelligence", "ultra-precision" and "high functionality, while adhering to its basic policy of "high reliability" in product development.	Invents & manufactures technologies for global challenges of energy, safety, security, productivity & urbanization. Blending physical products with software for connected systems, improve homes, buildings, factories, utilities, vehicles and aircraft	Improve the quality of life by making the world more productive and sustainable. Enable next generation of smart manufacturing. Integrate control and information across the enterprise to help industrial companies and their people be more productive. Work to boost your productivity.	Firm participated in a NPD forum, several factors to improve performance were identified: Ensure customer are part of R&D culture; Improve PM governance; Introduce lean and Agile methodologies to Waterfall process; Practice open innovation with start-ups, universities	Provides systems and technologies together with customers that prompt them to change perspectives. Innovation process consists of three concentric layers: Innovation Activities (Research); Standardization, IP, Open Innovation; External Environment

*using exchange rate as of September 5, 2018

Consumer Discretionary (Industry) – Perimeter Access (Sub-Industry):

Prominent firms competing within perimeter access market include: Anixter International, Axis Communications, Johnson Controls, Honeywell International, United Technologies, and Chamberlain Group (Grandview Research 2017) (Reuters 2017). Table 8.8 summarizes details of these top sub-industry competitors, the 'Main Businesses' section describes key areas such as where each firm competes, specifically, the types of components produced, along with a section entitled 'Of Note', which describes future business focus areas and or strategic priorities (Anixter 2018) (Axis 2018) (JCI 2018) (Honeywell 2018) (Chamberlain 2018) (UTC 2018).

Table 8.8 - Prominent Perimeter Access Firms

Name	Anixter International	Axis Communication	Chamberlain Group	Honeywell International	Johnson Controls International Plc	United Technologies
Headquarters	Glenview, Illinois	Lund, Sweden	Oak Brook, Illinois	Morris Plains, New Jersey	Cork, Ireland	Farmington, Connecticut
Web Address	www.anixter.com	www.axis.com	www.chamberlaingroup.com	www.honeywell.com	www.jci.com	www.utc.com
Main Businesses	Network & Security Solutions; Electrical and Electronic Solutions; Utility Power Solutions	Majority of sales from video products: Network cameras; Video encoders; Accessories and Application Software	Residential garage door openers; Commercial door operators; Gate entry systems; Connected Products	Aerospace; Home and Building Technologies; Safety and Productivity Solutions; Honeywell Performance Materials and Technologies	Buildings; Batteries; and Distributed Energy Storage	Aircraft engines; Aerospace systems; HVAC; Elevators and Escalators; Fire and Security; Building systems; Industrial Products
Employees	~9,000	~3,000	PRIVATE	~130,000	~120,000	~200,000
Sales	$7.6B	8.6B SEK ($0.95B)	PRIVATE	$40.5B	$30.2B	$59.8B
Of Note	Works with integrators, end users, and contractors to build connected systems that handle data demands of tomorrow. Anixter helps to address industry challenges and maximize performance and value of your assets throughout a project's lifecycle.	First company in the world to launch a network camera in 1996, initiating the shift from analog to digital technology. Offers security solutions for crime prevention; Security solutions, including network cameras as building blocks for environmentally and socially sustainable cities	Design and engineer variety of access control products that are connected through innovative technology which empowers users to control or monitor their entry points through smartphone access. We are also the largest wholesale distributor of perimeter access control equipment in the U.S.	Invents and manufactures technologies for global challenges around energy, safety, security, productivity and urbanization. Blending physical products with software for connected systems that improve homes, buildings, factories, utilities, vehicles and aircraft	JCI focus on productivity, security, and sustainability. Create intelligent buildings, efficient energy solutions, integrated infrastructure and next generation transportation systems, promise of smart cities and communities.	Developing digital solutions - expanding digital capabilities – Aligned in: Smart Factory, Service Transformation, Connected Products and Customer Experience. UTC focused on Machine Learning - Algorithms to learn from, draw conclusions about and make predictions on data without being explicitly programmed.

*using exchange rate as of September 5, 2018

Healthcare (Industry) – Medical Devices (Sub-Industry):

The top competitors within the global medical device markets are: Johnson & Johnson, Medtronic, GE Healthcare, Siemens Healthcare, Philips Healthcare, and Stryker (IGEAHub 2018). Table 8.9 summarizes several business details of these top sub-industry competitors, the 'Main Businesses' section describes key areas such as where each firm competes, specifically, the types of components produced, along with a section entitled 'Of Note', which highlights areas of future business focus (JNJ 2018) (Medtronic 2018) (GEHealthcare 2018) (SiemensHealthcare 2018) (Philips 2018) (Stryker 2018).

Table 8.9 - Prominent Medical Device Firms

Name	GE Healthcare	Johnson & Johnson	Medtronic	Philips Healthcare	Siemens	Stryker
Headquarters	Chicago, Illinois	New Brunswick, New Jersey	Dublin, Ireland	Amsterdam, Netherlands	Erlangen, Germany	Kalamazoo, Michigan
Web Address	www.gehealthcare.com	www.jnj.com	www.medtronic.com	www.philips.com	www.healthcare.siemens.com	www.stryker.com
Main Businesses	Healthcare Systems; Life Sciences; Healthcare Digital	Consumer Products; Medical Devices; Pharmaceutical Products	Restorative Therapies Group; Minimally Invasive Group; Cardiac and Vascular Group; Diabetes Group	Consumer Lifestyle (consumer electronics, appliances, personal care); Healthcare; and Signify (lighting)	Diagnostic Imaging; Laboratory Diagnostics; Advanced Therapies; Ultrasound; Point of Care Diagnostics and Services	Implants; Surgical Equipment; Endoscopic; Communications Systems; Patient Handling; Emergency Medical Equipment; Neurosurgical; Neurovascular
Employees	54,000	134,000	84,000	114,188	45,000	33,000
Sales	$18.3B	$76.5B	$29.7B	24.5B Euro ($28.4B)	14.2 Euro ($16.5B)	$12.4B
Of Note	Global markets expand, predominately in China; Drivers were Ultrasound & Imaging, as hospitals and other facilities are built, particularly in emerging markets, & as equipment is replaced primarily in developed markets. Focus on productivity-based technology, services and IT/cloud-based solutions as healthcare providers seek greater productivity and better outcomes.	Improved quality, execution, & competitiveness; Near-term priority is to accelerate growth though innovation and improved execution; Instituted a rigorous portfolio management process to better focus; Expect increasing impact of technology & data on products	Focus on application of biomedical engineering in the research, design, manufacture, and sale of instruments or appliances that alleviate pain, restore health, and extend life. Direct growth in the areas of biomedical engineering. To strive for the greatest possible reliability and quality in our products	Mega trend of healthy living, new ways to proactively monitor and manage health. Value shifting from stand-alone products to systems, smart devices, software and services, which deliver greater benefits. Focused on convergence of consumer technologies, medical technologies, and cloud-based technologies	Four main tenets - Expanding Precision Medicine; Transforming Care Delivery; Improving Patient Experience; Digitalizing Healthcare. Global healthcare is transforming, pressure for better outcomes, lower cost; Drivers are increasing societal resistance to costs, payers shift to value-based reimbursement, chronic disease burdens, and rapid scientific progress.	Continued investment in R&D activities is critical for future growth. Most products and product improvements were developed internally. Invest through acquisitions in technologies developed by third parties, potential to expand current markets. Close working relationships with medical personnel, assist us in product development efforts.

*using exchange rate as of September 5, 2018

9 MULTI-CASE STUDY

A multi-case study approach was used to ensure the development of grounded, accurate, and generalizable theory, enabling comparisons that clarify whether an emergent finding is singular or replicated in other cases (Goggin 1986). The multi-case comparisons were conducted without a given hypothesis, the goal was not to test a specific set of variables, but to search for similarities and differences, successes and failures, between cases. These comparisons were repeated through several rounds of analysis to search for emergent theories and patterns (Yin 1999, Eisenhardt and Graebner 2007).

The five teams that participated in the study were defined BU's and treated as individual cases to create a comprehensive picture of the activities, functions, and methods for each group, along with cultural and team dynamics. Since large firms, such as the ones represented within this study, often do not practice NPD in the same manner across an entire enterprise, or ASGM may have only been practiced within a particular project team, the BU's were treated as unique entities. These firms have thousands of employees, were geographically dispersed, competed in differing market segments, and often did not share methods or practices of product development. Each BU was ultimately aligned to a specific corporate grouping but the teams generally were very independent units of a conglomerate. In fact, it was common for study participants to highlight how other project teams behaved differently, so the treatment of a BU as a unique entity was appropriate. The selection of the firms and BU's included in the study were not based upon the sampling of attributes as the highest priority, but were selected with respect to balance and the opportunity to simply learn (Stake 2005).

To ensure the robustness of each case study, a variety of techniques were used including participant surveys, archival data, and document searches to gather a substantial amount of evidence and ultimately develop a common set of data (Yin 1999). Each case study was developed around similar elements used to drive consistency of approach and to enable cross-case comparisons. Researchers traditionally gather data on key facets to understand the nature of each case, historical background, physical setting, and informants (Stake 2005). To define each case study, information such as the following was collected and analyzed:

- Firm – Revenue, Margins, # of Employees, R&D Spend, Strategic Priorities, Market Challenges, Team Size, Geographic Dispersion, etc.
- Business Unit – Unique Development Team and Business Challenges, Market Characteristics, Team Culture, Organizational Responsibility, etc.
- Participant – Educational Discipline, Professional Experience (Years), Team Role, Current Title, Background, etc.

From this information and the participant interviews, a brief summary of each firm was developed, along with a description of the BU involved. The data was used to generate a clear illustration of the firm, BU, and participants, highlighting unique elements and challenges for each, additionally, each case was evaluated against the two research questions that framed the study:

- Agile/Scrum Implementation Techniques – Using eight main elements of Agile/Scrum as a foundation and an indicator of general 'Agile' practices, participant quotations were mined
- ASGM Measures of Success – Participant quotations were again used to validate perceived business benefits of speed, success, and resource consumption

9.1 THEME CONSTRUCTION

Cross-case comparisons were established in a manner that highlighted the few attribute differences that existed as to not encumber learning (Stake 2005). Table 9.1 summarizes the Primary and Secondary themes discovered and organized, all participant transcripts were analyzed, and themes organized. Each case was developed into Primary themes and Secondary themes, a quantitative grouping was conducted, based upon participants quotes, to establish the relative strength of each theme to illustrate the prioritized behaviors for each case.

Table 9.1 - Summary of Primary and Secondary Themes

Case #	Primary Theme			Primary Theme		
	Secondary Themes			Secondary Themes		
1	Process Speed			Innovation Enabling		
	Lightweight Process	Concepts	Team Talent	Relationships	Customer Value	Entrepreneurial Mindset
2	Process Speed			Market Success		
	Process Control	Process Flexibility	Project Communication	Customer Value	Speed to Market	Business Longevity
3	Process Speed			Market Success		
	Process Control	Process Flexibility	Team Engagement	Customer Value	Business Longevity	Speed to Market
4	Process Speed			Market Success		
	Process Control	Team Engagement	Team Communication	Business Longevity	Product Requirements	Customer Value
5	Process Speed			Market Success		
	Process Control	Process Flexibility	Team Communication	Team Talent	Customer Value	Business Longevity

Figure 9.1 illustrates the ASGM Primary and Secondary themes as extracted and organized with a content analysis methodology.

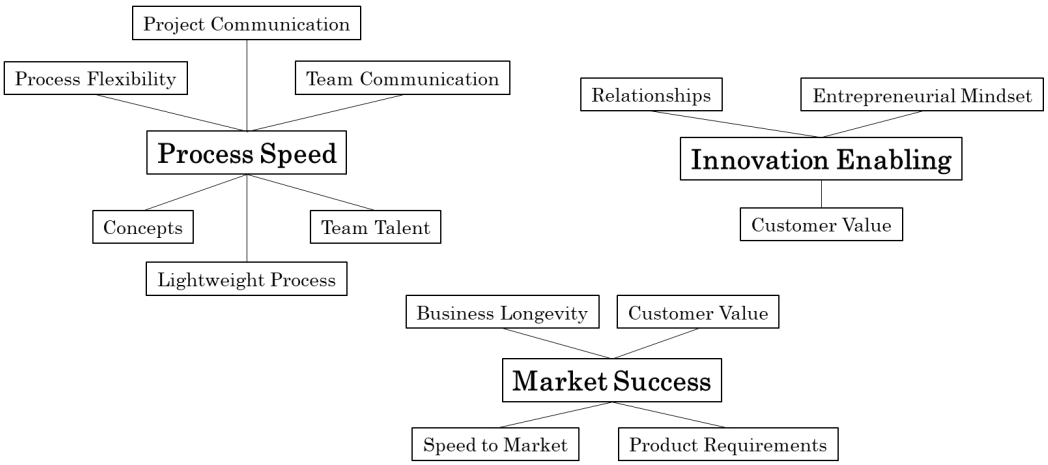


Figure 9.1 - ASGM Primary and Secondary Themes

9.2 CASE STUDY ONE (CS1)

One of the world's largest automotive suppliers, Case One was a conglomerate with many sites around the world, its strategic priorities are aligned with market megatrends, such as mobility and connectivity, and has business goals to accelerate profitable growth. The firm is a major component supplier to global automotive Original Equipment Manufacturers (OEM) with extensive design and manufacturing capabilities and traces its roots back to legacy automotive manufacturing but is actively trying to diversify and remake itself by developing newer technologies. The firm is unique in seeking mobility offerings, other automotive component conglomerates are also seeking "technology" as a key differentiator. The firm has added design and production capabilities through acquisitions with an acute focus on Asia and believes engaging and embedding early with OEM's and offering a suite of technological options will enhance their differentiation. The firm has created global innovation teams that focus on accelerating the pace of technology adoption, as well as, incubating an entrepreneurial mindset. Lastly, the firm employs its own Agile front-end research process, which leads to a traditional SGM framework to deliver a viable component, platform, or system, however, the firms' products, subsequently, must complete the OEM's development process which was normally an SGM approach, as most of the BU's products are not directly sold to end users.

9.2.1 BU SUMMARY

Participants were part of a team focused on front end Technology Scouting (TS) and innovation process activities that remained largely upstream of the traditional development process. They sought external partnerships with universities and/or

start-ups in an attempt to identify and acquire new technologies and/or capabilities desired by customers. These partnerships manifested as technology development and/or licensing agreements. CS1 had many different opportunities in-play at any moment, reserving evaluation capacity, because of the uncertain nature of their work, evaluations happened quickly, pivoting often.

Process rigor was strongly avoided for the sake of speed, most TS projects were quick engagements with immature businesses and technologies, these quick assessments could help establish a first mover advantage. The BU's mission was based upon growing innovation for their parent organization, where TS projects were purposely kept at a "strategic distance" from the main product development organization to "avoid bureaucracy, career building, and institutionalization", however, each opportunity had to be thoroughly evaluated, standing on its own merits within the broader portfolio.

The BU utilized quick Proof of Concept (POC) models that, if approved, ultimately fed a traditional SGM development process. A POC generated by the team would then transition over, once successfully completing a phase review, to the local market engineering groups, which worked to mature a given technology in preparation for a potential product development program with an OEM.

CS1 members felt that the incentives the influenced business executives often did not support higher risk technology evaluation, as leaders were typically measured on near term financial success, which were often in conflict with TS projects that were years away from fruition. Because of these concerns, a separate, autonomous organization that was solely focused on front end research and opportunity evaluation was created. Participants also felt the firm was challenged by marketplace change and struggled to maintain relevancy and commoditization, but with a focus on higher customer value areas, such as mobility and connected platforms, this could change.

Agile techniques were sought by the team because of the lighter process footprint compared to traditional SGM, along with a perceived speed benefit thought to be very beneficial to the research process. In addition to utilization of Agile techniques within the front end of development, the BU had modified their internal NPD process to execute more of the detailed engineering work toward the manufacturing phase and away from the front end to unencumber earlier phases of development.

9.2.2 THEMES

Based on the interview transcripts, two major themes were discovered: Process Speed and Innovation Enabling, from these, several Secondary themes were also extracted. Table 9.2 summarizes the Primary and Secondary themes discovered from CS1 along with relevant participant quotes that support the assertions made.

Broadly speaking, Process Speed was a more dominant Primary theme than Innovation Enabling, the team simply balanced a full portfolio of opportunities which required, fast, thorough decisions.

Process Speed – Process Speed, as defined for this Primary theme, represented the team's desire to move through the development activities as quickly and efficiently as possible. Communication, either intra-team or inter-team, development framework flexibility to manage all styles of projects, the ability of the managing framework to deliver repeatable performances, team-to-team, as well as the delivery of required design artifacts, such as drawings, test reports, quality analysis, manufacturing planning documents, and other critical design information, are all key concerns study participants revealed. CS1 operated largely within the fuzzy front end of product development, mining technology and partnership opportunities, where once completed, projects fed a traditional SGM style process. TS projects were short term, technology and business evaluations, which required quick concepts, guided by a framework that was flexible, but staffed by experienced, focused, cross-functional resources. Because of project volume and timeliness desires, the evaluation process had to be lightweight for rapid decisions. The team desired speed, not necessarily speed-to-market which is often discussed in today's journals, but speed to project completion, where completion was an evaluation of a particular engagement or technology application. The ASGM method implemented enabled this 'speed-to-decision' with a viable and repeatable framework. Several supporting Secondary themes were extracted and organized, in order of theme strength, Lightweight Process, Concepts, and Team Talent were the top three.

Process Speed Secondary Themes:

> **Lightweight Process** – To enable the team's efforts towards timely decision speed, a lightweight or minimalistic Agile inspired process was created. The desire for a methodology, which would deliver consistent results that was not exceedingly burdensome nor one that mandated excessive decision points or work that did not fit specific project hurdles, was clearly stated. Several project opportunities advanced in parallel in the form of intense, direct, twelve-week engagements with targeted partners. The team was very active, but the simple, streamlined and focused methodology worked, by choice the team was separated from the main product development organization which was seen by CS1 participants as overly bureaucratic and sluggish. The decision information gathered had to encompass a technological assessment, along with evaluations of the market opportunity, perceived end customer value, as well as, project time and cost estimates, therefore, the evaluation effort was thorough, not simply fast.

Concepts – The CS1 team charter was to evaluate technology opportunities quickly by mining global relationships found typically in startups, university technology transfer offices, or mature, but maybe smaller companies. Many of the BU's partners were immature or incomplete entities or technologies that had unclear pasts, or uncertain futures. The team worked in these uncertain areas to establish a potential competitive edge, to help the firm stand out from its peers, the business wanted to be first to market or, at least, first to demonstrate differentiated offerings, as such CS1 identified, evaluated, and understood end customer 'value' intrinsically. Projects could not simply accumulate within the active portfolio, the open project list had to be manageable and meaningful for the business, so quick, but thorough Go/Kill decisions were a priority. POC's were crucial to their project evaluations, either a demonstration of a particular technology in and of itself, or a full vehicle demonstration was conducted. Quick prototypes, which allowed the team to maintain lock-step with the customer base and has been a hallmark of Agile, enabled faster decisions, which drove improved Process Speed.

Team Talent – The ASGM process was used to keep development activities on track and repeatable as opportunities were evaluated, however, the study participants also stressed that an experienced and highly skilled team was equally crucial. Personnel had to be entrepreneurial in spirit, which moved quickly in a flexible manner, open to ideas and possibilities, but also possessed the correct categories of technical talent, such as, mechanical, software, and hardware design, as well as, marketing, finance, quality, and manufacturing. The procurement of specific skills was based upon the particular technology being evaluated, a software only product would not need mechanical design talent as an example. To move quickly with thoroughness, all of the functional experts were on the team and were highly experienced, this was no place for novices or experts distributed across competing priorities.

Innovation Enabling – The CS1 operational model was as an "accelerator" that searched for new technologies and partnerships, internal or external. The team aimed to engage potential new partners quickly to develop concepts, along with business plans, with a focused team, running time bound activities, through intense engagements. CS1 had many opportunities active at any point in time, pivoting frequently. The team was staffed with a dedicated and separate group of technical, but yet business minded, entrepreneurs that could advance a concept quickly but was mature enough to enter into a development pipeline with an OEM customer. The firm wanted to maintain a leading technology position with their OEM customers by offering a plethora of options, a variety of cutting-edge technologies

that aligned to customer needs and market mega trends. The broader firm also supplied foundational elements from their long history within the automotive supply chain, however, as market forces drove dramatic change, the CS1 team had to provide unique solutions to position themselves as true innovators with pricing power. Innovators provide solutions that are not found elsewhere in the market, they must deliver value and opportunity to customers where others had failed. Supporting the Innovation Enabling Primary theme, several Secondary themes were identified and organized, by magnitude, Relationships, Customer Value, and Entrepreneurial Mindset were the top three.

Innovation Enabling Secondary Themes:

Relationships – With a goal of a recognized and differentiated portfolio, the team could not simply rely on internal technology development. CS1 scouted technologies globally that pursued new relationships especially those outside of the traditional automotive component supply chains. Market disruptors were pursuing self-driving cars, in some cases these organizations were not traditional automobile manufacturers but were technology companies with focus on change and disruption, not plants, tooling, and production quotas. CS1 had to find relationships and technologies quickly, evaluated through product demonstrations, the team had to ensure opportunities were real before disclosing them to potential customers. CS1 could acquire these new technologies and relationships, but in the end, their offerings had to be legitimate before a large contract, often worth hundreds of millions of dollars, could proceed. NPD cycles for this market often take years before commercialization, a new technology carried risk, therefore, the technology had to be viable.

Customer Value – Customer Value was defined within this Secondary theme as the desire of the business to align, specifically, to the things their customers wanted, needed, and most importantly, were willing to pay for. These features were often the differentiators one firm had over another, or one competitor over another, these were the "Why Buys?" articulated in sales brochures or marketing materials. A tremendous amount of work went into finding these needs, this was often not a long list of features to accommodate a tender process, this was a shorter list of what truly made one product differentiated from another and resonated with customers. If the end customer was enamored with a unique feature, but would not pay for it, or simply did not order product, then the feature was arguably, worthless. The true winners were products or features that were unique, wanted, provided compelling stories, simply, ones that brought enormous value to a customer.

Technology could not be developed simply for its own sake, NPD work was expensive, the cost of development, particularly for firms that created physical products, consumed large sums of resources, often over the course of years. TS projects had to deliver real value, scouting these relationships had to yield results. The firm represented by CS1 was a publicly traded entity, shareholders demanded a return, long term viability of the business was strongly linked to business growth, where margin improvement came with more advanced technologies, the firm was actively trying to move away from commodity businesses and toward mobility and other technologies, not just to gain market share, but also establish pricing power. Customer demonstrated value was the foundation for innovation projects.

Entrepreneurial Mindset – The CS1 team aligned strongly with an entrepreneurial spirit, the old ways of doing business had to be discarded, the "same old" thinking, which included the tools and processes used for development, had to be revisited and challenged. Team members had to be unencumbered to question, even encouraged, to contest orthodoxy, but also understood the needs of the end customer. The team intrinsically comprehended end customers' desires or user needs, along with the problems to be solved. The firm was a large global automotive component conglomerate, inside of this behemoth, CS1 was a technology scouting group charged with developing prototypes and opportunities, the group was strategically separated from the rest of the organization for a reason, with dedicated personnel, leadership did not want to activities to become "institutionalized" within the broader organization, becoming slow and staid. The team members thought like small business owners who were unafraid to gamble or fail, in the world of Facebook, Apple, and Google, old line staid manufactures had to change to remain relevant.

Table 9.2 - CS1 Participant Quotations Primary and Secondary Themes

Themes	Sub-Themes	Organizational Role	Participant ID#	Relevant Participant Quotations
Process Speed	Lightweight Process	Leadership	1	…we are basically taking an accelerator model, and modified it to a concept model…we try to make that be very light in terms of what the requirements are…
		Program Management	5	…focus on doing minimal amount of paperwork…I guess make sure we are not bogged down by the process. The process itself is not the end game, the process itself is not what people are spending all their time on…What allows us to be faster…minimizing the process and the details…
		Leadership	1	…based around the proof of concept, and it has kept at an arm's length from the organization that it doesn't get embedded in a bunch of bureaucracy, and career building…
	Concepts	Program Management	10	…there is value in being able do more things more quickly and make decisions and fail-fast if you want to use those terms.
		Leadership	1	It's basically a way for us to prove out the hypothesis surrounding the technology, the startup, and business market opportunity, and by forcing the tight timelines around it.
		Program Management	5	…our process does a lot to do that earlier, because we found that we can no longer go very far down the path without getting customer feedback. What we do is as early as we possibly have an idea…we go back to them and say, "Here it is, what do you think?"
	Team Talent	Program Management	10	The perfect scenario is that you have this cross-functional, collaborative, open, disruptive team…an openness to be surprised. So some percentage of the activity and some level of trust is there to allow for people to push in different directions.
		Leadership	1	To get through the process to make sure that we're getting the right information created or learned, it really is almost about having the right people leading those projects.
		Program Management	5	…if you have the right creative people, if your projects are being led by entrepreneurial people, maybe they're technical and skilled…hiring the right people, and we have to think outside [the box] …you have to think about that when it comes to hiring too.
Innovation Enabling	Relationships	Program Management	10	When we have an engagement with a startup company…our approach is that there's a gate for the…project that is enabled by that relationship…at a bigger picture we're doing investment committee portfolio reviews about the overall opportunity…We're connecting the two so that we're not doing investment from things where we don't have a product or otherwise a business relationship.
		Leadership	1	It's critical and paramount, if we're actually working with mutual benefits in the mind. It's really got to be both of you working in partnerships that delivers some value. I think those are the things that pop in mind to me.

		Leadership	1	We are looking at a lot more at public-private partnerships, where we create an eco-system around the technologies and concepts that we are considering.
	Customer Value	Leadership	1	I think that you got to have a use case and align what provides true value to the end consumer. Not the [Manufacturer], but the manufacturer's consumer...It's not [simply] new technology, it actually provides a value in terms of solving a problem or creating an opportunity for the end consumer.
		Leadership	1	…we need to think like a consumer not about what the customer is going to say. Is there a benefit to the consumer that consumer looking at use-cases, user experiences and so on. It takes that kind of mind set up front.
		Program Management	10	…the individual bits had business cases that made sense…the overall big picture has value but you might need to invest in this or that and an individual thing is not maybe going to return what you need. In a situation of one plus one plus one equals eight…
	Entrepreneurial Mindset	Program Management	5	It's having a lot of input where no one even worries about what the answers are because something new will come out of that conversation. What allows us to be faster upfront…but I think it's also the mindset of the person. Do they have a business mindset, are they thinking it like a consumer?
		Program Management	5	What allows us to be faster upfront is not only the minimizing the process and the details we have to go in through, but I think it's also the mindset of the person. Do they have a business mindset, are they thinking it like a consumer?

9.3 CASE STUDY TWO (CS2)

The firm was founded over a century ago as a manufacture of electrical components, today it delivers a large portfolio of technology solutions for global utility, industrial, transportation, and infrastructure customers. The firm spent roughly 4.0% of revenue on R&D at several research centers and was a major competitor within many markets, producing highly engineered components and systems with a global footprint. With its technology established, firm performance recently had been underwhelming, prodding executives to place more focus on the financial aspects of the business, a key challenge was to combine margin improvements with growth to drive earnings performance. The selling divisions had recently improved gross margin performance through employee compensation reductions and working capital limitations, instituted a revised employee compensation system, and assembled a streamlined organizational structure. The firm made progress towards improved business competitiveness, higher-growth segments, and a more palatable business risk profile, not only through these aforementioned initiatives, but also from Mergers & Acquisitions (M&A) activity. NPD teams across the firm, and its many R&D centers, did not practice development in a common manner, however, the over-arching, company-wide approach, tended to be a Stage Gate method, although, many pockets of groups, especially developing software, had adopted and embraced Agile techniques.

9.3.1 BU SUMMARY

The BU engaged in the study was based in Western Europe and competed in a sophisticated, mature market, which delivered railway transportation propulsion components and systems for global customers. The market where CS2 engaged was a center piece of many significant worldwide challenges, such as public transportation availability, energy efficiency, and climate change, however, the actual technologies implemented to address these concerns have been known for years and appeared to change slowly. CS2 supplied complex, integrated systems that powered high-speed trains, either new production or refurbishments, that balanced cost, reliability, weight, size, and energy efficiency.

The BU's customers were highly regulated, which required significant external testing to industry or international design standards as a means of demonstrating compliance and tended to operate traditional SGM practices with development cycles that usually lasted a year or more. The customers of CS2 typically pursued government issued contracts through a tender based bidding process, as a direct, or Tier-1 supplier, or in other cases, a sub-contractor, or Tier-2 supplier to a rail manufacturer. The tender process, which was common for the industry, often provided the BU a detailed, but somehow, incomplete list of project requirements that were often deficient articulating detailed system specifications which led to ambiguous and confusing product specifications. Occasionally rework of tender

specifications, due to a lack of clarity, led to friction with its customers, and in some cases NPD projects had to be halted, modified, or cancelled outright. The friction between CS2 and its customers, on rare occasions, degenerated into difficult legal disputes harming the BU's reputation within the marketplace. Most NPD projects were a direct result of customer contracts, conversely, to a lesser degree, the BU would execute feasibility projects to align and maintain their technological leadership status which supported customer expectations.

The CS2 team practiced a popular, commercially available version of Agile, with ambitions to operate this methodology as recommended, in its entirety. Since the BU's customers, and broader corporation, relied on traditional SGM, the CS2 group practiced Agile largely in an intra-phase manner, where phase reviews were dictated by an overall rigid project schedule described within the customer development contract. Study participants mentioned that regulating bodies who evaluated their designs against international standards, were not as familiar with Agile techniques and therefore were concerned about their application for external certifications which presented an additional headwind.

The group from CS2 were partnered with a subset of technical folks in Eastern Europe, as well as, some functions, namely Software Development in India. The team was truly global in scope with strong geographic dispersion. Agile techniques were originally desired because a of perceived time to market benefit, along with a desire to erase a subtle history of failed long cycle projects due to poor customer requirement clarity. CS2 participants felt that, on too many occasions, resources were being wasted delivering inadequately specified designs that were ultimately rejected by the customer or required significant project rework.

9.3.2 THEMES

Based on the interview transcripts, two Primary themes emerged: Process Speed and Market Success, from these, several Secondary themes were discovered. Table 9.3 summarizes the Primary and Secondary themes from CS2 along with relevant participant quotes that support the assertions made. Process Speed was slightly more prevalent than Market Success for the CS2 team.

Process Speed – Process Speed as organized from the transcripts, had the same tenets as those understood from Case Study One. Here, the R&D team was responsible for key components of railway propulsion systems and other platform technologies for adjacent product lines. The team aligned around Agile techniques originally due to past influences and positive experiences from internal software projects, but also based upon the advertised flexibility of Agile, along with specific communication tools, and the flexible controls offered. An appropriate amount of structure was needed for commercialization of a product with a steadfast focus on the elimination of waste but based upon established priorities. Implementation of

these Agile tenets delivered additional benefits, such as, improved NPD team communication and increased team engagement. Process Speed was established as the rate at which the project team would move through the defined development process. Simply put CS2, because of their implementation of ASGM, had experienced improved communication flow, with co-located project teams, a regular cadence of daily huddles, and extra care to connect dispersed but interfacing scrum teams. Within this study a distinction was made regarding communication, dialogue within the project team was denoted as Team Communication, whereas, information, such as project status, between the project team and management, was labelled as Project Communication. The CS2 team was also happier, achieving product demonstrations were wins to the engineers, additionally, focus also brought satisfaction, which ensured priority elements were being advanced. Process Control, Process Flexibility, and Project Communication were the top Secondary themes identified aligned to the Primary theme of Process Speed.

Process Speed Secondary Themes:

Process Control – Process Control was defined here as the tools and methods used to manage specific NPD projects, this was often the Stage Gate framework, Agile modified SGM hybrids, Systems Engineering V-Model, Agile/Scrum techniques, or other processes and procedures used by teams to guide and facilitate a sound approach. Simply, this was how development teams would control and guide activities to ensure a repeatable and reliable outcome. Control was centered around the framework of the NPD process, the methods had to be useable with clear guideposts, or direction, for the project teams. The CS2 team used a commercially available Agile methodology recognized in the software world. The team applied this methodology largely as intended by its authors, which included key elements such as defined Sprints, Program Increments, Release Trains, Epics, with dedicated Scrum Master and Product Owner roles, along with an integrated Systems Engineering V-Model for technical work. The leadership team and corporate offices continued to use the SGM approach for business related decisions as opposed to technical assessments to determine whether projects were achieving financial targets and if market assessments were on track, additionally, these gates leveraged detailed, documented checklists with fairly well supported reviews. The gate assessor played a prominent role who often provided tough questions during project review sessions and also led the decision making for gate passage. This method was seen as positive by the study participants of CS2 for a majority of project instances, but not all.

Process Flexibility – Process Flexibility was defined as the ability of the NPD framework to manage development activities, as well as, the ability of the

particular framework to be modified to fit different styles of projects, such as technology exploration, research, platforms, and feature addition projects, along with the ability of the process to change over time to suit new needs or address new challenges the business had encountered. The CS2 team expressed several doubts and concerns with the traditional SGM process in use and continued to be used elsewhere within the firm. For new to the world inventions or new to the firm projects, thought of as "Greenfield Projects", the team felt that SGM was a poor fit for these types of projects due to the tendency to thoroughly map requirements early in the development process. Also highlighted, heavily described gates and gate requirements only fit approximately 80% of the projects, these tended to be projects that needed more "breathing room" to sort through the details, in other words, product ideas with greater levels of uncertainty. This concern was also expressed for generic research activities, as well as traditional projects within the Fuzzy Front End (FFE) or research portion of the development process. According to the CS2 participants, SGM placed undo pressure on development teams to quickly define requirements, which restricted teams from experimenting, or casting a wider net for innovative solutions. The NPD management process had to be flexible, even for Agile inspired Sprints, the durations had to be flexible based on work scope or the sub-systems being developed (e.g., software vs mechanical). The flexible mantra of ASGM was also extended to team roles and responsibilities, the previous methodology defined the particular skill-sets that performed tasks, with Agile, personnel were more willing to cross over and help regardless of responsibility. CS2 operated within a heavily regulated industry, external testing or certifications was required for these testing or regulatory bodies, traditional SGM approaches for development was the desired methodology based on clearly developed test plans, protocols, and project steps.

Project Communication – Project Communication was defined for this Secondary theme as the communication from the project team to external members of team (i.e., broader business unit), this included communications such as gate reviews, project status reports, burndowns, financial reviews, and generic status updates, this connection was largely created as management updates, the information tended to be higher-level in nature to assess the progress along with the health of a particular project. This Secondary theme was not simply data and reports, but included the methodology or language used to communicate with business leadership. Agile and Scrum have long encouraged frequent communication, the daily ritual of quick meetings to share information had pulled the team closer together, but also helped frame for the individual team members, a more

holistic understanding of the entire project not just their own functional areas, the "big picture" was clearly understood. Members of CS2 expressed a transparency short coming of the SGM method that was previously employed. One study participant, from the management ranks, felt the old method limited information, the approach offered minimal understating of team status and progress, where only gate reviews provided useful insights to true status, whereas the constant discussion and broadcasting of project information including backlogs, roadblocks, and staffing challenges, the ASGM approach provided much desired additional insights. Information broadcasts from phase gate reviews singularly, were simply not enough, team members and management needed more frequent updates. The CS2 team also struggled with interfacing communications between the ASGM and SGM approaches, the broader organization, including executive leadership spoke SGM, whereas the project teams were developing products within an ASGM framework, communications sent needed particular attention to ensure the language used was appropriate and did not reduce confidence or clarity. As portions of CS2 worked on platform focused projects, clear, synchronized communication with business leaders, including prioritization, were critical, particularly, during stretches of resource conflict.

Market Success – Market Success was defined by this Primary theme as the desire of the team to achieve business success, simply put, to get new products to market and win. Selling more products than previously sold, establishing new markets, to experience financial success, to have the "best" most favored product on the market with unique features at an optimal price which delivered immense value for customers. Ascertaining true customer value based on an optimal balance of features and product cost, of course, a first mover advantage was desired, all of this to maintain long term business viability and growth. To be clear, simply being on the market and available for purchase is not enough, the firm must realize the financial rewards of NPD investments. The goal was to generate profit, to be commercially viable, to grow and prosper, to return value to shareholders and repeat. To not grow was to die! CS2 participants were focused on understanding customer value in terms of product features, however, often unstated customer needs which were crucial to product success. The BU was a market leader and was determined to maintain a technological edge against the competition, Agile techniques fit nicely within the ideals of constant customer feedback to ensure understanding and alignment with what truly defined value. Customer requirements were mined often using prototypes or demonstrations with internal customer surrogates or actual end purchasers. CS2, with an intense desire to get the product right and aligned to their customers, also pursued development speed, quickly moving through process steps and design iterations was not only an

important goal of their ASGM implementation, but also a result. Long term business success was top-of-mind during interviews, developing strong customer connections with the right product, aligned through prototypes, driving decisions quickly, would allow the BU to retain their market leader position. The first mover advantage with a new technology or feature set was critically important for CS2 participants due to concerns of fast followers, from emerging countries with fewer hurdles to market, capturing market share. Customer Value, Speed to Market, and Business Longevity, in this order, were the Secondary themes identified from CS2.

Market Success Secondary Themes:

Customer Value – Customer Value as defined within this case study was nearly identical to the Primary theme established within Case Study One. Arguably the strongest Secondary theme, an intense focus on customer value defined by features that were truly important to the customer, was the main concern of the team. Participants described more than a few cases in the past where early development misunderstandings led to poor project outcomes. The creation of insightful and meaningful customer requirements, established through frequent feedback loops ensured alignment with key constituents. Over and over, the team expressed that good requirements equated to positive project outcomes, being close to customers, understating in detail what was wanted, and what users would pay for, along with understanding the 'why', was crucial. A prophetic statement offered by an Individual Contributor, "*Assumptions are evil*", framed much of the thinking. The ASGM methodology implemented, engaged, if not required, Product Owners (PO) to become immersed within the market and project, and to remain engaged throughout the development process, the process also forced feature and task prioritization, frequently leading to a defined minimum viable concept. Plainly, more customer interaction during development would yield a much better product, which would lead to increased market share.

Speed to Market – Speed to Market was defined by this Secondary theme as different from Process Speed, which were the tools and techniques used to navigate the defined development process more efficiently and faster. Speed to Market was categorized as the rate to which all of the activities, not just those defined as a part of the NPD process, such as, design, testing, market/financial analysis, but commercial contract execution and portfolio decisions, the total time from which an organization traversed from idea inception to commercialization. Speed to Market was also a competitive advantage, being first to market with a product or feature that addressed a critical customer need had inherent value, being first allowed the firm to set

trends, establish the market, define narratives, and build a brand before other players joined the market. Development contracts, strongly influenced by a tender based selling process, generated an environment where product development teams expeditiously operated against customer expectations that were documented, in a contract, but not sufficiently defined. Rapid action on unsatisfactory customer needs caused frequent design rework, adding time, expense, and delays to projects. In some cases, legal resources were brought in to help resolve uncomfortable customer situations and to extricate team commitments. Excessive and customer disappointing reworks or design changes were reduced, which led to a perceived reduction in time to market. Less development rework, but secondarily, clarity of requirements and deliverables, along with clear project and product feature priorities allowed the CS2 team to improve. By using an ASGM framework, changes of design direction or specification creep became less prevalent, one set of Scrum teams in particular, experienced an increased delivery rate of four-fold, the teams were taking a straighter line to commercialization by working with customers frequently. The increase in speed came with an additional benefit of increased management confidence within the project teams, which, in-turn, afforded more team autonomy.

Business Longevity – Business Longevity was defined by this Secondary theme as the need for financially prosperity. NPD investments, such as staff compensation, project related expenses, manufacturing capital, for firms within scope of this study, were significant, development projects routinely surpassed one year and would often migrate well past. Business Longevity was a desired result of proper development, the firm expended resources to capture a new market or customer need, however the long-term business outlook had to improve, to not innovate was to decline, staying stagnant was to deteriorate, allowing competitors to take market share was to perish as a business. CS2 participants understood their firm was a market leader, somewhat under attack, however, maybe more generally, western companies had to be technology leaders, this was, in the minds of participants, a critical differentiating factor for BU customers. Other countries, with strong competitors, were seen as fast followers, or outright copiers, so technological differentiation, particularly tied to true customer wants, as well as arriving to market quickly, were keys to long term survival. Smaller competitors posed a threat due to their nimbleness and possibly a lower level of scrutiny from regulators. Worrisome, the railway industry was largely conservative and slow moving, not known for the wholesale adoption of new technology, this provided a conundrum for the CS2 team.

Table 9.3 - CS2 Participant Quotations Primary and Secondary Themes

Themes	Sub-Themes	Organizational Role	Participant ID#	Relevant Participant Quotations
Process Speed	Process Control	Individual Contributor	21	So for 80 percent of the projects, we get to have those. And then, of course, there are always exceptional things, which are not fitting directly into the objectives, where the gate assessor has done the mandate to ask additional questions and look at these areas, which are not powered by their regular checklists.
		Resource Manager	17	In a sense, we have been doing Agile, using Scrum, basically. Probably two to three years back, in fits and starts, but for the last year, we have been implementing this scaled Agile framework. That's basically the model that we have adopted in our product development.
		Resource Manager	6	…all product development projects…are governed by the stage-gate model because the KPIs…[are] bound to the stage-gate model we have. We need to again encapsulate our activities into projects running along the gate-stage model such that they can be financed. That might kill innovation because people aren't afraid to just look into something, but they have to look into a very specific thing.
	Process Flexibility	Individual Contributor	4	The greenfield type of approach, where you are starting out with something completely new… something which you have never…or your company has never done before…I think that if you would approach that with a waterfall approach it's very dangerous.
		Resource Manager	6	…quite often new ideas pop up and the solution has to be quite well understood…[to] start a product development project. Under heavy time pressure [from the process], we try to rush to solutions…which hinders us in terms of…innovate[ion]. Instead of trying to rush to solutions…we should rather look into…different possible solution alternatives…That would drive innovation more than we do.
		Resource Manager	17	I think if it is a completely new product development, and you're at the cutting edge of technology…what we need to do is…depending upon what product and how much hardware…[or] software…then it can be more rapid. And in case if there are hardware development, I would leave it flexible to the organization to select what is the time period for each iteration.
	Project Communication	Resource Manager	6	The way we live it though is kind of a stage-gate model with, per gate, very specific semantics of what a project has to deliver at a certain gate and integrate it with the stage-gate model. We have a marriage between pure stage-gate business decision model in addition with a product development model…is [a] long lists of what documents do you have to deliver as a project team at which gate.
		Leadership	2	They are more informed about the track that we have to go with that project and I think really it's on the teams. It's more direct working together, having success also together and not building walls between involved parties and throwing stuff over the fence and other

				people have to take up. We try to come to a situation where we win as a team or we lose as a team…
		Resource Manager	6	…we didn't understand the way the team stands, whether they're progressing or not. We didn't see what they're working on, so confidence in the team was extremely low. Very in-transparent…t's very transparent of what they deliver [now]…today is really trusting their team…
Market Success	Customer Value	Leadership	2	This is not easy to handle in a contract based - we found out that this lead to a better success of your contract and it leads to a much better customer satisfaction. We went into that direction and also the customers got a better product.
		Individual Contributor	4	You should be aware when you're starting to make assumptions, be that if you're a project manager, a product manager, whatever. Assumptions, ultimately, are evil. It's okay to make some, but…you should really strive for getting them out of the way as quickly as possible.
		Individual Contributor	21	Because if you do the iterations while developing the product…the customer looks at the most critical things first, and then do the changes and modifications…I believe that the final product will better suit the needs of the customer, will then lead to a higher market share
	Speed to Market	Leadership	2	The goal…we have…[is] way shorter iteration cycle[s] where we come up with something that we can show to the customer…discuss with the customer and to get early feedback…[to] see that we are going into the right direction. With the use of the Agile…the distance between…the start of the project and delivery to the customer, the line is more straight.
		Resource Manager	6	We started with the Agile Scrum with Scrum setups, Scrum down to the school book. After, that might be close to a year. Even now, we are in the situation that we've seen after about 10 Sprints off. They increased their team velocities, story point-wise by a factor four, then we sat together.
	Business Longevity	Individual Contributor	21	And in order to secure the future of [FIRM] and [FIRM's] customers in this complex sort of landscape, especially since we have a big player in India, or in China…and especially European manufacturers must ensure that they have to take technology ahead of competition.
		Resource Manager	17	…we are one of the leading players in many of the segments…[FIRM] is the market leader in some of the segments there. So, these are all cutting-edge technologies…to stay ahead of the competition…important for [FIRM] to invest in R&D. And R&D productivity is something that's key to stay ahead of the competition…where smaller players also are able to have quick R&D, and then gain the competitive advantage.

9.4 CASE STUDY THREE (CS3)

The firm enrolled as CS3 had the same corporate parent as CS2, however, the global BU that performed the NPD activity was geographically removed and competed in a totally different market segment, with no shared context, knowledge, or reporting with the team in Case Two.

9.4.1 BU SUMMARY

The BU was based in Canada and competed in a narrow, but unique market, producing quality assurance technologies for manufacturers and was largely a self-contained team that performed all aspects of product design. The BU's products included devices for material identification, quality analysis, molecular identification, and systems for the evaluation of molten materials. These products were used in many industries, including military, meteorological, and environmental applications, as a market leader, the BU had delivered several thousand products to customers where many devices operated non-stop, as such, market expectations centered upon high reliability. The BU's products ranged from hand held devices to large, integrated solutions, business growth for the BU occurred through organic means, as well as, M&A activities, new technologies and adjacent product lines had recently been added. The BU would also execute several technology exploration or platform development projects outside of a customer driven project to investigate emerging innovative ideas.

Agile techniques were pursued originally as an outgrowth from their software development experiences, but more prominently due to the team's desire to facilitate increased learning throughout the NPD cycle. Participants opined that too often original project specifications, which numbered in the hundreds, had to be kept, requirement flexibility and customer feedback were difficult, unfortunately, resources and time were wasted pursuing unwanted features. The team used a well-known System Engineering V-Model (SEVM) for technical activities, which correlated each phase of development to product testing. SEVM started with high level system requirements then cascaded down into lower component level activities in a linear fashion.

9.4.2 THEMES

Based on the interview transcripts, two Primary themes were discovered: Process Speed and Market Success, from these, several Secondary themes were also extracted. Table 9.4 summarized the Primary and Secondary themes discovered from CS3 along with relevant participant quotes that supported the assertions made. The Process Speed theme was observed much more frequently than Market Success by a fairly large margin.

Process Speed – Process Speed was observed for this case in a very similar fashion as Cases One and Two. The ASGM implementation at CS3 had improved control of

the development process but still functioned with a degree of process flexibility and fostered an environment where project teams performed well. Team members interacted during stand-up meetings, focused and co-located teams brought people closer together and enriched problem-solving practices. Sprint durations were flexible, the overall ASGM framework had become adaptable for the particular product, however, the project teams did struggle with message translation between the Agile managed projects and communication with external management, as well as, external design certifications. The canned Agile methodology used at CS3 afforded the team a repeatable framework to assist with program control and improved speed through the development process. Process Control, Process Flexibility, and Team Engagement were the top three Secondary themes uncovered during this analysis.

Secondary Themes under Process Speed:

Process Control – Process Control as observed from CS3 was very similar to Case Two. The CS3 team also used a very popular, commercially available framework of Agile made popular with software products. The ASGM implementation included well defined and executed Sprints with rules that governed daily stand-ups, such as maximum duration and topic restrictions, along with many other well-known elements such as Backlogs, Program Increments, Epics, and Stories, "*Agile right out of the text book*", as one participant articulated. CS3 also leveraged a team management model where Core team members, such as Hardware, Software, and Test Engineering would attend daily stand-up meetings, and Extended team members, such as Manufacturing, Quality, and Purchasing would support a weekly project download session. The Core versus Extended rosters changed as the project progressed toward commercialization, where later stages, as an example, the Core team could include manufacturing and quality, but fewer design related resources. The CS3 team maintained a rigid gate structure with well documented checklists, gate attendees, and a robust decision-making process to ensure control of development. Effort was expended to bring consistency to Sprint conclusions with a focus on a "Definitions of Done" consensus, the team had to define, then agree, with task acceptance criteria at the Sprint onset, as well as, unanimity at the end of activity.

Process Flexibility – The Process Flexibility theme here was regarded as consistent as that unearthed in Case Two. When implemented, ASGM created an environment of flexibility within the project team, not only a desire to ensure product features were optimal through repeated customer involvements, but where Sprint durations evolved during development based on the type of product and tasks aligned for each increment. These ranged

from two to five weeks, in addition, the CS3 team incorporated hardware and mechanical elements into the ASGM framework, abiding by the Agile mantra of dissecting larger activities into smaller increments. The CS3 team believed the best form of AGSM was the one that fit the specific business and product portfolio, meaning their implementation had been tailored to their unique needs. Conversely, the team had struggled with external design certifications (e.g., Underwriters Laboratories - UL). An iterative approach of design, empowered by Agile, had experienced resistance from these agencies who routinely evaluated systems designed completely with representative software for testing, not increments of a product.

Team Engagement – Team Engagement was defined for this Secondary theme as the mental state of the team, their level of performance, or in other words, the happiness of the team to come to work every day and funciton at a high level. High performing teams were generally thought of as happy, engaged, well communicating, and open, who accomplished a great deal during their time in the office. Strong personal relationships, trust between peers, positive team rapport, closeness amongst team members, were all indicators of a highly engaged group. With the ASGM implementation at CS3, team members felt more efficient, focused, and more empowered to make critical decisions, with faster feedback from customers and management. Utilizing the prioritized Backlog elements, the project teams were largely autonomous, free to define tasks and next steps. Management supported the effort by allowing the team to stay focused on either a singular project or a much smaller set of projects, the teams were also kept largely stable, which minimized roster churn. With strong team cohesiveness built on quick, pointed communications and proximity, the members grew closer, built a tremendous rapport, and were noticeably happier at work. The team relied less on documented or written communications, such as interfacing design requirements, and more on face-to-face communications with the broader team being aware of the goals and aspirations for the overall product, not simply their own component designs, as such problems or constraints were easily resolved through partnerships.

Market Success – Market Success as examined from CS3 was very similar to this Primary theme from Case Study Two. As the second Primary theme revealed from the interviews, Market Success, manifested itself around four Secondary themes: Customer Value, Business Longevity, and Speed to Market. The team had an intense focus on understanding customer value, specific features or products that would make a real difference and bring significant financial benefits back to the organization. A key ASGM mindset that enabled a richer market understanding was the increased usage of "customers", either actual end customers, or internal

experts that were used to inform the design team. Since the BU's products were often integrated into a complex manufacturing system or application, systems personnel became valuable. All of this allowed the CS3 team to move through the development process faster and is believed to have created a brighter financial future for the business.

Secondary Themes under Market Success:

Customer Value – Customer Value was observed in this case as similar to Case Studies One and Two. With ASGM, the CS3 team was very bullish on product requirements, specifically, their ability to achieve more of the desired requirements, also delivering better or more informed customer requirements, along with a deeper understanding of critical needs through more frequent market interactions. The ASGM framework demanded more of the Product Owner (PO) and other marketing personnel, more interfaces, a deeper market understanding that was much closer to the customers voice than previously, ideally, the team felt the actual end client would be involved throughout the development cycle, espousing that the more client involvement would result with in greater levels of products satisfaction. The "Customer" here was often actual end users, occasionally it was intermediaries such as, systems integrators, applications groups, testing engineers, and internal technical experts.

A few lessons learned from the CS3 team regarding customer feedback, mistakes were made by honing the design specifications towards one influential customer and not broadening the feedback during development to multiple customers, this pre-eminent voice who was critical for business opportunities also had different viewpoints of the product, which led to late specification changes to accommodate a broader market. Another concern was linked to a lack of Minimum Viable Product (MVP) where on a few occasions the early stages of product conception, the marketing teams would overload the product with content, an endless set of features to make the business case as bullish as possible to secure resources and funding, this generated outsized expectations for the design and engineering teams to deliver. Without a MVP defined, the inevitable scope reductions to contain project slips were more difficult than needed. ASGM by design was perceived to place great emphasis on prioritization of features and to create an iterative approach toward market commercialization, meaning several releases of product, not simply, one major introduction.

Business Longevity – Business Longevity as uncovered here from CS3 was similar to this same Primary theme observed in Case Study Two. The products designed played a critical role within modern manufacturing

facilities, ensuring appropriate levels of product quality, customers have come to rely on these devices, however, critical process monitoring equipment can cause tremendous pain when inactive due to performance concerns, therefore, reliability was the number one product attribute. The team had a tremendous number of products already on the market, part of the design considerations for new products was older product, "Backwards Compatibility" was an additional constraint on the project team, new designs, mainly software, had to be available for these previous sales, however, this additional design limitation could not hamper the adaptation of new technologies deemed critical for long-term business success.

Speed to Market – Speed to Market as organized here in CS3 was similar to this same Primary theme observed in Case Study Two. There were several markers from the CS3 team about speed, with frequent customer demonstrations, a dedicated, focused, and engaged project team, an increased rate through the development process, to name a few. The previous gate model, along with the Systems Engineering V-Model (SEVM), was considered too serial for the needs of the CS3 team, which emboldened a disconnection with clients. Other than the project teams being focused, happy, and empowered, the R&D group at CS3 was more aligned and synchronized between disciplines, such as, Electrical, Software, and Mechanical Engineering, due to the team's proximity to one another, and the move away from strictly relying on documented design interface requirements. The team also noted that an increased reliance on reusability and commonality when designing families of products was also an approach with positive speed related qualities.

Table 9.4 - CS3 Participant Quotations Primary and Secondary Themes

Themes	Sub-Themes	Organizational Role	Participant ID#	Relevant Participant Quotations
Process Speed	Process Control	Individual Contributor	3	Everybody that are at this meeting, and the core team has something to say…If there's some key requirements that are not met or something. So everyone has a word to say about this, but at the end, for after that there's the gate with all the direction, supervisor. The final decision is made by those people at the end at the gate. If there is some point that are presented that not meet what they want…
		Individual Contributor	3	Okay but [gates] are quite good though. That's in the technical milestone or like a concept review or design reviews or pre-ship reviews…always a core team that we have for each product…required to the milestone meeting. We have a…very well developed for each milestone…a list of thing that have to be achieved…some documentation that have to be approved…presentation that is built up by all the technical team and presented…for all different departments in the company for product development.
		Individual Contributor	8	It's just with the gating process here at YOUR FIRM in order to get through certain gates, you have to have to find a budget, and to find that budget you have to have a set of defined requirements.
	Process Flexibility	Individual Contributor	3	At the end, sometimes, the first requirements…is not anymore valid. But we still continue to work on it, because that was what we said we'll do. I think there's some limitation about this that the stage gate is not agile in working with the changing in requirements. We have to keep [these], once since we spec out of the gate, that's what we said we'll do. Then, we have to do it.
		Leadership	7	…research and explorations of new technologies…it's got nothing to do with the gating model because your purpose is not to end it up at the end…with a product, but more an opinion on technology or its application for your business…If you think that every activity…needs to fit in standard Stage-Gate, then you're definitely limiting yourself because there's no way you're going to run some…very useful activities of exploration…
		Individual Contributor	8	…we try to have a sprint that lasts at the most a few weeks but we're not very rigid about it. We've had sprints that were supposed to last two weeks that ended up lasting four weeks and we still didn't get everything done because things come up and we end up adding things…we're not ideal in our use of sticking to a certain methodology. In the end, I do think that it has helped.
	Team Engagement	Leadership	7	Another thing that will be greatly improved…[is] engagement of the team. If you just rely on ICDs and stuff that was mentioned [on] them, released in officially versions…in terms of product ownership, people will say, "My role is not to comply to the whole product…expectations. My role is to comply with the ICD I was given."

		Individual Contributor	3	A big impact as well is on the team itself, it's not just agile methods, it's not only procedure to follow, it's really a way to interact between people. We gather all the team together and meet every day, every morning few minutes for scrum meetings…dynamic you have the team is much better than what I've seen in the past.
		Resource Manager	9	For me, one thing would be that will be more efficient, because people will be more empowered into the project. It's what we see, in fact. And we put some responsibilities into the execution team to give the feedback faster.
Market Success	Customer Value	Leadership	7	The product will certainly meet a lot more of the requirements that are expected from everyone. Being marketing…price…feature…service stability of the product. All of those, I believe, will be a lot better addressed if you do a Agile development than if you do a Stage-Gate classic non-agile product development.
		Individual Contributor	3	We included more the product line manager and the product owner. Every time that we have a problem or something like that, we could shuffle the priorities. By the end, we build up something that is more, that meets more the needs of the client at the end.
		Resource Manager	9	One thing is that they are sometimes listening at one customer…commit themselves to that specific customer for a given feature, where they are not looking at the big picture to see that this feature is not something that the overall market wants…too much investing on the one feature…only one customer has used that.
	Business Longevity	Individual Contributor	8	New product development…to continue making headway in the market, so that the company remains profitable and you don't get left behind.
		Leadership	7	…if you don't bring in new product, eventually your product will get obsolete and then the whole company will get obsolete. You do need to bring in new product, not all product gets obsolete or are not useful anymore, but eventually they do, even the most useful product.
	Speed to Market	Individual Contributor	3	As I said, to have a dedicated team that working very near together and have a reflex to help each other as well to have incremental of the products always tested and working. For sure their time to market is improved.
		Leadership	7	with the Agile type…when everybody talks together on a more frequent basis…will rely a lot more on discussion…than the document being stamped and released…You'll review your requirements very often, as opposed to targeting to freeze the requirement at one point and then blame anyone who would look at changing…For that reason…I don't know if the development will be a lot faster…I tend to believe so.

9.5 CASE STUDY FOUR (CS4)

The firm is a global organization with a commanding market share position, designing, manufacturing, and distributing well-known brands primarily for the North American residential and commercial home products market. The firm had recently added innovative technologies to their product range through the incorporation of smartphone applications and data integration to help differentiate itself from peers. The firm's corporate headquarters was based in the United States, with executive management, back office, sales, marketing, and R&D functions located together, along with a manufacturing footprint in Mexico, and a sourcing activity in Asia.

The firm exhibited primarily a North American focus for its products through two different sales channels as either big-box retail outlets for residential customers or professional dealers for commercial customers. The firm saw these customers differently with unique needs and desires, this drove the team to create and maintain two pipelines of products to satisfy their range of customers resulting in a complex product portfolio.

The firm was originally founded shortly after the start of the 20th century, focused on processing equipment and components, later moving into metallic components for other industries such as appliance and defense. Through M&A, the business expanded into tangential markets, and now sells products in many portions of the world through the effort of several thousand employees from a handful of technology centers. The firm's products had become more integrated into the connected lives of users with a focus on innovation and product quality throughout the manufacturing process.

9.5.1 BU SUMMARY

The BU's products largely represent the main products for the firm and were regulated, complex, electro-mechanical devices, designed with a variety of product options, sizes, and models. The team was geographically located at the corporate headquarters and represented all elements of product design, including mechanical, electrical, software, testing, manufacturing, and regulatory, as self-contained and self-organizing groups with dedicated project spaces. Products were designed as platforms or families since the team leveraged reusable components and sub-systems with common macro-level user needs and functions. The CS4 team was incredibly versed in product development techniques including Agile methods, where many team members were aware and knowledgeable in the latest NPD management methods, as well as, traditional approaches.

The BU originally pursued ASGM methods due to a perceived level of process inflexibility for traditional SGM frameworks. The participants felt projects with a

higher degree of market or technological uncertainty were better suited for an ASGM approach due to the method's focus on adaption and learning from customers through demonstrations. This thinking was extended to technologies that were either new to the firm or to the firm's customers that could have established new markets. As the BU reviewed it products, market position, and future customer needs, the leadership within CS4 realized a shift was about to engulf them, they would no longer produce, known, comfortable, well defined, electro-mechanical products, they would increasingly become reliant on user applications and software to differentiate. This assessment was another reason the CS4 team pursued ASGM for their business. The BU started down a more flexible NPD path by implementing a lean startup model that swiftly investigated new customer needs, prototyped concepts, tested markets, and commercialized products on a limited basis in an effort to get to customers quickly to learn the intricacies of the market without an outsized effort or investment. The lean startup teams were minimal in size and cross-functional but were entrepreneurial in their mindset to quickly uncover market opportunities. Later, the BU incorporated Agile methods for an increasingly larger set of projects, including electro-mechanical projects, where the team completed the largest program in business history utilizing an ASGM framework. Today, all NPD projects conducted by the BU use an ASGM methodology.

9.5.2 THEMES

From the interview transcripts, two Primary themes were discovered and were consistent with a many of the other cases: Process Speed and Market Success, from these, several Secondary themes were also developed. Table 9.5 summarizes the Primary and Secondary themes discovered from CS4 along with relevant participant quotes that support the assertions offered. The Primary themes were nearly equal in observance from CS4, however, Process Speed was slightly more prevalent.

Process Speed – As observed from Case Study One, Two, and Three, Process Speed, as previously defined for this Primary theme, was aligned within CS4. Many of the Secondary themes observed were discovered in other cases as well, however, Process Control, far and away the strongest, was followed by Team Engagement, then Team Communication to complete the top three Secondary themes.

Secondary Themes under Process Speed:

> **Process Control** – Process Control as previously defined within Case Study Two and Three, applied to CS4. The team utilized a six step SGM style development process to manage NPD, however, the team had merged Agile techniques to support design and development work underneath this traditional gate "over-lord" structure. Overall program timing, critical milestones, including launch dates, and manufacturing tool kick-offs were established by management decree and market needs. The team along with

executive leadership created and approved a fully constrained, over-arching program schedule, with clearly established dates. During the heart of product development, the team leveraged product demonstrations "religiously", almost on a weekly basis to ensure alignment with key constituents. Here again, as in most of the other cases, the team used Agile techniques largely as widely taught, the use of Sprints, Backlogs, Epics, Burndowns, and other elements, were widely utilized. The creative twist here was the usage of Epics to track major SGM program milestones, the team used the Sprint activity leading up to the Epic defined milestones. Further under the guise of Process Control, the CS4 team members discussed the additional need of broad Agile training, ASGM process champions, and, of course, good sound process documentation, such as procedures, along with clear roles and responsibilities. Process roles today remain somewhat unclear, unfortunately, the Agile and SGM tracking and communication tools in place do not communicate with one another directly, manual re-entry of data was an additional burden placed upon the project teams. On another note, Agile backlog tasks aligned toward milestone completion, still must be well documented with sound time and resource estimates, this was not always the case.

Traditional gate reviews were still conducted, unchanged from the previous SGM framework, these reviews were comprised of three key elements: technical, business, and marketing, which provided management a complete understating of each project. At the end of the day, the ASGM implementation at CS4, allowed the project team to accomplish the largest program in company history, largely on track, establishing a rhythm to the development activities.

Team Engagement – Team Engagement as previously defined within Case Study Three, applied to CS4 here. The BU staffed a fully cross-functional (e.g., mechanical design, electrical design, project management, software design, testing), focused, largely co-located (i.e., approximately 80%), project team, with dedicated project rooms where teams could keep materials, prototypes, marketing plans, and other items. The daily scrums and other ASGM tenets, such as clear Backlog items, defined Epics, and Burndown charts provided for better communication and coordination, along with team involvement and planning, these project activities created a strong environment of accountability. Participants mentioned routinely, that the team was staffed with experienced personnel, no one wanted to let another team member, or the team, down by not living up to a particular commitment. Each team member understood that at daily scrums, all participants had to speak up and provide updates, along with achievements

and commitments, including help across disciplines when needed to achieve project timelines, there was a subtle amount of pressure to act. Overall, the ASGM implementation at CS4, specifically the daily meetings, communication tools, and team arrangements, allowed the Program Manager to step back and manage at what he deemed to be *"an appropriate level",* as the teams Quarterback, the Program Manager could *"see tasks develop and designs evolve, without losing connection with the project team".*

Team Communication – Team Communication was defined for this Secondary theme as the intra-team communications that took place amongst project members, particularly daily scrums and prioritization discussions, including technical information, this communication was the main conduit of information to conduct the work of NPD. The CS4 team, as mentioned, was highly engaged, many of the key elements that drove the team to higher levels of performance, such as communication, accountability, cross-functional dedication, also improved the flow of information between team members. This openness of information, delivered on a regular basis, established great team focus, the team members knew exactly what was coming at any given moment, they understood the tasks, priorities, and tradeoffs that were made. The communication structure utilized, as observed in other areas of the study, a Core team, and Extended team philosophy, where the Core grouping would attend the daily team huddles, and the Extended members of the team would receive less frequent communication, often a weekly cadence. The Product Owner, who did not have a technical background, especially felt that the increased flow of information was crucial to the team's success, no challenge could sneak up, or specifically, "*no bombs*". This level of togetherness and communication did come with a cost concern, the level of dedicated staffing was arguably greater than leveraged on past projects, potentially driving up resource costs. Finally, with respect to Team Communication, one member felt that more transparency into the detailed processes used within the firm would be helpful, meaning, if a task left the Core project team and travelled through a remote, companywide process, occasionally this felt "*like a black hole*".

Market Success – As observed from Case Study Two and Three, Market Success, as previously defined for this Primary theme, was aligned within CS4 as well. Many of the Secondary themes observed within CS4 were found in other cases, however, one new theme did emerge, Product Requirements, which was the second strongest Secondary theme, preceded by Business Longevity, then followed by, Customer Value.

Secondary Themes under Market Success:

Business Longevity – Business Longevity as previously defined within Case Study Two and Three, applied to CS4. The BU enjoyed a dominating market share, there were two main constituencies, retail and commercial customers, both with unique user needs, selling strategies, and service points. Since the CS4 team developed products for their entire portfolio, the team had a full suite of projects to manage, with a continuous pipeline of activity being the goal. The team's ambition was to not only keep up with market and competitive trends, but to avoid stagnation and commoditization through fresh product releases and innovation. The belief was that this effort would boost profit margins, emboldening the financial future of the business, simply, NPD was the key to the future, financing tomorrows payables. Firm leadership conducted an effort into self-reflection and analysis, not only of the markets they were competing in, but of emergent technologies, along with the methods used to support NPD activity. Leadership realized a change was needed, a migration away from their view of the world, to a more customer centric approach, this also led to a realization that technologies were changing rapidly, and they could no longer design, build, and market, successfully, legacy products. The broad application of software, through customer applications, along with other ubiquitous electronic features that have found their way onto so many other products, would change the CS4 approach to their products. The team also wanted to improve their NPD "Hit Rate" (i.e., product success) along with a measure of product freshness called the "Vitality Rate" (i.e., percentage of new products within the portfolio). The CS4 team was the most engaged within this study and enamored with NPD as critical to their future when considering the other four cases.

Product Requirements – The CS4 team, almost to a person, brought up the topic of Product Requirements, this was observed on many occasions from several participants. A distinction must clearly be made between two Secondary themes, Product Requirements and Customer Value. One could be confused by the other, Customer Value speaks to the development efforts to find true user needs that translate to customer delighting value, as an enabler to business success, simply, to understand, specifically, what feature drove a customer to a purchase decision. The Product Requirements Secondary theme has to do with the detailed definition and usage of the entire list of product definitions. Whether the customer falls in love with your designs or not, most products, especially physical products within the scope of this study, have hundreds of requirements. Technical teams tend to live and die by nuanced definitions in technical terms, that outline a product, this theme centers upon the management of specifications not the effort to find

the "Right" specifications. The CS4 team was very passionate about requirements, early alignment within the development process with the project team members was crucial, starting a project with defined requirements, targeting a percentage of 70-80% was considered ideal. Ongoing control of these requirements, where specifications were "Locked-In" or frozen as soon as possible, was also important, furthermore, broader changes to program-level definitions were termed "Scope Creep" and was tightly managed and strongly avoided.

Customer Value – Customer Value as previously defined within Case Study One, Two, and Three, applied to CS4 as well. The BU team utilized prototypes and product demonstrations extensively to ensure team alignment with customers. The demonstrations were often held at sprint completion cycles with the project team, but also with external customers, this included several "Field Installations" where mature prototypes, which were considered similar to production intent, were installed in the market with customers to gain real world feedback and insights. While immersed in the use environment and supported by key project team members, product revelations were discovered and implemented. These frequent demonstrations tied to the ASGM implementation at CS4, participants felt, ultimately led to better, higher quality products, where the team was able to leave the office and get out to collect valuable customer feedback. This learning was cycled back into the design team, simply put, one participant opined, "*More demos equal less crisis*". The previous SGM framework used for NPD was considered limiting for customer involvement, as well as the biased view point from BU leadership, the team members cited that often product iterations and learning were not embraced, and thought not possible, the BU had several instances with poor customer feedback based on a simple lack of understanding around true customer needs and uses.

Table 9.5 - CS4 Participant Quotations Primary and Secondary Themes

Themes	Sub-Themes	Organizational Role	Participant ID#	Relevant Participant Quotations
Process Speed	Process Control	Resource Manager	12	The sprints would be the execution towards the milestones in the daily management of the work. We weren't using the backlog to drive dates, we were going the other way around. We had dates and we're using the tool to figure out what work had to be done for that time, and then track towards it.
		Individual Contributor	22	So, again, because we did keep a Waterfall schedule, we would know the date of our build, and when we need the parts of that tool. So, we worked backwards from there, and we knew by when we needed to be done with the design. So that's how that was, basically.
		Leadership	14	…very clear deliverables, and you need to be able to have it published in a very obvious place, so that new team members…can fully know where to go and how to use it…clear documentation on who needs to do what...Then you can have a governance process with…leadership, which is really clear on what the stages mean…don't allow teams or stakeholders to change scope without understand the ramifications of that.
		Resource Manager	23	…it wasn't until we figured out how to map epics, or different mechanisms within [software tool]…or basically the Agile framework to the Waterfall framework. It wasn't until we did that, that we were really starting to build confidence that this was going to work…[and] be effective for us…
	Team Engagement	Individual Contributor	13	…[we] have the empowerment to make decisions and sometimes we forget that that's what our leads are for…make sure we empower those people to make the right decisions…don't need 10 levels of upper management to be involved, we should be able to empower the people that are on the team to make decisions.
		Individual Contributor	16	…it was just an unusually good group of people…my driver was not wanting to let my teammates down…I was willing to work hard, for this project to succeed, to not let my team members down, because they're also working hard…
		Resource Manager	12	[ASGM] gets buy-in early and new features as well, everyone is at the same page. Just running SCRUM itself is good and makes people accountable for the work they're doing each day.
	Team Communication	Individual Contributor	13	…I feel like I had clear visibility…things would come up…[engineers] try to fix things in the background and then you get hit with it months later…[your in] this little pickle that you can't solve…able to address things faster by having that open communication.…able to get things done quicker by having an open communication and being collocated and having an open dialogue.
		Leadership	14	We just put everybody in the room…the benefit was that everybody knew what was really going on in the whole program. And the people that have never gone have always felt like it was over the wall, like our technical service center. The manufacturing engineers in the plant

				were just thrilled…they had no surprises…not only stakeholders, but team members, who were feeling much better plugged in.
		Leadership	15	…[in] our Scrums, everybody was accountable to their teammates…everybody has to stand up in front of their class and give a book report…they would very quickly be self-managed by their team, because they were the only one that was there trying to speak, and had nothing to show for it up on the board. We had a very visible team room…accountability was huge…very quickly, everybody self-managed.
Market Success	Business Longevity	Leadership	15	…we're becoming more of a connected products company, and…less of a durable goods company, we still make products manufactured…And as we figure out how to monetize that…[we] learned is that in that arena of IOT products…software just works differently…But the software of end of it…the more of our products that get connected, the more we can take advantage of that kind of capability…[that] lends itself to…Agile.
		Resource Manager	19	Without NPD you run the risk of running yourself out of business…you've got to have a new product, or your competition is going to catch up to you…we have…a very large part of the market. And there are a whole lot of [businesses] out there…all they need is a small chunk of it…our new products keep them at bay.
		Leadership	20	…the company is an engineering company…we're doing NPD…[as] engineering-centered. As we looked at what we were doing…we started to realize that we needed to be more market-driven…we actually did a significant revamp of our NPD process…to be successful and improve our hit rate…with the market, we needed…a better process for NPD that put more emphasis on…market trends and needs…which starts tying into why we were trying to work in some aspects of Agile, even with the electromechanical NPD…
	Product Requirements	Individual Contributor	13	…once you are in development and the team is working on moving forward, any kind of change that you make is disruptive, and we can't keep changing requirements because someone decides that they have some genius idea that they thought of six months later…You have a timeline…and a deadline that you're trying to meet, [it's] just too disruptive.
		Resource Manager	23	…I can tell you that even with Agile, having good fundamental core requirements nailed down is probably the most important thing that we can do. And we often cut it short just to get moving, seeing how we're going to figure it out when we go, or we think that it's not going to change, and it sure as heck does.
		Individual Contributor	22	…I would say…probably 70 percent, 80 percent would be locked in…we would discuss it with a project manager, and let him know that this came up, and this is what it's going to mean, for it's going to take this much time, if there are risks, or whatever... we discuss it…if we thought that we have time...it happened where we just didn't. We rejected the requirement…decided not to do it, or do it later, or do it a different way.
		Resource Manager	19	…you've got to manage the scope and the scope creep…Early on, there was a lot of scope creep. We finally…shut the door on part of it…goes back to…rigorous definition…discovery

				processes…making sure that you understand what you're getting into…alignment across engineering, marketing, and manufacturing…get as much of that alignment early on…that's what Agile helps you do…
	Customer Value	Leadership	11	…the ability to work iteratively to add features…in a way that the stakeholders can see what's developing…"Hey, yes. That's good…That feature is great." No, this feature is not exactly what I had in mind…let's quickly iterate and see that again…you don't go through an entire development cycle…[to] find out it doesn't meet everybody's expectations…have to go back through that entire cycle again.
		Leadership	20	…verifying…"Are we on the right track?" We would do the Sprint demos…at the end of every Sprint, and we would say, "We want to physically demonstrate to you where we're at, and does everyone feel like we're on the right track?"…actually to the business unit, because there was a lot of collaboration there, and alignment on, "Yeah, what we're asking for, we like what we're seeing," or "No, you're not on the right track."
		Resource Manager	23	…most of the core team…we incorporated into our VOC…they were actually there…collecting data from the customers…So, we got to hear firsthand what the needs were…had an understanding of what requirement X meant. Because we were there, and we heard several people discussing it and telling us what it meant…[allowed] requirements to be…"looser", but we didn't have to spend as much time debating them…

9.6 CASE STUDY FIVE (CS5)

The BU that participated was part of a larger corporate parent founded in the mid-twentieth century, which provided equipment for healthcare providers, since then, the firm had grown into a global medical technology company with an immense portfolio of products and services for customers around the globe through distinct operational businesses. The firm had experienced tremendous growth over the most recent two decades leveraging internal product development, sales force expansions, and a heavy focus on M&A. The firm's revenue growth, financial performance, and an intense customer focus were hallmarks of its brand. The firm spent approximately 6% of revenue on R&D through dozens of decentralized and independent engineering centers located throughout the world.

A portion of the firm's growth had been realized from an aggressive acquisition strategy, along with measured expansions into global markets to diversify its business away from a North American focus. The firm's financial performance had allowed it to build a strong balance sheet to fund internal development projects and other growth initiatives outperforming other companies within their industry and sector from a financial standpoint, even with its performance and global growth, it remains proud of its small-town beginnings. As a medical device company, the firm continued to navigate several critical global healthcare concerns, specifically, access, cost, delivery, and effectiveness. As governments increased spending on health-related services, particularly within the United States, scrutiny continued to fall on the firm and other players within the market to affect this massive concern.

9.6.1 BU SUMMARY

The BU in scope developed automated surgical products for the human population and was based in Western Europe with additional NPD and manufacturing elements in other countries. Engineering, along with project leadership of technological sub-systems, was executed in Europe including product software and other critical elements, these sub-systems were then integrated into an over-arching, complete product at a second development site in the United States. Customers that purchased the BU's products embraced leading technology to affect challenges within the healthcare space, including patient stay reduction and procedural costs. The project team formed recently through a series of acquisitions which created a slight undertone of uncertainty from a process and methods standpoint. While technology in the market was desired and needed, quality and accuracy of product function and procedural execution, were crucial. In other words, technology sold the product but quality performance brought customers back.

Navigating a heavily regulated market provided unique challenges for the team, specifically external product certifications and governmental registrations. The BU

operated within an expanding global market where entrants had similar technologies and capabilities and attempted to ride a global demographic change (e.g., aging population) that was heavier and more sedentary that in the past to expand sales.

The BU leveraged traditional SGM methods historically, but experimented with Agile methods for a few years, usually with software projects, only recently had the team committed to ASGM frameworks for physical products based upon an urging from leadership. The team initially sought ASGM because of the positive history realized from internal and external software efforts, to be clear the team implemented ASGM as a largely intra-phase approach with rigid gates for the overall project structure. The study participants felt that being a medical device company with requirements from global regulators forced them towards traditional development methods for purposes of device design documentation requirements.

9.6.2 THEMES

From the interview transcripts, two Primary themes were discovered, and were consistent with the other cases: Process Speed and Market Success, from these, several Secondary themes were also developed. Table 9.6 summarized the Primary and Secondary themes discovered from CS5 along with relevant participant quotes that support the assertions offered. Of the two Primary themes, Process Speed was more dominant, the CS5 team was more focused on execution and timeline commitments, than ensuring Market Success.

Process Speed – As seen in the other cases, Process Speed, as defined for this Primary theme, was the desire of the BU to move through the defined development framework as quickly and efficiently as possible, and was consistent with Case Study One, Two, Three, and Four. Many of the Secondary themes observed were discovered in other cases, however, the ranking was different, Process Control was clearly the strongest Secondary theme, with Process Flexibility second, and Team Communication third.

Secondary Themes under Process Speed:

> **Process Control** – Process Control as previously defined within Case Study Two, Three, and Four, applied to CS5 as well. Previously the CS5 team utilized an SGM style framework for NPD, where the team noted indiscriminate direction changes as a concern, the team often migrated from one design concept to another without focus and direction. Participants felt that the "*report-out*" points were infrequent which caused significant "*thinking spots*", allowing external influences to create havoc, forcing delays and deviations. The engineering team, under the previous SGM approach, dictated timing for prototypes without enough diligence into planning

activities, dependencies were not fully vetted, often producing schedules that lacked confidence. With the team's implementation of ASGM came improved levels of team focus, clear and visible goals, defined Sprints, Retrospectives, including positive and negative learnings, detailed Epics and Stories to define clear customer value. The team also leveraged the classic Agile approach of frequent, detailed, cross-functional planning sessions at the start of each Sprint but also at the project kick-off which outlined the main project goals, design architecture, and a prototype strategy. CS5 used a series of Epics to provide additional structure at approximately six-month intervals where fully functional prototypes were demonstrated. The team also spent significant time on the acceptance criteria for each task, where clarity around the Definition of Done (DoD) was deemed a key issue. Specific criteria were developed during the planning session for each four-week Sprint, the team strove for a "*black and white*" understanding of each deliverable.

Unfortunately, some sprint work packets were not designed artfully which caused some confusion as the team introduced their ASGM methodology, also team members, initially, did not embrace the flexible mindset. External dependencies proved to be an additional challenge, partners, including internal customers or BU's who were not working in an Agile manner, often remote from the main development site, needed additional time to understand the new process. Participants cautioned that DoD activities initiated additional struggles, determining a balanced view between "*absolute done*" and "*mostly done*" was difficult, the team did not want to unnecessarily return to completed activities for documentation reasons, universally, work task debt was viewed poorly.

Process Flexibility – Process Flexibility as previously defined within Case Study Two and Three, applied to CS5 as well. The ASGM implementation at CS5 defined the "*Circle of Agile*" early on, questioning how far the team circumference should be drawn, in other words, who was considered pivotal for the project and who was not. The broader organization was not to be managed in this new Agile manner, requiring the project teams to "*speak two languages".* There were nominal rules established between team members which improved the flexibility of the team, now personnel could cross traditional boundaries, as long as the correct skills were present, this was particularly valuable for design documentation creation, simply, everyone was thought of as capable. The project team leveraged Agile techniques alongside a gate style project management structure with a defined series of design reviews that were well documented and choreographed rigidly. The participants used ASGM for platform and technology exploration style projects as well, based upon a desire to plan frequently but thoroughly, which

established an environment of learning without an oppressive management structure. The teams previous SGM methodology created organizational silos, cross-functional personnel often retreated to their home domains. Most importantly, the team believed the SGM frameworks were best utilized for "*Paint by Numbers*" projects which had straightforward goals, low technical uncertainty, and manageable risks. On the other hand, for complex projects with outsized amounts of project uncertainty, the team refused to excessively plan every detail like they had with SGM, they embraced learning, however, with a controlled process, where new ideas could be easily uncovered. In fact, longer endeavors with vast amounts of project documentation (e.g., project schedule), such as the two to three-year journeys that were commonplace within CS5, offered a false sense of security to the management and project team. Assumptions tended to change during long projects, the preponderance of documentation elicited a feeling that all was known and risk was low.

Team Communication – Team Communication as previously defined within Case Study Four, applied to CS5 as well. Transparency was regarded as critical, the team ensured that all members had clarity of purpose and mission, the quick, fifteen to twenty-minute daily meetings were key, everyone spoke, all voices were heard which fostered a level of transparency within the team that emboldened an ability to discover and realign quickly. ASGM mandated that teams found and addressed risks quickly along with broad communication, internal and external, within the project team. The daily cross-functional stand-ups, or "*Dailys*", helped people get to know one another, they created an openness and fostered relationships which were especially important for this geographically dispersed group. Communication technologies such as high definition video conferencing, good quality speakers, microphones, overcame the time zone differences, these sessions ultimately saved time and were more efficient than email.

Market Success – As observed from Case Study Two, Three, and Four, Market Success, as previously defined for this Primary theme, was aligned for CS5 as well. Many of the Secondary themes observed within CS5 were found in other cases, however, one new theme did emerge, Team Talent, which was the strongest Secondary theme, followed by Customer Value and Business Longevity.

Secondary Themes under Market Success:

Team Talent – This new Secondary theme emerged from CS5, it was centered on the individual team members, the skillsets they possessed, the experiences they brought to bear, and frankly, the job performance exhibited. Whilst this Secondary theme could align to either Market Success or Process Speed, supremely talented individuals surely could produce more innovative

products, however, they could also navigate the development process more expeditiously though fewer design iterations. Since the comments from participants afforded a greater allegiance toward innovation and products than to speed, these behaviors were aligned to the Market Success Primary theme. Talent and experience were important to the performance of the team and capacity to deliver new products, with ASGM, personnel came ready to work, sprints demanded action, as one participant mentioned, "*no lazy people*" could be team members. CS5 mentioned that Scrum Master (SM), Product Owner (PO), and Program Lead (PL) roles had an outsized positive impact in shaping project tasks and direction quickly and efficiently, but also pushed the team with respect to product features and design techniques. The PL was known as a great leader due to innate abilities, but also noted were tremendous product vision, along with an extensive engineering background, this antecedent was considered helpful for the PO role as well. The alignment between PO and SM was essential, these individuals had to co-exist in harmony, or at a minimum could not be in conflict with each other crafting the broader project vision and team cadence.

Customer Value – Customer Value as previously defined within Case Study One, Two, and Three, applied to CS5 as well. The design and marketing camps of the CS5 project team were aligned on features and value, as well as priorities, project and product, but they often professionally challenged one another to find true, underlying value. This cohesive team had an overabundance of ideas for their product, focusing on what really resonated with customers they were not be afraid to leave Secondary or tangential features aside. An iterative approach to the market was pursued, with clear prioritization, the team continued to reassess, often asking harshly, "*Is this still the right product?*" Technology for its own sake was resisted, a deep understating of how a technology would impact the BU's patients had to be the compass point. The CS5 team could secure project funding and team staffing, however, defining specific product features was more challenging, historically, it was simple to include an excessive number of features.

Business Longevity – Business Longevity as previously defined within Case Study Two and Three, applied to CS5 as well. The corporation from CS5 was, internally and externally, known as a sales engine, the BU was competing in a growing market with a significant installed base of existing customers. Market technology changed rapidly, not as fast as the consumer electronics space, but often for the regulated medical device market, focus was placed on developing new technologies, where nimble business start-ups were a concern. NPD was considered the heartbeat of the organization, sufficient staffing, funding, and sound development processes would propel

development into the future enabling longevity. The teams aspired for innovative features but also had to deliver high reliability with unparalleled quality.

Table 9.6 - CS5 Participant Quotations Primary and Secondary Themes

Themes	Sub-Themes	Organizational Role	Participant ID#	Relevant Participant Quotations
Process Speed	Process Control	Individual Contributor	27	…with the big picture in mind, we're chewing off our bite-sized goals, and setting those goals for the next five weeks…our Sprint planning looks like…four hours of reviewing what we have accomplished…goals listed out. We discussed what went well…[not] so well, what we could do better…set clear goals…tomorrow we will meet and discuss what we were doing yesterday, what we plan on doing the rest of the day, and if we are seeing any roadblocks.
		Individual Contributor	28	…we have one big workshop to define how long the project will last…main goals regarding the design input, and what we want to achieve….we defined the high-level architecture…we know how many components we are going to have, and a lot of planning for the research phase…we defined the architecture…[and] who is responsible for which component…and when the [PL] defines how much generation of prototypes we will have…so I guess every six months we ought to have a new fully-working generation of prototypes, which are a big improvement compared to the older one.
		Individual Contributor	29	…you're not collecting things that you really need to take care of at the very end in order to come to the product, and that is really bad. So you really need to inform everybody…to do the right things at the right time, and not to say, "Okay, I think I'm done. Acceptance criteria for me is good, and now I'm going to touch it someday, but it's good for now, as long as the others don't know."
	Process Flexibility	Leadership	26	…[SGM] worked out with very clear projects, and also, the biggest projects. So, we called it "Painting by Numbers" projects. So, pretty straightforward. You know everything, and you really can plan models like in a production area. And there are not big risks…put a lot of time and planning in, and you work out scenarios, which you think would [work]…but then, the first thing happened, and then the whole plan collapses.
		Project Manager	25	If you don't accept change…during development, you will have a huge problem that the target is the day you come to the launch is no more than where it was…and you don't reach the target. I think a market changes even during development. It could be that marketing comes around and says, "Oh, you have to get that feature away and put this new feature in", and we have to have the ability to react on change.
		Individual Contributor	28	…because we are like these clearly defined work packages, we can also shift directions pretty fast…it's not clearly defined how there is [a] technical solution for a problem…we serve it is going really fast during our experimentations…we can shift and adjust to new problems really quickly, and this has proved to be really useful.
	Team Communication	Individual Contributor	27	…it is useful, and it saves time ultimately. Though it is 15 minutes out of your day, it saves time because we can meet with those people on a daily cadence, getting road blocks out of the way…It's

				a lot more efficient than an email…[it's] more important when we are separated by many hours…We know what to expect day to day, and we are going to [the] stand up and meet…
		Individual Contributor	28	…so that every team member knows in which direction it is going…we have epics related to these big generations…epics related to more project planning like…documentation related to certification…we do Sprint planning every month…we define sub-tasks or sub-stories… and each team member has a chance to say what is feasible on our team in the next month. And this is how we work.
Market Success	Team Talent	Project Manager	25	…if you hire someone…for an Agile team…HR should be aware what are the skills of someone who can work in an Agile team…[HR] should have to help to hire people that are able to work in Scrum teams…product development is first but I think we should even get the others into the boat…quality, supplier management, purchasing…HR, and…marketing…must come piece by piece or step by step into that boat.
		Individual Contributor	29	But also, it is really necessary for my point of view that product owner and Scrum master are not really fighting each other, but that the product owner also understands that in case he's adding features and features during the project, that will screw up the project as well.
		Individual Contributor	28	…what's working well is that a lot of it is related to our project lead…he has a vision of what needs to be done…[the] direction we could go…this helps us a lot with not wasting time doing silly things. So, being Agile or not Agile does not replace good visionary people…
	Customer Value	Individual Contributor	30	So, figure out what is right, what the customer needs, and then do only this, and don't change anything that the customer doesn't want to have. And involve the customer during the product life cycle, or design life cycle, every day. Talk to the customer and talk about the customer.
		Individual Contributor	29	I would say that is a big plus for an Agile project to really be transparent in a way, and to show stakeholders where we are at, to also step back in frequent phases, and think about the project, or the features and topic of the product. Again, rethink, "Is that still the right product?"
	Business Longevity	Leadership	26	…[is] a fast technology growing market, because it's complex technology, and it changes a lot. Not that fast like consumer electronics…there is a big pace there of change…you only can win if you innovate very fast…bring new products and new features…Otherwise, you will be dead pretty soon, and all the other startups will overrun you.
		Project Manager	25	The future are in the new products and if you don't invest a minimum of 7-10% into product engineering and research and product development, you will miss your goals in the future…this is like the heartbeat of the company…if it is fruitful then you will get your future products out. But if this heartbeat is slow and you don't invest enough for it, you will not have good products out.

10 RESULTS

Results from this comprehensive study into ASGM practices are organized into six sub-sections, the first frames the research questions which formed the basis of this study, the second delves into the Primary and Secondary themes, the third and fourth sub-sections represent results across all cases encompassing the entire study, the fifth delves into cross-case comparisons looking for differentiating factors between cases, and lastly, the sixth section articulates how the cases structured their overall ASGM framework implementation to manage NPD.

- Research Questions
- Primary and Secondary Themes
- Flexible Techniques Implemented
- ASGM Measures of Success
- Cross-Case Analysis
- ASGM Hybrid Framework

The study will offer an emergent framework for the concepts uncovered, strong evidence provided in the form of participant quotes, scrutinized to ensure intent and context were preserved, summarizes each topic. The Flexible Techniques Implemented sub-section provides insights into the Agile/Scrum pillars implemented, whereas, the Measures of Success sub-section sheds light upon the perceived benefits that ASGM frameworks have delivered to their respective BU's. The Grounded Theory models summarize the implementation practices of the five cases and how the behaviors of firms developing physical products differ from the Agile techniques used within the software and IT domains.

10.1 RESEARCH QUESTIONS REVISITED

The study goal was to inductively develop theory on how firms manage NPD of physical products using ASGM hybrid frameworks, and to understand if these ASGM hybrids yielded positive business results. Specifically, the two research questions were:

- How do firms that design, develop, and manufacture physical products implement the techniques of Agile/Scrum within their ASGM framework to manage NPD?
- What outcomes do these firms experience from the adoption of ASGM when managing NPD?

10.2 PRIMARY AND SECONDARY THEMES

Revisiting Table 9.1 and Figure 9.1, the Primary and Secondary themes were extracted and organized according to classical Content Analysis techniques as previously cited. Broadly, across the cases three Primary themes were discovered: Process Speed, Innovation Enabling, and Market Success. The specifics for each

theme, with supporting participant quotations, was articulated in Section 9, however, a macro view of participant desires revealed something distinct. The cases were focused on becoming faster to market, desired a closer relationship and understanding of true customer wants in hopes of generating more market success, and, with Case One, were inclined to bolster the broader business innovation portfolio through focused, quick engagements with unique technologies. The teams attempted to increase development speed through reinvention of the product creation process, for this study the implementation of ASGM, empowering team level decisions, establishing clear roles and responsibilities, as well as project milestones, and creating a foundation for robust team communication patterns. The cases also sought greater levels of market success with new product launches, this was seen as the lifeblood of the business. The ASGM framework enabled teams to do this, based on the transcripts, through constant engagements with customers, and frequent demonstrations of product prototypes with internal and external experts. Not all BU's delivered products directly to the market, some teams were creating platform technologies, so dialogue with "customers" was varied, but in all scenarios the development teams searched for product features that were truly valued by customers. The goal was to discover as many valuable and unique features or products as possible to build robust business cases. Lastly, especially in Case One, supporting market expectations as a technology leader, framed the BU activities and initiatives. The team excavated the market for unique, but often underdeveloped technology opportunities, this allowed the team in CS1 to offer a robust portfolio of innovative products to their end automotive OEM customers.

10.3 FLEXIBLE TECHNIQUES IMPLEMENTED

The observance of the eight Agile/Scrum tenets, as typically described by the Agile Manifesto (Alliance 2001) or the Scrum Framework (Schwaber 2004) used in the development of software, were key to understanding the ASGM implementation methodology. Building on the Agile background highlighted in Section 7.1, these hallmarks of Agile/Scrum, including examples, textual cues, keywords utilized, and occurrence rates, are shown in Table 10.1.

The interview transcripts were reviewed, in the same line by line fashion as the theme development Content Analysis effort, where a verbal description by a participant was used as evidence of the Agile/Scrum element being implemented and supported by specific transcript quotes. Care was taken to ensure intent and context were preserved to build a robust body of evidence utilizing participant quotations (Sandelowski 1994).

Table 10.1 - Textual Cues for Agile/Scrum Techniques

Agile/Scrum Element	Element Description	Element Cue Example	Element Occurrence
Team Interface (TI)	Individuals and interactions over process and tools	Teams focused on tasks at hand, finding solutions to product features, less interested in the path taken Key areas such as: Autonomous, Flexibility	96.6%
Product Demonstrations (PD)	Working software/product over comprehensive documentation	Frequent product, feature, sub-system, component demonstrations as a means of illustrating progress. Keywords such as: Demonstration, Test, Customer, Integration, Evaluation	86.2%
Customer Involvement (CI)	Customer collaboration over contract negotiations	Pulling in customers, internal or external, to ensure features are valued, less worried on formalized engagement Keywords such as: Evaluation, Demonstration, Test, Feedback, Review	75.9%
Specification Flexibility (SF)	Responding to change over following a plan	Planning often, accepting of specification change or learning from customer interactions Keywords such as: Change, Flexibility, Update, Priority, Feedback, Learning	79.3%
Team Structure (TS)	Product Owner/Scrum Master/Self-Organizing	Team organizational structure that employs key Agile/Scrum roles, such as an empowered Product Owner, and behaviors that illustrate empowerment Keywords such as: Empowered, Autonomous, Engaged, Customer Focused, Accountable	86.2%
Time Bound (TB)	Time bounded sprint activity with planning	Sprints that are concretely time bound with specific activities planned Keywords such as: Week, Month, Quarter, Defined, Time	82.8%
Feature Prioritization (FP)	Establish product feature priorities, creating Epics/Stories to support importance	Clear establishment of feature or task priorities, culling of less desired features or reduction of scope, implementation of user stories to support feature importance Keywords such as: Minimum Viable Product (MVP), Priority, Learning, Feedback	69.0%
Communication (Comm)	Scrum team meeting, team location, communication tools	Team communication patterns, such as frequent, quick team meetings, interactions of team members, tool usage such as burndown charts or backlogs Keywords such as: Transparency, Communication, Alignment, Burndown, Engagement	86.2%

If a participant quote, within its context, from anywhere in the interview transcript, was attributed positively to any of the eight aspects of Agile/Scrum it was considered in support of the technique. If no quote was found throughout the interview transcript that could be aligned to the topic, then the participant was found not supportive of the topic. The occurrence rate shown in Table 10.1 is based on upon the individual participant responses.

The eight elements of Agile/Scrum traditional techniques as used by software and IT project teams around the world were defined as:

Team Interface (TI) – Individuals and interactions over processes, teams were biased to act, simply put, the teams were focused on accomplishing development tasks, finding solutions for product features and less concerned with the procedures employed. Transcript reviews were guided by key words such as: Autonomous, Procedure, Structure, and Flexibility. The individual participant observation occurrence rate for TI was 96.6%.

Product Demonstrations (PD) – Working software or products were more important than comprehensive design documentation. The teams utilized frequent product, feature, sub-system, or component demonstrations as a means of measuring progress. Transcript reviews were guided by key words such as: Demonstration, Test, Customer, Integration, and Evaluation. The individual participant observation occurrence rate for PD was 86.2%.

Customer Involvement (CI) – Customer collaboration was much more important than contract negotiations or documented relationships. The teams engaged customers, internal or external, to ensure features were valued, where the participants were less worried about formalized engagements. Transcript reviews were guided by key words such as: Evaluation, Demonstration, Test, Feedback, and Review. The individual participant observation occurrence rate for CI was 75.9%.

Specification Flexibility (SF) – Responding to change over following a plan, planning often, where the teams were accepting of specification changes and willing to change, simply learning from customer interactions. Transcript reviews were guided by key words such as: Change, Flexibility, Update, Feedback, and Learning. The individual participant observation occurrence rate for SF was 79.3%.

Team Structure (TS) – Cases organized their product development teams around two key roles, Product Owner and Scrum Master, with self-organizing, empowered, cross-functional teams. Transcript reviews were guided by key words such as: Empowered, Autonomous, Engaged, and Accountable. The individual participant observation occurrence rate for TS was 86.2%.

Time Bound (TB) – Teams operated under time bounded sprint activities, often between two and five weeks, but were flexible depending on the sub-systems or products in scope. The organized sprints leveraged planning, including retrospectives, as well as demonstrations, however, these product development "chunks" were restricted to a specific duration. Transcript reviews were guided by key words such as: Week, Month, Quarter, Sprint,

Defined, and Time. The individual participant observation occurrence rate for TB was 82.8%.

Feature Prioritization (FP) – Cases established product feature priorities, creating epics and stories aligned to customer value to understand relevance and importance. The creation of feature or task priorities, but particularly the culling of lesser desired features or a reduction of project scope, based upon user stories to support feature importance. Transcript reviews were guided by key words or terms such as: Minimum Viable Product (MVP), Priority, Learning, Scope, and Feedback. The individual participant observation occurrence rate for FP was 69.0%.

Communication (Comm) – Teams held frequent, often daily, brief scrum meetings, where pointed information was shared with the project team. The cases leveraged communication tools, such as backlogs, prioritization charts, and burndowns to articulate project status in a transparent manner for team members, along with project sponsors, and leadership. Transcript reviews were guided by key words such as: Transparency, Communication, Alignment, Burndown, and Engagement. The individual participant observation occurrence rate for Comm was 86.2%.

Transitioning from individual participant evidence of the Agile/Scrum techniques to the aggregate responses for each case study, if a simple majority of participants, through substantiating quotations, were discovered in support of a technique, then the entire technique was deemed appropriate for the specific case. Table 10.2 summarizes the eight techniques and the outcomes for each case study.

Table 10.2 - Case Summary of Agile/Scrum Techniques

Techniques	Case #1	Case #2	Case #3	Case #4	Case #5
Team Interface (TI)	Y	Y	Y	Y	Y
Product Demonstration (PD)	Y	Y	Y	Y	Y
Customer Involvement (CI)	Y	Y	Y	Y	N
Specification Flexibility (SF)	Y	Y	Y	Y	Y
Team Structure (TS)	N	Y	Y	Y	Y
Time Bound (TB)	N	Y	Y	Y	Y
Feature Prioritization (FP)	N	Y	Y	Y	Y
Communication (Comm)	N	Y	Y	Y	Y

Three of the eight Agile/Scrum techniques were found in all five cases, the remaining five techniques were observed in four of five cases, for these, Case Study One, did not provide evidence of implementation of four techniques. A single significant participant quote was extracted from the interview transcripts for each of the Agile/Scrum techniques and is shown in Table 10.3 as an example of the participants responses and alignment to the techniques.

Table 10.3 - Evidentiary Quotations for Agile/Scrum Implementation Techniques

Agile Scrum Technique	Organizational Role	Participant ID#	Participant Quotes
Team Interface (TI)	**Program Management**	5	I would really focus on doing minimal amount of paperwork, maximizing the amount of time people are actually brainstorming and talking to one another…no one even worries about what the answers are because something new will come out of that conversation…we are not bogged down by the process. The process itself is not the end game…it's not what people are spending all their time on.
Product Demonstrations (PD)	**Program Management**	7	…put prototypes in the end of the customer, but not the marketing guy. The actual customer. Then have the engineering team, as much as possible, or the design team, whether it's the service guys, whether it's the engineers themselves, in front of the customer and discuss the product.
Customer Involvement (CI)	**Individual Contributor**	3	One thing is because the client's more involved at every stage of the project. At every step, the client or customer is able to see what's going on, what are the good and bad things and re-adjust and do not have to wait until the end of the project. There's one thing why I think the client is happier.
Specification Flexibility (SF)	**Program Management**	14	Not working on stuff or features that are going down the wrong path. We had several instances where we demonstrated something early, found…big issues with the product, and did a very rapid and effective course correction. So, they became less of a crisis. So, there were several instances where we just prevented disaster by seeing stuff early.
Team Structure (TS)	**Individual Contributor**	13	It allowed me as a Product Owner to see different pieces of the puzzle… Our Program Manager…we also had a Scrum Master. Our team was located in one of the buildings…we had marketing, engineering, and the [Project] team actually collocated in a space in one of these buildings. We had firmware, mechanical, regulatory, all sitting in the same space.
Time Bound (TB)	**Individual Contributor**	29	…a group of ten colleagues, and we have daily stand-ups. We have a Sprint of four weeks. We do Sprint planning after that period of time, and before the next Sprint.
Feature Prioritization (FP)	**Individual Contributor**	21	…in four product increments, which are then being discussed and being prioritized. So, we have quarterly prioritization review in a bigger round…which is then for the prioritization…And then, of course, that's a negotiation with the stakeholders and the business owners about the prioritization, about what is being part of the product influence, and what has to be postponed or put to another lower priority.
Communication (Comm)	**Resource Manager**	17	…we have a backlog of features…a common backlog, which is visible to all…it consists of epics that we shall then drop down into features…where we can look at the product backlog items…and look at the progress through a burndown. We do still maintain a physical board, where the team can then gather around the physical board, and look at their individual items, and also mark any bottlenecks.

From the data shown in Table 10.2, a simple model that describes the behaviors of the particular firms has been created. Although eight Agile/Scrum techniques have been widely publicized and taught within the software world and normally all used in harmony, the developers of physical products only practice three: Team Interface, Product Demonstration, and Specification Flexibility, see Figure 10.1. Evidence of the remaining five techniques can be found across all BU's, however, only the three techniques, not shaded, were found in all five cases.

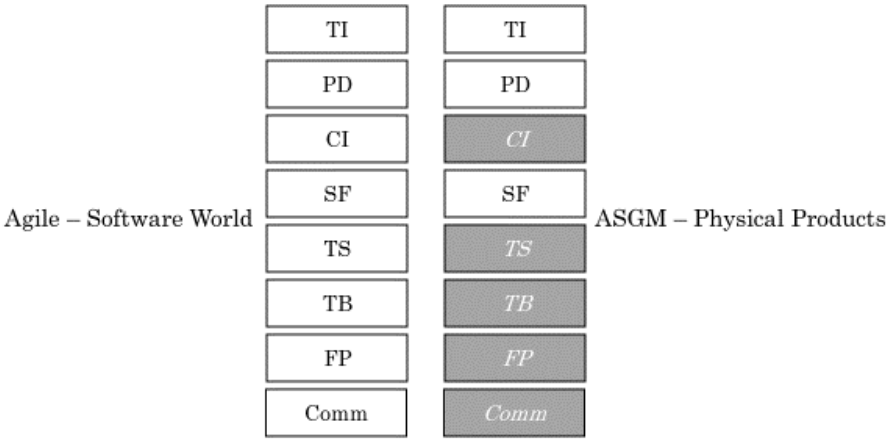


Figure 10.1 - ASGM Implementation Model for Physical Products

10.4 ASGM MEASURES OF SUCCESS

Assessing tangible business outcomes from the use of ASGM was another requirement to achieve the research goals of this study. Three business outcomes of particular interest were:

- Improved Speed to Market
- Reduced Consumption of NPD Resources
- Greater Market Success

The interview transcripts were reviewed, in the same line by line fashion as the theme development Content Analysis, where responses to the three measures of success were recorded. If a participant quote and its context from anywhere in the interview transcript attributed positively to any of the three aspects of ASGM success, it was assumed aligned with the topic. If no quote was found throughout the interview transcript in support of the topic, then the participant was not found to be in support. Each participant was specifically asked during the interviews if the usage of ASGM had any impact on their business results. All three measures of success were defined based upon, simply, the perception of the highly experienced study participants. From Table 10.4 the three ASGM Measures of Success have been defined, along with further descriptors, and unique keywords that guided the

analysis process, however, since the participants were asked directly, keywords were not as critical as in the Agile/Scrum Technique search.

Table 10.4 - Textual Cues for ASGM Measures of Success

ASGM Measure of Success	Element Description	Element Cue Example	Participant Occurrence
Improved Speed to Market	**NPD teams traversing the defined development process at increased rate**	Comments specific to how fast the team moved to launch Keywords: Speed, Faster, Rapid	65.5%
Reduced Consumption of NPD Resources	**Project teams using fewer people, or a lower cost of resources to complete the project**	Participants feeling on the number of resources used or the size of the team Keywords: Staffing, Fewer/More, People	17.2%
Greater Market Success	**Participants describing the impact, or financial results of the new product launch**	Team member opinions on how well the product performed on the market, customer acceptance Keywords: Hit, Success, Smash, Success	62.0%

The three ASGM Measures of Success, discovered through transcript analysis, were defined as:

Increased Speed to Market (STM) – This measure of success was based upon NPD teams traversing the defined development process at an increased rate, in essence project teams achieving commercialization faster. Transcript reviews were guided by key words such as: Speed, Faster, and Rapid. The individual participant observation occurrence rate for Increased STM was 65.5%.

Reduced Consumption of NPD Resources – Perceptions of this success measure was based on project teams using fewer people or experiencing lower staffing costs used to complete NPD projects, this was also indicated by a smaller development team. Transcript reviews were guided by key words such as: Staffing, Fewer, Lower, and People. The individual participant observation occurrence rate for Reduced NPD Resource Consumption was 17.2%.

Greater Market Success – Participants described the financial results of a new product launch, team member opinions centered on how well the product performed once in the market, where the degree of customer acceptance, along with positive business growth was attributed to launch. Transcript reviews were guided by key words such as: Hit, Success, Smash, and Win. The individual participant observation occurrence rate for Greater Market Success was 62.0%.

Transitioning from individual participant evidence of ASGM success, the case studies were then summarized. Utilizing a simple majority for the strength of occurrence, none of the three ASGM measures of success were discovered across all five cases. Improved Speed to Market and Greater Market Success, were found within four out of five case studies, see Table 10.5 below, whereas, Reduced Consumption of NPD Resources was uniformly, not found in any of the cases.

Table 10.5 - Summary of ASGM Measures of Success

ASGM Measure of Success	Case #1	Case #2	Case #3	Case #4	Case #5
Improved Speed to Market	Y	Y	Y	**N**	Y
Reduced Consumption of NPD Resources	**N**	**N**	**N**	**N**	**N**
Greater Market Success	Y	Y	**N**	Y	Y

Again, a single, significant participant quote, was extracted from the interview transcripts for each of the ASGM Measures of Success and shown in Table 10.6 as an example of the participants responses.

Table 10.6 - ASGM Measures of Success Evidentiary Quotations

ASGM Measure of Success	Organizational Role	Participant ID#	Participant Quotes
Improved Speed to Market	**Program Management**	2	When you look at that from the overall perspective, I think yes. We are faster on the market with the product that meets customer demands. It's really faster.
Reduced Consumption of NPD Resources	**Resource Manager**	9	For me, one thing would be that will be more efficient, because people will be more empowered into the project. It's what we see, in fact. And we put some responsibilities into the execution team to give the feedback faster.
Greater Market Success	**Individual Contributor**	21	…if we start from the product itself, I believe that the product will much better fit the market needs…Because if you do the iterations while developing the product, and your notes emphasize that the customer looks at the most critical things first…I believe that the final product will better suit the needs of the customer, will then lead to a higher market share.

Building upon the ASGM implementation model shown in Figure 10.1 and incorporating the benefits espoused Agile/Scrum teaching and of the participants, Figure 10.2 illustrates the total picture of ASGM implementation behaviors, with perceived benefits.

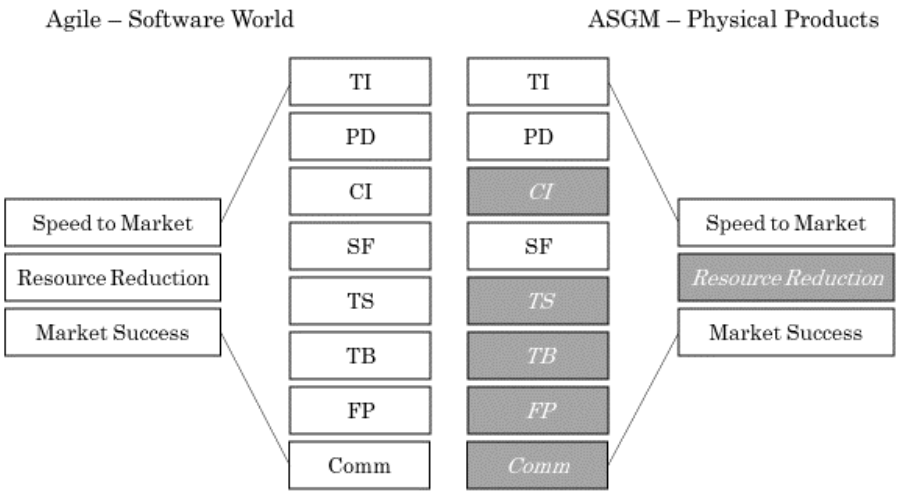


Figure 10.2 - ASGM Implementation - Behaviors and Benefits

Global developers of physical products in scope of this study, utilized three of eight classical Agile/Scrum techniques within their hybrid ASGM approach for NPD, additionally, the cases only realized two of the three espoused benefits: Improved Speed to Market and Greater Market Success.

10.5 CROSS CASE ANALYSIS

To create thorough, accurate, and generalizable Grounded Theory of ASGM practices, cross-case analyses were conducted. Each case offered unique product lines, business climates, and team challenges from distinct NPD teams. Comparisons were conducted without a hypothesis to simply search for similarities and differences, successes and failures, between the cases. The cases were reviewed and analyzed singularly and collectively to mine for descriptors that potentially made each case unique. Cycling through transcripts several times and incorporating the secondary data collected, a few factors became apparent that made the cases unique. Table 10.7 contains these elements or descriptors for each case, these variables were factors that influenced the behaviors of the BU teams' approach towards ASGM and its implementation. For the research questions within scope of this study a comparison between case elements that were different, as well as, analysis between case elements that were similar was conducted.

Table 10.7 - Cross-Case Analysis Factors

Analysis Factor	Factor Descriptor
Schedule Flexibility	Degree to which the team had flexibility in the project launch schedule, Low, Medium, or High
Portion of NPD Process	Team responsibility for the NPD process, such as Up-Front Research, Product Design, Engineering Development, or Manufacturing Execution
Path to Market	Selling strategy for the BU's products, such as Direct to Customer, Sales through Intermediary, or Platform Technology
Market or Business Turmoil	Level of market or business turmoil from technology or other factors experienced by the BU team, ranked as Low, Medium, or High
Participant Experience	Average amount of professional experience of the BU in terms of years
Agile Exposure	BU team experience level with Agile techniques in terms of NPD projects executed, such as High, Medium, or Low
Team Dispersion	Number of physical locations that make up the BU team, such as High, Medium, or Low
Agile Tool	Team used a software package (e.g., Jira or Version One) to manage project tasks, or were following commercially available Agile frameworks (e.g., SAFe)

The eight generic cross-case analysis factors discovered through an iterative analysis process were shown in Table 10.7 and are further decomposed for each case and shown in Table 10.8.

Table 10.8 - Cross-Case Analysis Factor Summary

Case #	Schedule Flexibility	NPD Process Portion	Path to Market	Market or Business Turmoil	Participant Experience (Avg Years)	Agile Exposure	Team Dispersion	Agile Tool
1	High	Up Front	Intermediary	High	29.7	Low	Low	No
2	Medium	Complete	Platform	Medium	18.6	High	Low	Yes
3	Low	Complete	Direct	Low	18.3	Medium	Low	Yes
4	Low	Complete	Direct	Medium	24.5	High	Medium	Yes
5	Low	Complete	Platform	High	13.7	Low	High	Yes

10.5.1 AGILE/SCRUM TECHNIQUES

To develop comprehensive grounded theory, the cross-case comparison technique was utilized, this practice included comparisons where cases were fundamentally

different between a specific topic, as well as, cases that had strong similarities. As mentioned, Team Interface, Product Demonstrations, and Specification Flexibility were found in all five cases. Each case demonstrated some form of Agile structure that was more focused on solving problems, finding technical solutions based on product specification with an empowered team, as opposed to a rigid development process with strong central oversight. All five cases utilized some form of product demonstration to ensure alignment with "customers", either those inside of the firm, such as Product Owners, management, or technical experts, or those that were external to the firm, such as sales representatives, users, or distributors. All cases demonstrated a willingness to learn about their product designs and were open to modifying their plans based on feedback, to some degree, after customer sessions or product demonstrations to suit the needs of the market.

10.5.1.1 AGILE/SCRUM DIFFERENCES

Leveraging the summary data in Table 10.2, Case One and Case Five did not exhibit all eight elements of Agile/Scrum. CS1 was a consistent outlier in terms of Team Structure (TS), Time Bound (TB), Feature Prioritization (FP), and Communication (Comm). Case One did not utilize Agile team roles, in name or in purpose, such as Product Owners or Scrum Masters, and also did not execute project tasks in a time bound manner as envisioned by classic Agile techniques, such as, defined quick, focused, Sprints for portions of the development process. CS1 also did not actively seek to extract on-going learning from customers and critically prioritize product features to maximize value through concepts such as Minimally Viable Product (MVP), nor did the case implement communication patterns such as stand up meetings, Burndown charts, Sprint planning, or Epic definition. Utilizing Table 10.8, a few factors potentially explain the behavior of CS1:

- Highly experienced participants (Average of 29.7 years)
- Focus on Technology Scouting activities framed by minimal durations
- Low team dispersion due to small staffing levels and co-location

Since CS1 operated in the research phase of the NPD process and already had a quick engagement mindset and low geographical dispersion, the team may not have felt the need to have formal stand-ups to communicate and may not have required the quick twelve-week Proof of Concept (POC) opportunity assessments to be decomposed further into three or four-week Sprints. The average experience level at nearly thirty years could have facilitated a mindset of extreme process revulsion towards even the lightweight concepts espoused within Agile. Table 10.9 offers participants quotations that illustrate the unique concerns of CS1 participants, specifically, for the ASGM Measures of Success, participant insights for non-alignment to Agile/Scrum elements TS, FP, and TB.

Table 10.9 - Case Study One Participant Quotes

Agile Scrum Technique	Organizational Role	Participant ID#	Participant Quotes
Team Structure (TS)	Program Management	5	…I would estimate…that 15 to 20% of the engineers in the world can't rarely be an innovation engineers because engineers are almost trained to stay within the box or try to put the issue your trying to resolve inside the box almost too soon not let it flow out there a little bit.
Feature Prioritization (FP)	Leadership	1	…we're going to write the spec, and…use that to help influence what the spec is…Early enough in the technical development…we can basically help write some of the parameters…If we're not early in the process, then we're basically responding to a request for quotes from our customer, and the specs are going to be largely defined.
Time Bound (TB)	Leadership	1	…we are basically taking an accelerator model, and modified it to a concept model. We engage with start-ups…for [a] 12-week proof of concept, and then we try to make that be very light in terms of what the requirements are…It's basically a way for us to prove out the hypothesis surrounding the…business market opportunity, and by forcing the tight timelines…

Another outlier was Case Study Five, here the team demonstrated seven of eight Agile/Scrum techniques however did not strongly consider Customer Involvement (CI), either internal or external voices. This was possibly due to their role within the commercialization process within the firm, the team was a provider of technology platforms as opposed to complete end products for sale to customers. The team tended to rely exclusively on cascaded product requirements from the "receiving" system and did not get involved into reviews with actual customers, or minimally this activity was not top of mind. Other possible factors that seem to suggest a lack of CI were the limited Agile experience of the team, only some Agile development for Software products had been completed, and only one electro-mechanical product, also, the overall professional experience of this team was the lowest within the study at 13.7 years. Also, the team was very geographically dispersed, with design elements in several locations around the globe. Table 10.10 provides quotations that illustrated the unique concerns of the CS5 participants, specifically, for the ASGM Measures of Success, as insights for non-alignment to Agile/Scrum element CI.

Table 10.10 - Case Study Five Participant Quotes

Agile Scrum Technique	Organizational Role	Participant ID#	Participant Quote
Customer Involvement (CI)	Program Management	29	We own a component that gets integrated in other platforms…We do not really have a real customer, more the [Product] integrating team is the customer.

10.5.1.2 AGILE/SCRUM SIMILARITIES

Referring to the summary data in Table 10.2, Cases Two, Three, and Four had utilized all eight of the Agile/Scrum techniques within their ASGM implementation, two case factors from Table 10.8 stand out that possibly explain the similarities of results:

- Medium to high levels of Agile exposure
- Use of an Agile tool to support product development

Since all three teams had previous levels of Agile experience, either from related software projects, or had performed other electro-mechanical projects, this could explain why these teams adopted the techniques in their entirety, or minimally, these teams had a more robust understanding of the Agile mentality. These teams also were using some type of Agile tool, either a software package to manage work tasks, such as Backlogs, or were using methodology frameworks which guided the teams with their use of Agile during the integration into ASGM. Table 10.11 provides participant quotations that supported the potential rational for the cases that responded similarly.

Table 10.11 - Participant Quotations for Agile/Scrum Similarities

Agile Scrum Technique	Organizational Role	Participant ID#	Participant Quotes
Communication (Comm)	Individual Contributor	3	…we're using JIRA a lot here to manage the sprints and everything that is done in the project. This really is a good tool that is a really nice tool to have for interaction and follow up and for not forget anything and for reporting and all this stuff.
Team Structure (TS)	Resource Manager	20	…what I saw benefits in taking the Agile principles…It encouraged the engineers…to start breaking down what needs to be done into more manageable chunks…it got them to start thinking about, "Let's set up. Let's start breaking down the project into Sprints. And then let's come to an agreement.

10.5.2 ASGM MEASURES OF SUCCESS

In a similar fashion as the Agile/Scrum technique case analysis, the cases were cross-compared for factors that were similar, as well as, unique, again, this comparative practice was intended to deliver well rounded, comprehensive, theory. For the ASGM Measures of Success highlighted in Table 10.5, none of the cases demonstrated unanimity for the success measures. Four of five cases felt ASGM delivered an improved pace to market for their NPD projects, additionally, four of five cases believed that the implementation of ASGM had brought more market successes. Where consensus did occur was with the ASGM impact on project team resource utilization, all five cases felt that there was no perceived benefit of the

implementation, meaning resource utilization during NPD was unaffected by ASGM, in fact, a few participants mentioned a possible negative effect, increasing resource levels from the dedicated staffing model employed by the cases.

10.5.2.1 ASGM MEASURES OF SUCCESS DIFFERENCES

One ASGM Measure of Success was demonstrated by all cases, however, a few notable differences were indeed observed. The participants from Case Study Four did not feel that ASGM allowed them to get to market faster, this is possibly explained by scope of the projects executed, particularly the groundbreaking project that drove so much of the discussion during the interviews, this project was large in scope with many products involved and waves of introductions. Additionally, a substantial reason for this particular ground-breaking product was due to a change in regulatory requirements within the main markets. This performance standard change, without significant development, would have meant expulsion from the market, resulting in a significant loss of business and a fairly rigid, and hectic, program launch schedule.

Alternatively, the participants from Case Study Three did not feel that ASGM delivered Greater Market Success, participants largely felt that ASGM helped them coordinate tasks better and improved team morale, however, a possible factor could be the level of business and market turmoil experienced by the CS3 team. The BU was arguably the market segment leader, however, in a somewhat slower technological changing industry, the team placed a heavy focus on improving the performance of their products in the field, responding to customer performance concerns over new innovations. Table 10.12 provides participant quotations that support the potential rational for the case teams not aligning with others illustrating differences between the cases.

Table 10.12 - Participant Quotations for ASGM Measures of Success

ASGM Measures of Success	Organizational Role	Participant ID#	Participant Quotes
Improved Speed to Market	Program Management	15	I think the value that it brought to our company is that it allowed us to execute the largest New Product Development program that we've ever done, and do it properly… So, I think it helped us from a transition planning, it helped us meet our dates, and achieve big business objectives
Increased Market Success	Resource Manager	9	And in fact, this, at the end, was held to have better metrics in terms of team help, and a better predictability of where we are and what is remaining to be able to reach it, and give it better feedback into the marketing about the solution we are putting in place, and be more flexible into the scope change sometime with that.

10.5.2.2 ASGM MEASURES OF SUCCESS SIMILARITIES

Universally, none of the cases perceived that ASGM frameworks impacted resource utilization positively, meaning a reduction of resources consumed, in fact, a few respondents accentuated that the Agile desire of focused, fully allocated teams, actually worsened the resource impacts, driving up project staffing costs. The cases were much more vocal about team alignment, team communication, product features, and schedule attainment, rather than a reduction of resources, the overwhelming rationale was to "*get the product right*", quickly. Although, Agile can be thought of as an outgrowth from manufacturing lean principles of the 1950's and 1960's with a focus on waste minimization and has a belief of simplicity by maximizing the work completed, most of the Agile credo is centered around customers, flexibility, people, and demonstrations. Table 10.13 provides participant quotations that support the potential rational for the cases that responded similarly.

Table 10.13 - Participant Quotations for ASGM Measures of Success

Agile Scrum Technique	Organizational Role	Participant ID#	Participant Quotes
Improved Utilization of NPD Resources	Individual Contributor	21	In terms of resource usage…my experience is that the overhead is increasing, because you need people to be trained, you need…Scrum masters, you need a lot of people working on preparing the backlog items and prioritizing…But I really hope that in the next term we will also go down there with the resources.
Improved Utilization of NPD Resources	Individual Contributor	29	I think that's not a larger feature set as I started, and fewer resources, probably not. More resources, also probably not.

10.5.3 ASGM HYBRID APPROACH

A facet of ASGM implementation that was discovered during this study focused upon the specific phases where the teams where Agile and where they were not. The Scrum mindset and terminology, including frequent, quick, focused cross-functional team meetings, often called "Daily Stand-Ups", was prevalent. Most cases also used pre-planned, time-bound Sprints, with quick design, build, and validate loops from dedicated teams. These established a keen focus on the immediate tasks at hand to accomplish near term deliverables. This behavior models closely with the generic Scrum process model that has been widely used for years. Figure 10.3 shows a singular Scrum loop, where a team sets out to release some new functionality, possibly a portion of a larger product plan, bounded by time, typically two to four weeks, and attempts to accomplish a pre-planned set of activities, selected from a prioritized Backlog, and ends with customer confirmation to ensure the functionality was valued by the "customer".

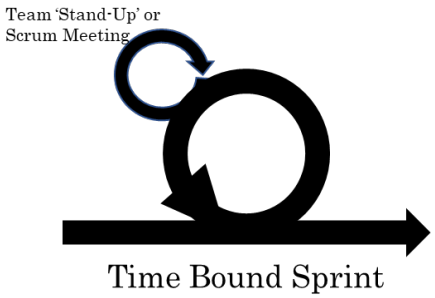


Figure 10.3 - Scrum Process Model

For complex physical products, such as those analyzed within this study, many Sprints were used, in one case over fifty Sprints were executed to complete the final product. Popular Agile implementations for software products, such as the Scaled Agile Framework (SAFe) (Scaled Agile 2018), depict multiple sprints leading up to a product release known as a Program Increment. In other words, the Agile model can be thought of as a recurring model of plan, design, build, test, review, and launch loops with customer demonstrations used to ensure "done is done". Figure 10.4 illustrates a simple, common, Agile three Sprint loop model with defined activities within each Scrum (Everaerts 2018).

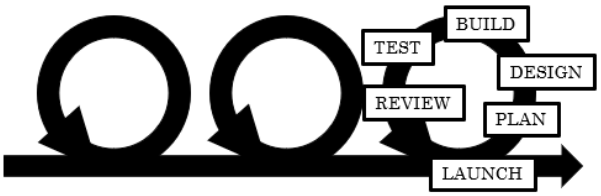


Figure 10.4 - Scrum Model

ASGM was defined as an Agile – Stage Gate hybrid framework (Cooper 2016), meaning the main tenants of each are integrated into one approach, the implementation practices, regardless of the perceived benefits or the exact techniques utilized, were studied. Indeed, the integrations of ASGM discussed with the participants of this study appear to balance the desires between fixed planning and iterative problem solving, a methodology coined Industrial Scrum (Sommer, Hedegaard et al. 2015) and illustrated in Figure 10.5.

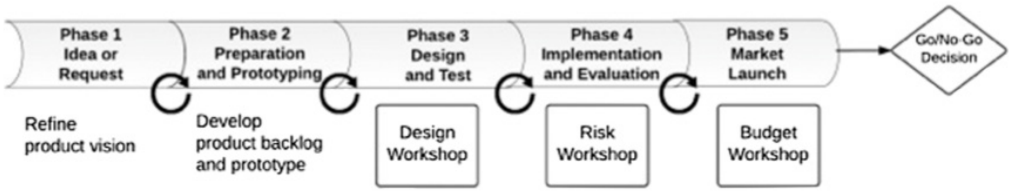


Figure 10.5 – Industrial Scrum Model (Sommer, Hedegaard et al. 2015)

Industrial Scrum described a framework where activities within each of the phases were completed by a number of Scrum team Sprints, roughly defined at the onset and which evolved as development proceeded. However, a defined gate was conducted to assess project progress and potentially "passage" onto the next gate if conditions were satisfied. As opposed to the Industrial Scrum approach espoused in Figure 10.5, the practices discovered within this study paint a different picture. Each case operated largely within an "Intra-Phase" implementation of ASGM, as well as "Inter-Phase", preferring to construct an early overall project schedule in a more waterfall, linear approach, with Agile elements leveraged inside of a given phase or across the main development phases, such as, research, planning, and development. These Agile behaviors were exclusively seen only in earlier phases, with none observed in the later phases of manufacturing or launch preparatory phases. Practitioners often viewed Program Increments, not as time bound, 'launch-ready' products, but as a more SGM style phase, based upon a task-bound set of activities supporting an overall product development plan. Each BU held structured, traditional, SGM style gate reviews, with a technical focus, business focus, or a combination of business and technical, and occasionally marketing, often utilizing detailed gate checklists and gate "Assessors" to ensure thoroughness and robust decision making.

To further this point, participants from all cases articulated a desire to have clear project milestones, including a thorough up-front project planning effort, often citing defined schedules and clear milestones as critical to success. Participants also mentioned that the structure and language of traditional SGM was required for senior leadership to understand the state of a given project, the progress achieved, and to articulate a perception of control, also, many participants felt that executive re-training of Agile terminology was not worth the effort because Agile was seen as "open ended", hence a hybrid workable solution was developed. Each case delivered project related activity, technology scouting, complete products, or platforms with ASGM but all co-existed within a larger, non-Agile world. This co-existence required a translation of sorts, between the project teams and their work, and the desires of leadership to maintain a comfortable level of control.

Leveraging the basic SGM process flow shown in Figure 6.1, the specific phases could be described as Research, Planning, Development, Launch Preparation, and Launch, since these were companies that had significant product testing, capital tooling, and production preparation cycles common for complex, electro-mechanical, physical products, this modified SGM flow is shown in Figure 10.6. The addition of Pre-Launch and Launch phases is acknowledgement of the significant work and risk that remains before serial production and after the product designs are largely complete. This appears to be a crucial difference in thinking and behavior between software only and physical products.

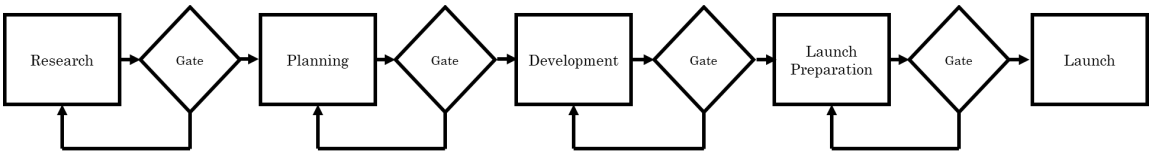


Figure 10.6 - Physical Product Stage - Gate Framework

The cases all demonstrated the ability and desire to utilize Agile techniques, hence the inclusion within this study, however, they do not practice Agile as popularized, the cases are maximally Agile within the early stages of development, a blended model to explain the behavior is proposed, where Figure 10.7 articulates the proposed hybrid implementations based on actual observations. Meaning, the cases were not simply Agile or spiral "within" a defined SGM phase, the teams were Agile or spiral ACROSS the first THREE phases of the over-arching framework of Research, Planning, and Development.

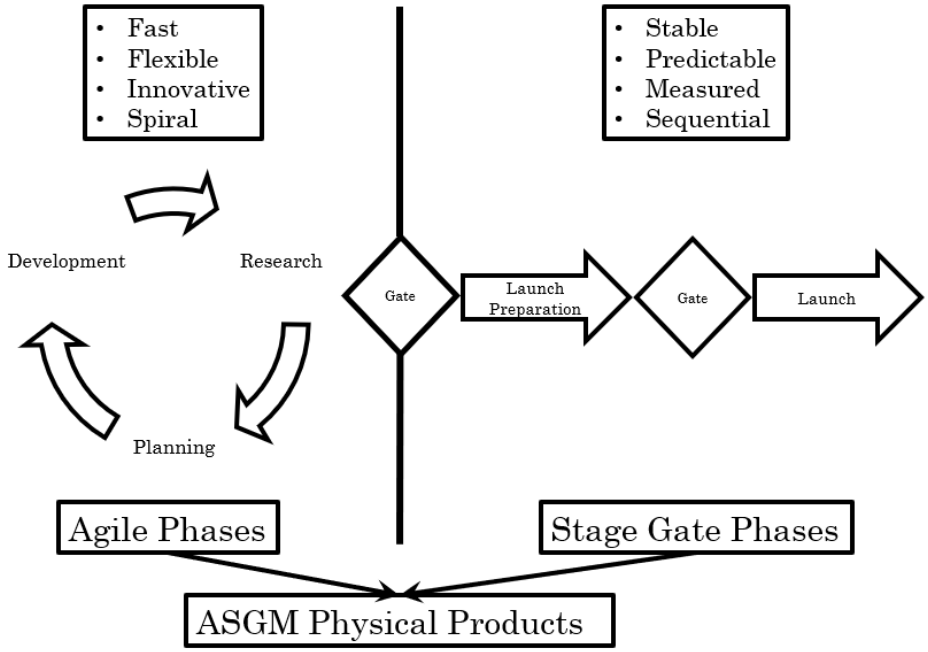


Figure 10.7 - ASGM Framework for Physical Products

Figure 10.7 illustrates how the implementations of ASGM applied only to these "earlier" stages of development, Research, Planning, and Development, with very little Agile tendencies in the Launch Preparation phase or thereafter. For this behavioral model, Agile techniques move across phases, where closer to product commercialization, Agile, when it was applied, was performed in more of an "Intra-Phase" method, as other authors have suggested. Again, the teams simply were "Inter-Phase" in their Agile behaviors early on.

Others have studied ASGM, highlighting 'spiral' development activities, much like the well-known Agile plan, design, build, and test loops, however, these other models do not show Scrums or Sprints crossing phases, see Figure 10.8 (Cooper 2016). The spiral activity certainly occurred at a local level, within a design phase, or tooling development activity, however, the larger, structured project plans did not loop, in fact there was a significant penalty for loops in later phases, the BU's simply did not appreciate nor seek learning in these latter phases.

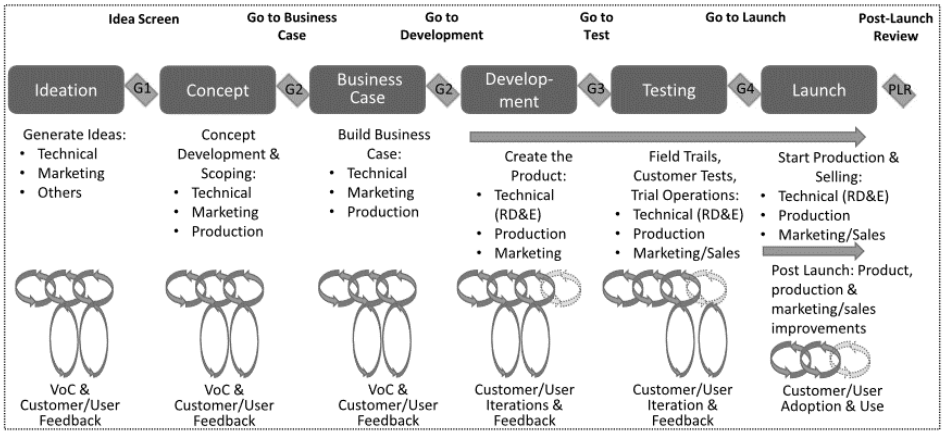


Figure 10.8 - Popular ASGM Model (Cooper 2016)

The early phase desires and usage of Agile/Scrum within the broader ASGM framework to facilitate learning through frequent feedback cycles was an effort to develop the best product possible, however, this was counterbalanced by a desire to eventually gain a level of stability as the march toward commercialization took place, and where substantial testing, along with manufacturing spending occurred. Table 10.14 outlines several participant quotes validating the behavioral model illustrated in Figure 10.7. Study participants highlighted three specific areas where learning, flexibility, and change, are less than appreciated, capital tooling, product certification testing, and executive business expectations.

Table 10.14 - Participant Quotations for a new ASGM Framework

Organizational Role	Participant ID#	Participant Quotes
Resource Manager	19	…the factories, the manufacturing guys, can't do a whole hell of a lot without drawings. You've got to start with a design…I understand software, where you're making ones and zeros, and you can erase them…I've got stamping tools that you're buying from China that have four- or five-month lead times. You've got to make some decisions and make some documentation decisions up front.
Leadership	1	…we do get a long time to the market high-technical requirements. You're kind of a fixed and defined [a] time frame…Our development process is relatively lengthy. Any big product development is complex, and is time consuming…I don't know how to separate that from the stage-gate processes, and part of the product development process, we go from idea, to concepts of feasible to valid to launch…
Individual Contributor	21	In railway systems, if you were to develop a safety system with safety software, then the acceptance of a Waterfall type of development…is higher than for an Agile approach. Although Agile is not forbidden…you typically have to demonstrate more, you have to explain more – whereas with a traditional Waterfall, everybody feels comfortable with it.
Resource Manager	9	One thing that is very hard with the Agile is that all of the certification's…UL, for example. Those were not flexible as the Agile was asking for. We need to have a final version…to go into certification…they are very into the Waterfall…they don't want a part of the product to be able to go into certification. And we don't want to spend too much money to go several times into that certification. So this is a challenge for us…
Leadership	15	…we said, "OK, since those are time-based, why don't we just rename them…and call them our schedule milestones?"…engineering sample lot builds, manufacturing sample lot builds, pilot dates, design reviews, field tests... These are the big milestones in the program that we need to drive to…"Let's track them using Agile, and link them to the program plan."
Leadership	14	…the actual lead time with the supplier building a tool... I mean, it wasn't really "Agile-ized"…it's running more in the background. But all the things to get ready for the tooling release were burned on task…if we had to get a tooling release out by a certain day, that would be one of the elements that would be in one of those releases…it's just the lead time, you're not really burning that down; it's a task that's in the background.

11 DISCUSSION

Two main research questions were presented in this grounded theory study of ASGM practices of firms that design, develop, and manufacture physical products. Twenty-nine experienced industry professionals across four global firms, covering five distinct businesses defined five unique case studies of NPD teams that have developed products using ASGM. These firms, global in reach, were often significant entities within a much larger corporate conglomerate. From participant interviews and secondary data, three theoretical models were generated to illustrate how these teams managed product development, furthermore, this data was leveraged to build primary and secondary themes. These two research questions delivered four distinct and insightful answers.

First, as shown in Figure 9.1, Primary and Secondary themes, along with the respective linkages were developed, which resulted in three Primary themes. In order of significance: Process Speed, Market Success, and Innovation Enabling became clear as well as fourteen Secondary themes. Created utilizing a structured Content Analysis approach, these themes articulated behaviors, insights, and struggles of the cases and participants during NPD.

Second, the specific Agile/Scrum techniques implemented, and their occurrence rates were developed from the interview transcripts. Eight Agile/Scrum techniques were organized from well understood Agile and Scrum methods and organized using definitions and keywords, where the transcripts were then mined for these techniques. Of the eight, three techniques Team Interface (TI), Product Demonstrations (PD), and Specification Flexibility (SF) were used across all cases, the remaining were also highly observed and understood from individual participants, but simply did not rise to a level of prominence across the BU's interviewed.

Third, three ASGM Measures of Success were formulated, Improved Speed to Market (STM), Reduced Consumption of NPD Resources, and Greater Market Success as the primary business benefits of ASGM implementation. The cases unanimously panned the concept that ASGM would reduce NPD resources, whereas, four of five cases realized Greater Market Success and Improved Speed to Market. In all cases, the teams, and individual participants, had a tremendous focus on product specifications to "*get the product right*", as well as team communication methods in an effort to move through the development process faster.

Lastly, previous research has suggested that ASGM implementations were managed at a high-level with a traditional gate style structure, where Agile/Scrum activities largely occurred within a particular structured phase. In other words, the teams "spiraled" in an intra-phase manner, while this was certainly noticed within the five cases, a further refinement was discovered. For organizations that develop physical products, a baseline traditional SGM framework was defined with five distinct phases: Research, Planning, Development, Launch Preparation, and Launch. The unique ASGM variant developed based upon behaviors from the five cases was shown in Figure 10.1. Development teams were highly Agile across the first three phases of development, coined Inter-Phase ASGM, where Launch Preparation and Launch phases, much closer to commercialization, the teams were less Agile, operating flexibly inside a given phase, or Intra-Phase ASGM. This behavior may be unique to the world of physical products due to the, in some cases, year's long development cycles with significant testing and manufacturing tooling activities. Simply put, the teams desired to start with some level of product specification clarity, would gladly spiral across Research, Planning, and Development activities,

with check-in or report-out points enabled by Agile documentation, but worked towards a design specification freeze at some point. Once the freeze was accomplished, the teams then acted in a more serial fashion preparing test samples, executing product tests, validating manufacturing tooling, along with achieving external certifications.

To organize the findings of this study, the discussion section will be structured into five sub-sections: Primary Contributions, Secondary Contributions, Practical Implications, Limitations & Opportunities, and lastly, Conclusions.

12 CONTRIBUTIONS AND IMPLICATIONS

The focal phenomenon for this study was management of NPD projects within firms that design, develop, and manufacture physical products using an ASGM hybrid framework. This methodology was derived from integrating elements of Agile and Scrum, long used with success in the Software and IT worlds, with a more traditional gate style framework which is common for the development of physical products, such as automobiles, appliances, or medical devices. These products are electro-mechanical in nature, with long development and tooling cycles, often measured in years.

Leveraging a multi-case study format, this Grounded Theory study, developed different behavior models for the implementation of ASGM, which were validated with prescient participant quotations. The three operational models are:

- Agile/Scrum Implementation Techniques
- ASGM Measures of Success
- ASGM Hybrid Framework

To reset, from a literature review which established the foundation and direction for this study, the SGM knowledge gaps were:

- Universal NPD success factors
- Stage-Gate process flexibility
- Development process management practices

Combining the literature gaps and real-world challenges from practitioners with traditional SGM criticisms, seven areas of concern with SGM were crafted:

- Does NOT fit non-traditional projects
- Can NOT accommodate all project types
- NOT scalable to ensure 'right' amount of flexibility
- NOT fluid enough for late specification freeze
- Moves organizations towards incremental projects
- Drives MORE resource utilization

- Takes LONGER due to rigidity

Extending the knowledge gaps and criticisms particularly for physical products and considering recent research into ASGM which is purported to alleviate many SGM concerns, two critical research questions were proposed as a basis for this Grounded Theory study:

- How do firms that design, develop, and manufacture physical products implement the techniques of Agile/Scrum within their ASGM framework to manage NPD?
- What benefits do these firms realize from the adoption of ASGM when managing NPD?

A Grounded Theory, multi-case study approach was an appropriate methodology due to the complex nature of product development. The research plan utilized open ended but guiding survey questions, along with other external sources of data, to establish a meaningful dialogue that produced deep and complex insights from participants. As such, this study articulated behaviors and generalized the cases into a coherent set of norms based upon participants who were experienced industry professionals that utilized ASGM for the development of new, physical products.

12.1 PRIMARY CONTRIBUTIONS

This ground-breaking study has uncovered several contributions for NPD practitioners, researchers, and business managers, some are strong and direct, others are subtler.

12.1.1 AGILE/SCRUM TECHNIQUES

Eight Agile/Scrum techniques were extracted from the Agile Manifesto and classic Scrum orthodoxy, combined, then organized. These Agile/Scrum tenets were then deduced from the interview transcripts using a line by line approach and organized with high level definitions guided by a series of key words, placed in context, to assist with the identification process. Based on a simple majority of like responses within a given case, only three of the eight Agile/Scrum techniques were observed universally across the five cases, however, all techniques had a high occurrence rate based upon individual responses. Team Interface (TI) (96.6% occurrence), Product Demonstration (PD) (86.2%), and Specification Flexibility (SF) (79.3%) were highly observed in all cases, these teams established an environment where product developers were more focused on products than processes or artifacts, that extensively utilized prototypes to confirm product design direction, as well as alignment with customers. Lastly, the teams were more than willing to make modifications to product specifications to ensure strong customer value to a point.

With these tenets defined, from the world of software development, the three universally implemented techniques for physical products discovered from this study

were Team Interface (TI), Product Demonstration (PD), and Specification Flexibility (SF). Participant quotations highlighted the following areas of commonality:

> Team Interface (TI) – Aligned team behaviors were established by a desire to focus on products and features, along with business opportunities, market evaluations, much more so than development processes. Lightweight methods, to guide activities, but not encumber the teams' focus away from customer and products.
>
> Product Demonstration (PD) – Here, prototypes, physical or virtual, placed in front of, or with customers, internal or external, as a means of aligning the design to establish a robust value proposition. This was often performed with actual end customers or internal customers over the course of development.
>
> Specification Flexibility (SF) – Establishing a willingness to adjust specifications, to learn from product demonstrations in an effort to develop an optimal product, even if this learning came at inopportune moments, such as late in the development process.

12.1.2 ASGM MEASURES OF SUCCESS

Three measures of ASGM success were established for this study: Improved Speed to Market (STM), Reduced Consumption of NPD Resources, and Greater Market Success. Presence of these perceived success measures were extracted from the interview transcripts in a line by line fashion and organized using high level definitions guided by a series of key words, placed in context, to assist with the discovery process. Based on a majority of like responses within a given case, furthermore, only one measure of success was universally deduced across all cases, Reduced Consumption of NPD Resources was panned for all five cases, where only 17.2% of participants deemed it positive. Considering the broader viewpoint of the case teams, none of the teams perceived that ASGM implementation reduced the resources needed to develop new products, in fact a few participants commented that Agile methods, particularly the desire for dedicated, focused teams, would actually increase development costs. The two other measures, Improved STM and Greater Market Success, were impactful, as represented by a majority of respondents within a given case, in four of the five cases where 65.5% and 62.0% of participants respectively experienced benefits from ASGM.

12.1.3 ASGM HYBRID APPROACH

All five cases implemented a framework that interspersed Agile and SGM methods, hence the Agile – Stage Gate Method (ASGM) hybrid definition. Other authors have espoused spiral approaches to speed up development activities, as well as adapting to changing customer needs, better voice-of customer integration, better team communication, and improved development productivity (Cooper and Sommer 2016). The cases embraced Agile techniques due to these perceived benefits, in addition to a

belief in the flexibility of the development process itself. By design and defined through central tenets, Agile could be used to manage all types of projects and through all phases of development due to its flexibility.

ASGM implementation for these cases was mainly Agile methods within defined phases of an overarching SGM framework, or intra-phase, consistent with spiral thinking. Curiously, some Agile efforts, spiraled not only intra-phase, but then also travelled across defined phase boundaries, making the teams inter-phase Agile as well. A proposed gate cadence for physical products, highlighting the unique challenges of longer testing and complex tooling activities, was shown in Figure 10.7. Spiraling across defined phase boundaries tended to occur across the Research, Planning, and Development phases, as opposed to the Launch Preparation and Launch phases, in other words, inter-agile behaviors early in the development process, and intra-phase behavior for phases closer to commercialization, per Figure 10.7. The cases, early in the development process were defining customer requirements and establishing product designs, including market opportunities and business cases. The teams were open and comfortable cycling through and tracking back when needed prior to the Launch Preparation phase, hence the circular element of Figure 10.7. However, with long lead product testing, including external product certifications, or capital tooling expenditures, the teams were much less likely to spiral, in fact, for some participants, it was forbidden.

12.1.4 PRIMARY/SECONDARY THEMES

Using a structured Content Analysis methodology, the participant transcripts were decomposed, evaluated, organized, then through an iterative fashion, repeated several times, Primary and Secondary themes were extracted and articulated as shown in Figure 9.1. Through this process three Primary themes emerged:

- Process Speed, Innovation Enabling, and Market Success

Furthermore, fourteen Secondary themes were discovered:

- Lightweight Process, Concepts, Team Talent
- Relationships, Customer Value, Entrepreneurial Mindset
- Process Control, Process Flexibility, Project Communication
- Speed to Market, Business Longevity, Team Engagement
- Team Communications, Product Requirements

These themes provided valuable insights into the cases, although the participants may not have explicitly expressed these exact topics, or used these specific terms, the interview dialogue and secondary data collected helped define these theme relationships. Content Analysis, by design, moves outside of the observable elements of communication rendering the unobserved context of data analyzable,

simply put, content analysis is a research technique for making replicable and valid inferences from data to their context (Krippendorf 1989).

Process Speed – The dominant Primary theme across all cases was Process Speed, almost universally the teams had defined end dates for their project plans, in other words, commitments to the broader business or to specific customers had to be achieved. The elements of Agile, as well as the detail and structure of the overall project plans were heavily crafted and implemented with an intent to achieve commitment dates. The daily meetings, detailed gate reviews, transparent communications, dedicated project staffing, and co-location of team members were all largely implemented for purposes of speed, quickly completing tasks and achieving milestones within the defined development process and project plans.

Process Control – The principal Secondary theme was Process Control, this completely to the Primary theme of Process Speed. This theme provided process structure with known, defined NPD development steps or activities, articulating clear DoD requirements, holding detailed gate, project, and technical reviews to assess progress, and product or feature demonstrations to gather organized customer feedback, all conducted to maintain control of development. These activities were put into place to bring some level of control or organization to the unpredictable world of product development, the teams were determined to manage all of this work with a sense of governance.

A few other topics were dispersed throughout the theme generation process that are worth highlighting. These areas supported several of the Primary and Secondary themes:

> Rigid Gates and Reviews – Aligned to Process Control and Process Speed, these Rigid Gates and Reviews were key elements for many study participants. Even with a desire to be more Agile, teams, particularly Project Managers and Leadership, expected formal checkpoints to ensure the project was under control and tracking to commitments, this included key project points, technical designs, financial projections, and marketing plans.
>
> Defined Schedules – Similar to gate reviews, establishing and maintaining a defined high-level project schedule was a requirement. From thematic analysis, Defined Schedules was aligned to Process Control and Process Speed. Almost all organizational levels felt that a clear understanding of the holistic project schedule, with key dates defined, was crucial.
>
> Definition of Done (DoD) – Linked to the Process Control and Process Speed themes, DoD efforts were elemental for functioning, valuable scrum teams. In many instances DoD work to establish clear acceptance criteria for Sprint task closure was crucial, occasionally, participants sensed ambiguous closure

criteria led to un-needed sprint delays. Some cases made a concerted effort between the Product Owner and Project Team to identify, and communicate during Sprint planning sessions, as well as throughout the sprint duration. Acceptance criteria was used to fend off questions at Sprint completion and avoid unwanted, wasteful, dialogue.

Team Accountability – Daily information sessions, huddles, or "Dailys" as labeled by one team, were intended to quickly, but in an organized fashion, communicate top priorities usually in thirty minutes or less. Team members would often comment about tasks to be accomplished, tasks that had been finished, and tasks that were being planned. This "round-robin" approach where each team member had a mandate to speak to project peers quickly created an element of accountability. Team-mates were largely unwilling to be short on a task due to concerns of failing their peers. This element of accountability was aligned to the Team Communication and Process Speed themes.

Team Empowerment – Organized under the Team Engagement and Process Speed themes, self-organized and self-managing teams established a feeling of empowerment. Project personnel, in many instances, were left to accomplish project tasks without a high degree of management oversight. Activities were structured through Sprints where product feature decisions were left between the project teams and their respective Product Owners. This autonomy was felt to be more prevalent within the ASGM framework than previous approaches, simply, self-determination enabled faster decisions, which made the teams feel more relevant, which then brought about increased development speed.

12.2 SECONDARY CONTRIBUTIONS

The Primary and Secondary themes, Agile/Scrum techniques implemented, and the ASGM Measures of Success, were major insights into the use of ASGM for firms developing complex, physical products, and were central to this study. The following are several ancillary, secondary contributions, that were not focal points of the study, nonetheless, were behaviors derived from the analysis and worth noting:

- Frequent Sprinting
- Customer Sourcing
- External Partners
- SGM to ASGM Translation
- Flexible Requirements

These secondary contributions, could be considered cautionary tales for future firms or teams seeking to implement Agile who produce physical products. Almost

unanimously, the practitioners of ASGM who participated within this study were positive on its influence, not only for project teams but their businesses overall, nevertheless, there are a few facets that should be considered:

Frequent Sprinting – This is a central tenet of Agile that clearly delivered results, these short blasts of activity were easier to plan, manage, and execute. The teams were very much in an execution mode, where Sprints kept the teams focused and aligned, team-members understood Sprint goals if communicated often and well. However, a few participants expressed a concern about how constant Sprinting impacted the individual. The never-ending sensation of competing in a Sprint, day after day, brought on fatigue and some unhappiness. Additionally, the flexible nature of many ASGM implementations, where cross-discipline help was encouraged and expected, usually during crunch time, meant the engineers were always "On". Yes, it was beneficial to allow members of the project to assist one another, however, there often was little "Off" or down time for the engineers to think, pause, breathe, and plan for other activities.

Customer Sourcing – Customers were a key constituent of ASGM methodology, understanding what represented value and delivered product differentiation, that would drive market success through the creation and refinement of features. The timing and frequency of customer feedback was a strong undercurrent of this study, many participants felt that engagement with customers, particularly early within the development or research phases, was very helpful. Touch points with customers throughout the development process was also critical for success. A handful of participants thought it important for a key customer to be embedded within the design team from start to finish, such a voice could be leveraged continuously to ensure features met market expectations. A few words of caution were discovered about this customer sourcing activity, some teams relied on one influential customer, maybe one that was a longtime partner, or held a significant portion of the market, however, this influential customer was not always aligned to the broader market. This generated several late development loops to modify product features. Sampling from several customers, competing in many markets, could have been beneficial to ensure product acceptance as one voice was not representative of the entire customer population.

External Partners – Dedicated and focused teams, aligned with clearly defined common goals was beneficial, projects largely finished faster and with greater perceived market results. Many of the project teams physically resided in a common location or room, this allowed for direct and frequent,

formal or informal communication, at any time, waiting for meetings to discuss a topic was a barrier eliminated. Nonetheless, this mindset generated challenges for significant resource pools that were note "Core" or remote from the main teams, such as suppliers, distant manufacturing sites, and certification testing partners. While concerns with the first two, suppliers and manufacturing sites, were often vanquished with a greater focus on communication and alignment through technological means (e.g., Video-Conferencing), the external testing certification bodies were more of a challenge. Organizations such as Underwriters Laboratories (UL) that perform rigorous product evaluations were accustomed to conducting confirmatory testing with completed, production representative products, this protocol often left critical product testing until the end of development. Performing certification testing in an iterative fashion, which aligns well with Agile thinking, took some additional care, planning, and explanation. Participants opined that bodies, such as UL, were not used to iterative testing, preferring a more definitive Waterfall style plan and interaction.

SGM to ASGM Translation – As discussed, development teams functioned in an Agile manner, leveraging many of the classical operational elements such as Scrums, Sprints, Epics, and Backlogs. In many cases, senior management did not understand Agile terminology, nor were they interested in learning, SGM simply provided a better sensation of control for a long project. This chasm between the desires of management to conduct business in an SGM fashion against the development team's Agile operation posed challenges. Review sessions and project communication with stakeholders were tenuous, several participants discussed the need to "translate" between the two "languages", expectations, and operational worlds, where gate reviews or updates were communicated using familiar terminology from SGM. The project teams explained that Agile tools were used mainly within phases and that an overall rigid established project plan was guiding their commitments to the business. This largely satisfied senior leadership and helped balance the information flow from the project teams against external expectations. Several participants lamented that detailed, organizational wide Agile awareness training would have been helpful to level set the business.

Flexibility of Product Requirements – Each case spent significant resources building prototypes and demonstrating full products or features with internal and external customers, where a critical output of these demonstrations was alignment of key aspects of the product design with elements that the customer found compelling. This aligned well with the desires of Agile for early and often customer feedback. Another tenet of Agile is the minimal definition of requirements at the beginning of a project, along with the

Minimum Viable Product (MVP) concept, simply put not every feature needed to be understood from the start nor included in the first release. However, this flexibility and learning was muted by the desire of many participants to plan product specifications thoroughly, early, and with rigidity. The teams opined that well defined or "frozen" requirements, often in excess of 70%, was critical along with a well-executed specification change control process. An interesting dichotomy, teams spent significant resources to find and cultivate customers for product evaluation to foster learning, however, the very same teams pursued rigid product specifications preferring to lock, and keep locked, specifications. Were these teams really interested in customer feedback? Were they only willing to make product changes so long as the overall project schedule was not impacted? What happened when these two were in conflict?

12.3 PRACTICAL IMPLICATIONS

For NPD practitioners who work at large companies that develop complex physical products, there are several lessons and insights available from this study. The cases were cross functional business teams devoted to a portfolio of products across several industries, dispersed throughout the world. Many of the implementation challenges were similar and much of the ASGM practices and behaviors overlapped. Developing new products is not easy, frameworks are needed to guide teams and the development process from research to commercialization.

The implementation of ASGM at these firms was positive, clearly more often than not participants felt that their product development machine was faster and delivered better products that were closer to the customer needs and had positively impacted the bottom line of their BU's. Most participants also stated that they would happily work within the ASGM framework again due to team comradery, communication, and empowerment that was established, along with prioritization and alignment with customer needs, furthermore, Program Managers and leadership were positive over its usage due to the transparency delivered, focus that was provided, and success of the products commercialized.

There are several key positions or groups of personnel that are either directly engaged with product development or are responsible for oversight that formed the target audience for this study, implications for each to aid future development follow based upon study findings including participant quotations distributed throughout this dissertation.

12.3.1 PRODUCT OWNERS

Product Owners perform a central role within NPD, as an empowered, critical member of the development team the PO should be firmly aligned to customers and markets. The PO's were often the final decision maker for features and product content, although this was not universal. Main items for future teams to consider:

Priority – Feature priority was crucial for development teams, articulating a Minimum Viable Product (MVP), along with an iterative launch strategy for the market was important. PO's, and businesses, cannot fall into the trap of stuffing too many features into the initial release simply to get the project approved, the development teams should be stretched, but not to the detriment of the project.

Customers – PO's must stay aligned with customers, identifying key and significant players within the markets being targeted was important, to be clear, these customer partners should be engaged throughout the development process. A singular customer voice could be risky if they were not indicative of the broader market trying to be reached, engaging several customers, strategically selected, may be a more robust approach.

Engagement – PO's play a very heavy role early in the development of a product, where Voice-Of-Customer (VOC) activities tended to be right at the beginning of each project. This early feature definition not only helped sell a project idea to an overstuffed portfolio management body, but also set up the design teams with baseline requirements. Nonetheless, continued PO support is crucial for any project team to be successful, continued product refinement occurs up to commercialization.

12.3.2 DEVELOPMENT TEAMS

The development teams are the heart of any NPD effort, these are the people doing the actual design work, brainstorming ideas to create product concepts which in turn become demonstrations for customers. The teams provided all of the heavy lifting to take a set of user needs into product specifications, then into a tangible product. With ASGM, a few items should be highlighted for future development teams:

Communication – ASGM was built around autonomous, empowered teams, where communication was a clear enabler of speed and market success. Teams must take the daily stand-ups seriously, keep them quick and to the point, and ensure that all team members are involved and delivering value.

Definition of Done (DoD) – Establishing a clear DoD was very helpful for teams to avoid unnecessary friction end the end of a sprint. Several participants added the development of clear acceptance criteria to the Sprint planning sessions, with ongoing communication or reminders to the team during the Sprint on what was agreed upon. Surprises were not looked at favorably when trying to complete Sprint tasks and timelines.

Demonstrations – Product demonstrations were a focal point for all of the cases, often as prototypes, component or completed products, these were critical to share and measure progress within the project teams, and were important to communicate status to leadership, as well as crucial for aligning with customers to find features that were truly impactful. One study

participant, in Leadership said it best, "*We did demos religiously, every week someone, somewhere was demonstrating something*".

12.3.3 PROJCT MANAGERS

A slight distinction was required between Scrum Master and Project Manager. The Scrum Master was responsible for the development process with activities such as defining Sprints, building of Backlogs, formatting of Burndowns, entry of data in an Agile tool, whereas the Project Manager was responsible for overall program timing and project budgets. To be clear, Project Managers were in place to "*guide the ship*", PO's brought the voice of the customer to the team, where the Scrum Master operated the process and coached the team the process. A few key highlights for Project Managers:

External Partners – With a strong focus on team collaboration, communication, and co-location, external partners were an additional, unique challenge. Ensuring distant manufacturing sites, or team elements that were not co-located, particularly critical testing partners, needed some additional care to ensure timely and thorough communication. Most teams dealt with this through increased video conferencing efforts as well as weekly sessions, in a similar format as the on-site "*Dailys*".

People – Focused and dedicated Sprints were an advantage of ASGM methods, team personnel that could cover for each other with complete dedication to Sprint timing was also important, nevertheless, constant sprinting was draining on individuals. A few participants, Individual Contributors and Leadership, were attuned to this concern, it seemed with ASGM, Sprint after Sprint, along with helping team-mates, there was little down time for people to reset and recharge.

Talent – Development processes were important, innovation was often chaotic, extracting unstated user needs was difficult, organizing all of the activities needed a sound methodology. Several participants spoke in support of this assumption, but also added that talent was also crucial for project success, from some participant opinions, talent was the most important element. Teams had to be staffed with experienced, entrepreneurial minds, not simply to develop creative solutions, but also to think and act like consumers. Personnel had to be passionate, driven, and open, as one participant mentioned, "*No lazy people*" were wanted.

12.3.4 SCRUM MASTERS

Scrum Masters – As discussed with the Project Managers, Scrum Masters played a key role within ASGM implementations. Scrum Masters were the Agile process and terminology experts, often, teams only became "Agile" once a Scrum Master was experienced or certified. In some ways, for all cases, Agile terminology was new, the need for an expert to help teams understand Epics, Scrums, Release Trains, and Program Increment terms was crucial.

Training – As with any methodology or process, training becomes central for high level execution, ASGM being no different. Certified Scrum Masters were important, but also training for team members in addition to management, the Scrum Master became the focal point of "*all things Agile*". The teams leveraged this process knowledge on an ongoing basis, a few participants thoughts this was another area of opportunity, establishing and reinforcing Agile methods and terms frequently.

Communication – Training to establish expertise with Agile was crucial for Scrum Masters, however, communication patterns with internal and externals teams was also important. In today's world, a fair amount of work is performed externally, often globally, manufacturing and supplier partners must also be plugged in to ASGM, not only project schedules, but deliverables and terminology should be shared.

ASGM Elements – Results from this study have shown that only three Agile/Scrum foundational elements were used universally throughout the cases: Team Interface (TI), Product Demonstration (PD), and Specification Flexibility (SF). To realize all of the benefits of Agile thinking, the remaining five techniques should be prominent. Agile has produced positive business benefits with other types of products, leveraging the full suite of tools and tenets could be helpful.

12.3.5 LEADERSHIP

Leadership as defined for this study were positioned as R&D Senior Management, Business Unit upper management, or Executive Leadership. Implementation of something as significant as NPD processes often require endorsements from top management, these case studies were no different. Initial approvals, but also continuous affirmation, particularly when things became challenging, were needed. For two of the cases, leadership were the catalysts for change, provoking the business to embrace ASGM methodology for all of the reasons espoused within this study.

Agile Understanding – Leadership played a key role crafting the ASGM implementation, however, several participants described a consequential effort to communicate with Agile terminology. Many leaders did not understand the terminology or thinking, and frankly refused to embrace the approach, visionary leaders should make this effort to understand how their teams were functioning and be willing to adapt, as opposed to the teams adapting and translating between ASGM and SGM.

Agile Opportunity – From this study, ASGM for physical products has shown two distinct segments, early development or inter-phase Agile, and later development or intra-phase Agile. The opportunity for leadership is to understand the terminology but also this distinction for physical products. In other words, leadership should intrinsically know when teams can cut across

phases for the sake of learning and when the teams should be bounded by strong gates.

Milestones – Leadership must also have clarity of the ASGM intricacies, rigid program milestones that describe critical commitments have been retained, these simply align as Epics or Program Increments. Having clarity of purpose and deliverables for gate reviews makes them beneficial for all involved, leaders can help this process by articulating expectations early and often.

13 LIMITATIONS AND OPPORTUNITIES

This study was centrally focused on physical products from large global corporations that were often bureaucratic in function and that operated from a position of strength as most were established market leaders. The firms enrolled in the study competed in the Automotive Components, Medical Device, Perimeter Access, Process Monitoring, Railway Technology sub-industries. Twenty-nine experienced ASGM NPD practitioners, representing four conglomerates were organized into five distinct BU's, provided immensely insightful dialogue. These NPD teams designed and developed complete products, some sold directly to end customers, other businesses provided platform products that were integrated into a larger overall product by another development team, and one team was largely focused on technology scouting to support product innovation. Most teams ranged in approximate size between twenty and one hundred staff, all were cross-functional in execution. The teams interviewed were from many parts of the world such as Western Europe, North America, India, and Eastern Europe. All of the cases had primary locations that led the development activities but also leveraged other global sites for additional inputs such as software, sourcing, and manufacturing.

Although the scope of this study was impressive, a few limitations are apparent that represent future areas of study or clarification to establish deeper insights into the implementation of ASGM for companies developing physical products. There are several future research opportunities for ASGM frameworks, with an incredible amount spent on R&D annually, extending this exploration would seem prudent:

- The study was unable to attract businesses from Asia, particularly China and Korea, there are many large conglomerates that design and manufacturing physical products based in these countries that would be of interest to investigate. Are there regional or cultural differences between Asia and North America and Europe when implementing ASGM?
- Each business was a mature competitor within an established market, often amongst segment leaders. There are many other firms producing like products attempting to break into a market and acquire market share. Being the market entrant as opposed to a market

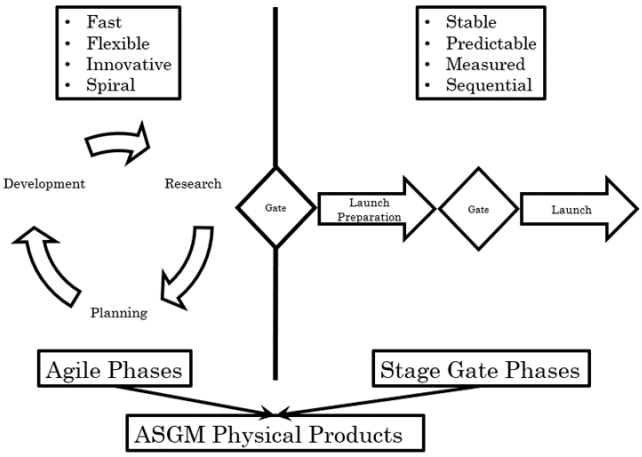
leader would be interesting to study. Would a hungry new comer to a market implemented ASGM differently?

- There was a mixture of direct selling businesses and platforms or technology teams, a uniform direct selling cohort where the businesses engaged directly with end or actual customers would be interesting. Does selling directly to end customers alter the manner in which you engage them ultimately modifying the ASGM approach?
- Most cases were a component of large publicly traded conglomerates with ample resource pools of experienced talent to draw from. Would smaller businesses or startups adopt Agile techniques differently assuming resources were more constrained?
- The ASGM Measures of Success were largely espoused verbally from study participants, very little hard data was produced or was made available to firmly suggest that ASGM made teams faster, reduced resources, or delivered increased business success. Only two cases, and a handful of participants offered any numbers to stand behind. Would measuring resources, business success, or speed in a quantifiable fashion be possible and if so would the ASGM methodology be different?
- All five cases manufactured their own products, from the proposed new ASGM framework discovered, long lead capital tooling and complex manufacturing footprints had an impact on Agile thinking. For these producers of physical products, would outsourcing production impact ASGM implementation?

14 CONCLUSION

There were four major findings from this Grounded Theory study of ASGM implementations at global firms producing physical products. The effort to study complex human behaviors such as New Product Development was perfectly aligned with a Grounded Theory approach. The development teams were largely enthusiastic and positive about ASGM, recommending the approach for future projects and other teams. The businesses pursued ASGM for speed and control reasons, as well as customer alignment for product specifications, ultimately, investments in new products along with the guiding methodologies for managing innovation, were on the minds of these teams. Table 14.1 summarizes the four findings.

Table 14.1 - Overall Study Findings

Finding	Topic	Summary
1	Primary & Secondary Themes	• **Primary:** Process Speed was by far the most prominent theme, with Market Success second • **Secondary:** Process Control was the principal secondary theme, followed by Customer Value
		Teams sought ASGM for improved project control, team communication, customer alignment, and project transparency
2	Agile/Scrum Techniques	• **Agile/Scrum Elements:** Universally adopted techniques Team Interface, Product Demonstrations, and Specification Flexibility
		Businesses were seeking empowered, self-managing teams with enough process to remain in control that built quick prototypes to ensure customer alignment but were willing to be flexible
3	ASGM Measures of Success	• **Measures of Success:** Greater Market Share and Improved Speed to Market were attributed to ASGM implementation, Reduced Consumption of NPD Resources had no or a negative impact
		Better products that are closer to the customer that deliver improved financials
4	New ASGM Framework	• **Flexible Framework:** Agile behaviors are more flexible for early phases of development and less Agile closer to production
		

These findings define the Primary and Secondary themes organized from participant interviews, the themes offered incredible insight into the behaviors, actions, and

concerns of the development teams. Three Agile/Scrum techniques were universally adopted, many others were highly prevalent. Implementation of ASGM helped the teams deliver products faster to customers and with improved financial returns. All of this led to the discovery of a new ASGM framework where development teams were not simply "spiraling" between subsequent phases but were Agile across phases based on the portion of development activity. Earlier phases of development, then teams were freely Agile, as development progressed closer to commercialization, the teams became less Agile. After reviewing hundreds of pages of interview transcripts, a few prescient participant quotations stood out, again, these were experienced ASGM NPD practitioners, many were very versed in Agile techniques, as well as, NPD management methods in general. All the businesses were market segment leaders, each understood that fundamental change was required with NDP practices, these teams largely functioned well with extremely composed personnel.

> *Participant #7: It's as if you say, "Anything that happens in my family, needs to go through stage gating because that's the best way to manage stuff." Well, if you wake up in the morning and…you're on gate two, but your daughter feels like going skating, you may say, "That'd be great but we didn't de-risk that and we don't have a risk analysis…so let's not go skating today." You just missed out on something that could have been great.*

> *Participant #15: At the end of the day, you have to be time-based in business, and you have to meet launch dates and commitments…[and] schedules that have to be met…what we uncovered was that we were missing that time basis…we were not meeting our schedule. And it's really difficult to have that conversation with executive leadership teams…"Well, you don't understand. We're running this as an Agile software, so we don't really have a schedule."*

> *Participant #15: "What's a Sprint?" "Okay, please write down what you're going to do in the next three weeks…a summary level." People should be doing that anyway. "What's a Scrum?" "Well, let's get together once a day for 10 minutes, or 20 minutes, and have a quick stand-up on what we are doing. Here's what I did today…here's what I did yesterday, and here's where I'm stuck."…Demos... "What's a demo?" "Well, why don't we periodically try to show our progress to stakeholders and get their feedback, rather than wait for three months?"*

> *Participant #23: …what I think Agile is very good at doing is giving you many opportunities to assess and correct, and to streamline and improve how that team is functioning. I bet you can do it in the other frameworks, but it's just more core to the way [Agile] is structured.*

15 APPENDIX A – INTERVIEW GUIDE

Dec 28 2017 - Grounded Theory Study of Agile modified Stage Gate Management (ASGM) Framework for New Product Development (NPD) – Discussion Guideline

Introduction [5 minutes] – Researcher background, Study goals, Participant information (e.g., years at current company, current title and role, education, total years of experience, how many years work)

Warm-Up Questions [Section A - 5 minutes]

1) Why New Product Development is important to your company?

- Probe about the tangible benefits the company receives by investing in NPD

Problem Related to SGM [Section B - 10 minutes]

2) Thinking of the traditional SGM framework that was in place before the Agile techniques were introduced, could the SGM framework be used to manage all styles of projects?

- Probe to see if their old SGM framework was suitable for new to the market innovation as well as plus one type projects – Try to understand if innovation was limited by the SGM framework

SGM Flexibility Solutions [Section C - 10 minutes]

3) How has your company added flexibility (Agile) to the new NPD process in use?

- Probe on the techniques brought over from Agile. What is used and how? Also, see how the challenges from question #2 have been solved

4) What benefits have been realized from the incorporation of these new NPD techniques?

- Probe to see how they would define the improvement from a time to market, from a resources utilization, or market success standpoint

Key Success Factors [Section D - 10 minutes]

5) From your total professional experience, if you were to create a new NPD development framework from scratch, what are the key elements that must be included to deliver successful projects?

-Probe for process areas, cultural elements, team organization, tools, etc

SGM Improvement Areas [Section E - 10 minutes]

6) If gate reviews are in use today, what are the elements required for a phase review and describe the dynamic of the personnel attending the review including what roles are present?

- Probe for details of the phase meeting, also look for the interface between traditional SGM and Agile

7) How does the SGM process currently in engage customers?

- Probe for the frequency and manner for customer involvement, along with requirements setting

Closing [Section F – 3 minutes] - Wrapping up Interview; Thank participant; Re-establishment timeline

16 APPENDIX B – RECRUITMENT FLYER

Michigan Technological University

Mechanical Engineering-Engineering Mechanics

R. L. Smith Building | 1400 Townsend Drive, Houghton, MI 49931-1295
906-487-2551 | f. 906-487-2822 | **mtu.edu/mechanical**

Qualitative Research Study of Flexible New Product Development (NPD) Practices

You are invited to participate in a research study evaluating the methods of flexible NPD practices as used in the development of physical products by Dr. Zequn Wang, Michigan Technological University; Houghton, Michigan; Department of Mechanical Engineering – Engineering Mechanics.

Each participant will be asked to support a 30-45 minute interview. The interviews will be conducted either live or over the phone, then transcribed and assembled into unique case studies. Monetary compensation will not be available.

If you are an industry professional, with greater than 10 years of commensurate experience, who has either lead, managed, or been a part of a NPD team that has used flexible stage gate methods such as Agile to organize a new product development project and would like more information about participating, contact:

John Salvato, Investigator/Doctoral Student at 269-720-7373 or jjsalvat@mtu.edu.

Objective of this research is to develop theory using interviews of experienced industry professionals who have practiced New Product Development (NPD) using Agile modified Stage Gate Management (ASGM) methods. The study seeks to interview participants from varying groups within an organization such as engineering, marketing, sales, quality, and manufacturing functions, along with differing levels of the organizational structure such as individual contributors (example: design engineer), project or program managers, and executive leadership. This study will be used to develop theory on how flexible development practices have been implemented by global firms, and the impact these practices have on organization performance.

17 APPENDIX C - COPYRIGHT PERMISSION FIGURE 10.5

Our Ref: P092618-10/URTM

26/09/2018

Dear John Salvato on Behalf of Michigan Technological University,

Material requested: Two Figures in
Anita Friis Sommer, Christian Hedegaard,
Iskra Dukovska-Popovska & Kenn Steger-Jensen (2015)
Improved Product Development Performance through Agile/Stage-Gate Hybrids:
The Next-Generation Stage-Gate Process?
***Research-Technology Management*, 58 (1): 34-45.**
DOI: 10.5437/08956308X5801236

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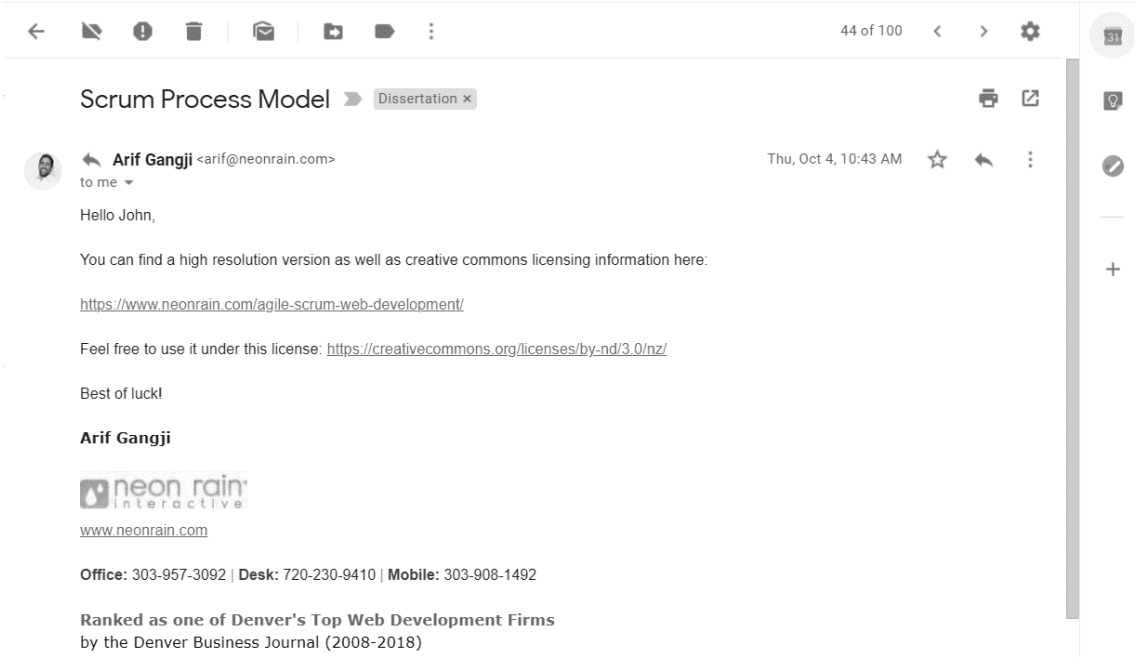
18 APPENDIX D - COPYRIGHT PERMISSION FIGURE 10.4



44 of 100

Scrum Process Model Dissertation ×

Arif Gangji <arif@neonrain.com> Thu, Oct 4, 10:43 AM

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19 APPENDIX E – COPYRIGHT PERMISSION FIGURE 10.8

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