NASA CAPACITY BUILDING PROGRAM

INTERN TEAM FINDINGS
FINAL REPORT
Summer 2020

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TEAM OBJECTIVES

NASA's Capacity Building Program (CBP) provides individuals and institutions with workforce development, training activities, and collaborative projects to strengthen understanding of Earth observations and expand their use around the world.

The team of eight interns set out this summer to work with CBP leadership to explore opportunities & innovations and identify process improvements within the program. For the 10-week summer term, the interns virtually assembled from Washington, Montana, Virginia, Maine, and Puerto Rico to collaborate on this project. The work was divided into four sub-projects: Data Analysis, Communications, Web Development and Strategy.

DATA ANALYSIS

Leads: Kylee Hartman-Caballero & Ben Hodgkins

The Data Analysis sub-project was responsible for parsing and discovering trends in the data the CBP has collected in the past three years. Tasks included analyzing the CBP's geographic reach worldwide as well as examining the program's most effective methods to build capacity. Additionally, a report on the most prevalent organizations and institutions the CBP interacts with was compiled. Thematic data corresponding to the sector of each organization was processed to reveal overall trends and weak points. Finally, the overall process for collecting and processing the data was dissected and small scale automation implemented.

GEOGRAPHIC REACH INSIGHTS (Kylee Hartman-Caballero & Grace Finstrom)

The necessity of the Geographic Reach insights portion stems from needing a way to coherently see where Capacity Building data is coming from. Finding a way to make the extent of the data a visual experience will help the Capacity Building Program to see what regions of the world and the country they should focus their efforts on. To do this, two sets of seven (7) maps were made using Python folium and seaborn libraries. The first set mapped how many organizations or institutions were engaged with in countries across the world and in each U.S. state.

Two maps were dedicated to ARSET data (one noting engagement by country and the other for noting engagement by U.S. state, including Puerto Rico and the District of Columbia). Two maps of the same type were made for DEVELOP data, one map of world engagement for SERVIR data (which has no engagement in the U.S.), and two maps showing the combination of engagements across the Capacity Building Program. The second set of seven showed the number of *individuals* that participated in CBP trainings across the world and nation. The second part of the Geographic Reach Insights portion was taking the data used to make the maps and putting it in other visualizations, such as pie charts and bar charts for not only geographic regions, but also by sector. These productions will help the CBP to better understand where their hotspots are located and where would be the best regions for more investment.

EFFECTIVENESS INSIGHTS (Aariana Maynard, Andy Velez, & Zac Marks)

Effectiveness insights identify what methods are actually used to build capacity by the CBP, where these methods are most effective, and how these methods can be expanded or changed. The product of this section was a document identifying capacity building techniques by reading end-of-project feedback from

users and teams and exploring through the Capacity Building website CBP's own self-identified methods. The document also included the organizations with which these methods are used. This will be helpful for the program because it will facilitate a keeping track of what it actually is that they do. With more research, the Capacity Building Program can determine if the methods they use now are the methods that they should continue to use and how they can be best adapted to the changing world.

PARTNER ENGAGEMENT INSIGHTS (Aariana Maynard & Jonathan Mo)

The partner engagement insights were created to determine which programs the Capacity Building Program had worked with in the past and those the program is currently working with. Additionally, it surveyed the specific purposes for the Capacity Building Program's involvement in the other programs as it related to Research, Academia, and other studies. The end deliverable produced was an infographic detailing the necessity behind a needs assessment that was undertaken by the Strategy project. For people new to the scope of Capacity Building, the infographic also gives an overview of ARSET, DEVELOP, and SERVIR, and the various ways in which the program engages with the world.

THEMATIC WORK ALIGNMENT (Ben Hodgkins & Hannah Wetzel)

Among the various indicators collected by the Capacity Building Program was the sector (Academia, Non-Profit, Federal Government, etc.) that an organization that interacted with the CBP belonged to. This data was analyzed to uncover the most and least prominent sectors as well as the prevalence of each sector worldwide. This report can be utilized by the CBP to make decisions on expanding/contracting the program's efforts in various sectors and regions.

CBP INDICATOR AUTOMATION (Jonathan Mo, Ben Hodgkins and Andy Velez)

The current data collection and analysis process used by the CBP is inefficient and time consuming. Data is manually collected from each program (ARSET, DEVELOP, SERVIR) and compiled into a master spreadsheet that is then manually analyzed. This process was critically examined for automation opportunities. Scripts were created to speed up this process and automatically clean up the data for easier analysis. This work can serve as a basis for future automation work at the CBP.

COMMUNICATIONS

Leads: Grace Finstrom & Aariana Maynard

The design of the Communications sub-project necessitated the design and creation of varied visual materials to explain set CBP metrics. These materials were designed with the idea of effective communication in mind, both internally and external to the organization. Tasks included design of visualizations for data and a graphic summarizing the data, creation of a video for public consumption explaining CBP work in a humorous and informative manner, initialization of an annual newsletter, and re-design and creation of new print materials.

INFOGRAPHICS (Hannah Wetzel)

The infographic was designed to represent 2019 Annual Report statistics in clarity on the Capacity Building Program webpage. It utilized "By the Numbers" data, studying thematic area representation by ARSET, SERVIR, and DEVELOP, as well as the number of countries and states reached, the number of participating individuals and institutions, and development of products and how they represented the appropriate sectors. The graphic was designed via Adobe Suite and will be prominently displayed in future Capacity Building Program communications.

DATA VISUALIZATIONS (Kylee Hartman-Caballero, Ben Hodgkins, Jonathan Mo, Andy Velez)

A set of data visualizations, twelve in number, were designed in order to creatively communicate Capacity Building Program metrics to varied audiences. These visualizations ranged from locations of participating individuals and organizations to a word cloud displaying the most commonly utilized words in the 2019 Annual Report. Intent behind these visualizations is to potentially utilize them in future communications, add them to websites, or simply to explore different ways to show data for future use.

VIDEO (Ben Hodgkins, Zac Marks)

A public video about satellites and the use of the data they collect for earth observations was created by two members of the intern team. This video was stylized as a nature documentary, a humorous take on important information. It is intended as a teaser for viewers to learn more. This video was publicly displayed at Applied Sciences Week and will be published for future reference.

NEWSLETTER (Grace Finstrom, Aariana Maynard)

The newsletter was created to allow those from all over the world to read about the Capacity Building Program various projects and partners. Programs such as ARSET, DEVELOP, SERVIR, CEOS, GEO, and the Indigenious Peoples Group were all featured within this Newsletter. There are specific highlights as to what the various programs have done in the past all over the United States and around the world which has positively impacted the present for the Capacity Building Program.

UPDATE PRINT MATERIALS (Zac Marks, Aariana Maynard)

In the update print materials section, interns examined both the Capacity Building Program flyer, bookmark, and other documents for items which needed to be edited and revitalized. The Capacity Building flyer and bookmark have excellent images and infographics for the public to actively engage with for further involvement in the Capacity Building Program.

NEW PRINT MATERIALS (Grace Finstrom, Hannah Wetzel)

New print materials were designed in a suite of five for varied audiences including: NGOs, Private Sector, Federal Government, State/Local Government, and Academia. These flyers were designed with the intent to explain what the Capacity Building Program does, display stories from ARSET, SERVIR, and DEVELOP tailored to these audiences, and discuss how partnering with the Capacity Building Program can benefit these organizations. This process was initiated with the idea that several iterations will be conducted with a graphic designer working with the program.

WEB DEVELOPMENT

Leads: Jonathan Mo & Andy Velez

The goals of the web development team were to gain experience in real world software development, as well as create new content for NASA websites. Some of the content included intern features, intern written articles, and website redesigns. The completed work of the web development team allows CBP and CEOS websites to reach a wider audience as well as giving the world a glimpse into the lives of a NASA intern.

CAPACITY BUILDING INTERN FEATURES (Grace Finstrom, Aariana Maynard)

The Capacity Building Program Intern Features was created to allow interns and NASA professionals a chance to connect and develop a relationship with one another. These features which are on the Capacity Building Website, allow the interns to reflect on their internship and the various connections they were able to create and develop during their summer experience.

CAPACITY BUILDING ARTICLES (All CBP Interns)

To update the CBP website and create new promotional content, sub-project team leads paired up to write four articles featuring Applied Sciences Week, data visualizations, SEDAC, and CEOS. These articles will drive traffic to the website and help connect viewers to available projects.

CEOS WGCAPD WEBSITE REDESIGN (Ben Hodgkins, Andy Velez, Jonathan Mo)

In order to obtain the best possible viewpoints for a redesign of the WGCapD website, several interns analyzed the site to put ideas together and create the most effective user experience. Previously, the site had large sections of text with no breaks as well as minimal imagery. Now the site contains different font and title styles, and images to break up the text. As a whole the site is much easier on the eyes and more inviting to users.

CEOS TRAINING CALENDAR (Jonathan Mo)

Several updates were implemented to the CEOS Training Calendar over the course of the summer. The first update completed was the addition of social media sharing options for training events. This new feature will allow for wider awareness of trainings as users can invite colleagues and even friends to these trainings over Facebook, Twitter, LinkedIn, Email, and Reddit. The next update of the site was an overall redesign, including the addition of banner images on each page and a new homepage offering more information about the site than previously.

The final and most difficult update was the connection of Applied Sciences events to the CEOS Training Calendar. This involved creating API parsers and carefully analyzing each field of the Applied Sciences API endpoint they provided. These updates enhanced the user interface, included additional training events, and provided the ability to share events in social media. These improvements aim to increase traffic and usability of the calendar.

STRATEGY

Leads: Zac Marks & Hannah Wetzel

Our objective in the strategy section was to assist the Capacity Building Program with the development of the 2020-2025 strategy. This was a unique challenge due to the need for a virtual path forward in the process. In order to achieve this objective the team conducted background landscape research for a foundation, explored how needs assessments are conducted across various organizations, and created a best practices document. The theory of change approach to strategic planning was researched resulting in a sample theory of change. These were all compiled into our strategic approaches document outlining our recommendations moving forward.

STRATEGY LANDSCAPE (Ben Hodgkins, Jonathan Mo, Andy Velez)

The team reviewed the strategies of NASA's Science Mission Directorate, Applied Science Program, and SERVIR and DEVELOP programs. Information regarding overarching strategic goals, the general flow of the documents, and the overall takeaways from each strategy was extrapolated. The team's findings were collected into our strategy landscape document and used for referencing how our strategy would need to encompass the goals of the elements as well as work towards the overarching Applied Science Program goals. This was crucial research for us in order to progress with our own strategic plan. In our pursuit of assisting the CBP with the development of its 2020-2025 strategy, the strategy landscape served as a foundation for efforts to build upon.

NEEDS ASSESSMENT (Aariana Maynard, Jonathan Mo)

For the Needs Assessment document, interns examined SERVIR's Planning Toolkit and other program websites relating to the Science Mission Directorate for insights on how to create a proper Needs Assessment for the Capacity Building Program. This included crafting a Best Practices Document detailing how to go about creating the most effective methods of partner engagement in the present and future. Additionally, interns met with a number of needs assessment experts to relay their findings on the Needs Assessment to determine their likelihood of success.

CAPACITY BUILDING PROGRAM THEORY OF CHANGE (Zac Marks, Hannah Wetzel)

Theory of change (TOC) was thoroughly researched as a part of an effort to help the Capacity Building Program move forward virtually with the 2020-2025 strategy. TOC has already been implemented by SERVIR as a working part of their strategy and their [service planning toolkit](#). Interns reviewed trainings on TOC, referenced SERVIR's template TOC, and interviewed Kathleen Cutting and Zoltan Milic from SERVIR and USAID. The bulk of the effort on this project was doing preliminary research on the subject and becoming proficient in the implementation of TOC as well as being generally well informed on the subject. The outputs from these tasks were a sample template TOC that can be used for strategic development, as well as knowledge about this valuable approach moving forward in the strategic development process.

STRATEGIC PLAN APPROACHES (Grace Finstrom, Kylee Hartman-Caballero)

After the completion of the prior projects in the strategy section we needed to have a document compiling all of the preparatory research and documents. Our other projects were all used to create our own plans

and recommendations for virtually moving forward with the 2020-2025 strategy. The team summarized our findings from each of the strategy projects and funneled this information into what we are recommending for the CBP. The generalized overview of our project is useful for presenting what we found to whomever may seek guidance in developing the new strategy, but does not dive too deeply into the logistics of every activity conducted. The strategic plan approach is the capstone of the strategy project section.

LOOKING AHEAD

FUTURE WORK

- Update Print Materials – the team collected information for updates to print materials in a Google doc and can provide the foundation for new flyers for CBP.
- New Print Materials - iterations with graphic designers will be necessary, as will nailing down the necessary stories for the flyers and the language utilized for pairing with organizations. Once finalized, they will be posted to the CBP website

RECOMMENDATIONS FOR FUTURE INTERNS

- Don't stress about not being 100% sure what you are doing right away.
- Spend time becoming familiar with the CBP and elements.
- Don't worry too much about making things perfect; you will get plenty of guidance along the way and succeed in a beautiful project.

WHITE PAPERS

Each member of the intern team individually explored a research topic of interest and drafted a white paper that identified if these topics were appropriate for further exploration by the Capacity Building Program. These topics included:

- Digital Badging - Grace Finstrom
- United Nations and Sustainable Development Goals - Aariana Maynard
- Game-Based Learning - Ben Hodgkins
- Barriers to Cloud Computing - Jonathan Mo
- Introduction to Theory of Change - Zac Marks
- The Art and Science of Data Visualization - Kylee Hartman-Caballero
- Data Cubes and Analysis Ready Data - Andy Velez
- Agile Project Management - Hannah Wetzel

The white paper findings follow:

DIGITAL BADGING (Grace Finstrom)

EXECUTIVE SUMMARY
The Complexity of Digital Badging and Affiliated Benefits

Digital badging, a creative technical way to track progress and accomplishments, is a subset of digital identity credentials developed in the late 2000s. These credentials are utilized to affirm an individual's skills and achievements regarding a specific platform. Some credentials are test-based, while others require completion of certain tasks.

These digital credentials were originally utilized by organizations such as Foursquare, one of the earliest recorded users, and other companies that required personalization of consumer data. A paper declaring a baseline for these credentials was published in early 2011, entitled "An Open Badge System Framework." The Mozilla Foundation, an advocate for internet public use, took over the task and created the Open Badge Standard in late 2011. As early as 2013, an estimated 1500 organizations had begun issuing digital badges for accomplishments.

While maintaining such a standard across all organizations is difficult, many subscribe to the Open Badge Standard, which has a strict set of requirements for badge officiation. Badges are required to present the following list of information to interested parties looking at user data: badge names, accomplishment criteria, issue data, issuer title, recipient name, and a uniform resource locator (url) reference.

Potential benefits vary by the individual. Badges can be utilized to motivate participation and collaboration amidst workers, for recognition and assessment both academically and in the workplace, or for alternative credentials. However, drawbacks for the system are also common. Academic oversight varies from institution to institution, while some academics and employers do not take digital badging seriously as a credential. Likewise, not all badges adhere to the Open Badge Standard and are considered immaterial.

The following white paper is a discussion on the use of digital badging and potential applications in the interest of the National Aeronautics and Space Administration Capacity Building Program, as well as the identification of potential opportunities and recommendations.

OPPORTUNITIES FOR CBP TO EXPLORE

Opportunities for utilization in the field vary, depending on the sector. For ARSET, a group that regularly holds virtual trainings, digital badging could be a great asset. Attendees can earn badges based on the thematic area of trainings or completion or certificate badges for the fulfillment of trainings. For DEVELOP, these resources can be used for recognition of workshops, such as the recent Software Carpentry Workshop. Recognition of achievement can drive involvement and allow for public sharing of such achievements on varied platforms external to the organization, increasing public notice of these programs.

RESOURCES NEEDED TO PURSUE

To move forward with this program, Capacity Building would need both time and programming expertise. A new page or system would potentially need to be created for the system to be implemented. Suggestions range from a new page for users to track progress to general badges being awarded via email or certificate post-training.

RECOMMENDATIONS FOR NEXT STEPS

Starting the process of utilizing digital badging will require a conversation with the leads of the Capacity Building elements to determine if this is a wise way to build the program. The current website codes should be discussed along with the feasibility of adding the code for digital badges. The difficulty in utilizing this resource should also be assessed. Following this discussion, the sites would have to undergo multiple iterations of updates to current code until the program is adequately implemented. Publication of this program may be in order to establish awareness for the general public and potential participants in CBP offerings.

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UNITED NATIONS AND SUSTAINABLE DEVELOPMENT GOALS (Aariana Maynard)

Insights into Capacity Building taking place around the United Nations' SDGs

EXECUTIVE SUMMARY

The following insights delve into Capacity Building Program initiatives taking place around the United Nations' SDGs or Sustainable Development Goals. To begin, one must note that the SDGs include supporting a plan which will "end extreme poverty, reduce inequality, and protect the planet by 2030" (Sustainable). It is pivotal that these recent changes be an active part of the Capacity Building Program so that the group is truly able to have a positive impact in the world at large. People all over the world are in need of assistance and relief from the stress and strain of poverty and despair. The Capacity Building Program in the United Nations equips individuals with the necessary resources and training to aid their specific countries and locations (Interview).

INTERVIEW SUMMARY

To learn more about the Capacity Building Program initiatives taking place around the United Nations' SDGs, I was put in contact with Dr. Argyro Kavvada. Dr. Kavvada is the Program Manager for Sustainable Development Goals. She has published numerous reputable articles relating to the subject of Sustainable Development Goals for locations all over the world. Dr. Kavvada's background lies in physics, earth science, and climate dynamics. Dr. Kavvada stated that she is passionate towards Sustainable Development and how it can have a lasting impact on the world at large (Interview).

During the interview, the topic of what a Project Manager for Sustainable Development does on a daily basis came up. Dr. Kavvada stated that due to COVID-19, she has been taking part in a number of calls and meetings to discuss development goals which NASA and other partners engage in. In the days before COVID-19, Dr. Kavvada was able to travel and meet with other countries and organizations who were looking to use NASA Earth Science data. She led meetings with the various project teams to see how data collected could be adapted by different counties or agencies for use (interview).

OPPORTUNITIES FOR CBP TO EXPLORE

During the interview, Dr. Kavvada explained that in the United Nations Sustainable Development Goals are communicated to the public and partner organizations through tutorials, workshops, and documentation which includes the use of a best practices document to share with the other counties. These practices are excellent for ensuring that CBP is able to actively engage with all of their partners and other organizations. Workshops provide hands-on training in an interactive way which is beneficial to assets of the Capacity Building Program. A working best practice document provides guidance for what has been successful in the past and what will be useful in the future (Interview).

RESOURCES NEEDED TO PURSUE

In reference to the resources needed to pursue the Sustainable Development Goals, one must look towards 2030. The Sustainable Development Goals have a 2030 vision which involves eradicating hunger, ending racial injustice, empowering women, and protecting Earth to make it a better place. Other countries such as Mexico and Japan are helping with this initiative.

There are currently 17 Sustainable Development Goals which follow the best practices document from Millennium 2015 project. Thankfully, there have been both direct and indirect contributions seen on both land and sea from the work of the Sustainable Development Goals (Interview).

RECOMMENDATIONS FOR NEXT STEPS

As the United Nations Sustainable Development Goals continue to be implemented, there are some recommendations for things to come. One recommendation lies in mobilizing efforts through other groups and initiatives outside of NASA. In terms of establishing constant communication with those overseas – it can be quite difficult. However, if NASA Earth science data could be shared in other ways, more countries might reap the benefits. Additionally, more webinars, symposiums, and tutorials could engage the audience more to care about NASA data which could improve their lives and the lives of those who come after them.

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Interview with Dr. Argyro Kavvada

GAME-BASED LEARNING (Benjamin Hodgkins)

ABSTRACT

Game-based learning, or GBL is an innovative new approach to traditional learning in the 21st century. GBL utilizes video games to teach learners concepts by having them play games designed or co-opted for educational purposes. GBL uses video games because they have been shown to have widespread appeal, especially to younger audiences. In 2019, the Entertainment Software Association (ESA) found that 65% of American adults play video games. The ESA also notes that around 75% of households in America have at least one individual who plays video games, so widespread exposure is common (ESA, 2019). Since so many people enjoy and are familiar with video games, using them as a teaching tool is becoming more popular. This white paper seeks to examine possible applications of game-based learning within the Capacity Building Program at NASA.

EXECUTIVE SUMMARY

Game-based learning (GBL) is an approach to learning that uses video games as an educational tool. Since a large portion of the population is acquainted with video games, they are a platform that is familiar to the average person. Current GBL projects such as Nemo-Net (developed at NASA's Ames Research Center) can be dissected as a basis for future endeavors. The Capacity Building program could benefit from incorporating GBL in all three of its component programs, especially ARSET and SERVIR. The resources needed to pursue GBL depend on exactly which avenue of GBL the CBP chooses to pursue. Finally, the DEVELOP program should take the next step of launching a 10-week project to further investigate GBL and its possibilities at the CBP.

INTERVIEW SUMMARY

My interview was conducted with Dr. Shobhana Gupta, the Open Innovation and Community Applications manager at NASA HQ. I asked Dr. Gupta a range of questions related to gamification and game-based learning. While gamification (using game elements in non-game environments) was noted as being common in the federal government (particularly the Department of Education), game-based learning at NASA appears to be in its infancy. Dr. Gupta noted that there is no central authority on game-based learning at NASA, leaving it up to individual programs to investigate and collect feedback. Also in the interview I inquired as to examples of game-based learning at NASA. Foldit (protein folding) and Nemo-Net (coral reef monitoring) were cited as currently running GBL projects that could serve as inspiration for future GBL. Finally, we discussed resources and recommendations for future GBL endeavors, noting the importance of several factors like testing, funding, and project scope.

OPPORTUNITIES FOR CBP TO EXPLORE

The Capacity Building Program is in an opportune position to take advantage of what game-based learning has to offer. All three programs, ARSET, DEVELOP and SERVIR could benefit from incorporating some aspect of GBL into their programs. DEVELOP is perfectly positioned to investigate the potential of GBL at the CBP. Since DEVELOP already conducts 10-week projects into earth observations, it would be a simple matter use GBL in some of the projects. GBL could also integrate nicely with ARSET and SERVIR's missions. All of ARSET and a good portion of SERVIR is comprised of trainings to educate users on various usages of earth observation data. Both online and in-person trainings could be examined for GBL integration. While this white paper only covers digital games, there are also possibilities to utilize board games or other types of physical games as well.

RESOURCES NEEDED TO PURSUE

The resources needed to pursue game-based learning can vary depending on the scope of the overall project. Simply adopting a current title on the open market for educational purposes is much cheaper than developing a title from scratch. Adopting a produced title means acquiring a number of licenses, which generally range from 0 to 60 dollars per license. However, a commercial title may not meet the goals of whatever learning objective is being pursued by the organization. As such, a game developed for a custom purpose may be desirable. The cost of developing such a game depends on the complexity of the game being proposed.

A simple 2D game for mobile phones is much cheaper than a complex 3D game for PC (Windows, Mac, Linux) or console (Nintendo Switch, Microsoft Xbox, Sony PlayStation). For reference, *Angry Birds*, a popular title for mobile, cost around $140,000 to develop (GamesIndustry, 2011). On the other hand, the blockbuster hit *Grand Theft Auto V* cost around $265 million to develop (including marketing costs, which made up over half the total) (GamesIndustry, 2013). Another variable that needs to be taken into consideration is the time required for development. *Angry Birds* took around nine months to develop, while *Grand Theft Auto V* took almost five years (Venturebeat, 2018). Again, this is down to the complexity of the game in question, as *Grand Theft Auto V* is a 3D game for PC and *Angry Birds* is a 2D game for mobile. Any game developed for CBP purposes would likely fall somewhere between these metrics both in time and money, most likely on the lower end of the spectrum. Estimates for any proposed developments would need to be assessed on a case by case basis due to the differences in costs like in the above examples.

RECOMMENDATIONS FOR NEXT STEPS

The immediate next step would be to utilize the DEVELOP program to conduct a preliminary investigation into different possible applications of GBL at the CBP. DEVELOP already has the infrastructure to conduct such a project and approaching GBL this way allows for minimal risk and for a plan for further action to be drafted. Based on DEVELOP's recommendations, the CBP can then begin planning the appropriate next steps for GBL implementation. A critical element in planning these next steps is ensuring either an individual or group is put in charge of the overall GBL effort at the CBP. This will not only be helpful in achieving meaningful progress on GBL, but also could serve as a liaison to other programs at NASA and in the federal government who are interested in GBL.

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Barriers to Cloud Computing (Jonathan Mo)

ABSTRACT

Cloud computing in the simplest terms is storing data and applications online, rather than in a physical form on your computer or phone. In essence, the cloud is simply a metaphor for the internet. Converting to a cloud computing model often brings savings and profit gains due to reductions in hardware and maintenance costs. In addition to the increased capital, cloud computing is shown to increase productivity levels. Rather than waiting weeks or months for software to be installed, cloud computing allows users to access their new software within a matter of hours. With all the obvious benefits to cloud computing, we will take a look at the barriers that developing countries face in implementing cloud computing within their borders.

EXECUTIVE SUMMARY

What is Cloud Computing?

Relatively speaking, cloud computing is a new business model in the world of computation. According to the official National Institute of Standards and Technology (NIST), cloud computing is defined as:

> "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."

The NIST also lists five essential characteristics of cloud computing as:

> *On-Demand Self-Service*: Customers can unilaterally provision computing capabilities, without require human interaction with each service provider.

> *Broad Network Access:* Capabilities are available over the network and accessed through standard mechanisms.

> *Resource Pooling:* Physical and virtual resources are dynamically assigned and reassigned according to demand, resulting in cost savings to the customer.

> *Rapid Elasticity or Expansion:* Capabilities for the consumer appear unlimited and can be appropriated in any quantity at any time.

> *Measured Device:* Resource usage can be monitored, controlled, and reported in order to provide transparency for provider and consumer.

The Service Models of cloud computing are listed by the NIST as:

> *Software as a Service (Saas)*: The applications are accessible from various client devices rather than through a client interface. Client does not control or manage the underlying cloud infrastructure (network, servers, operating systems, storage).

> *Platform as a Service (PaaS)*: The consumer is able to deploy onto the cloud consumer-created applications created from programming languages, libraries, services and tools given by the provider. Client does not control or manage the underlying cloud infrastructure (network, servers, operating systems, storage).

> *Infrastructure as a Service (IaaS)*: The consumer is given ability to provision processing, storage, networks, and other necessary computing resources. Client does not control or manage the underlying cloud infrastructure (network, servers, operating systems, storage).

The NIST listed cloud computing deployment models are:

> *Private Cloud*: Cloud infrastructure designed for use by a single organization. Owned, managed, operated by the organization and may exist on or off premises.

Community Cloud: Cloud infrastructure designed for use by specific community of consumers from organizations containing similar goals. Owned, managed, operated by one or more organizations in community. May exist on or off premises.

Public Cloud: Cloud infrastructure designed for use by general public. Owned, managed, operated by a business, academic, or government organization or a combination. Exists on premises of cloud provider.

Hybrid Cloud: Cloud infrastructure composed of two or more of the previous three models, which remain unique entities, but are bound together by technology which enables data and application probability (Mell and Grance).

Benefits to Cloud Computing

Before discussing the barriers to cloud computing, we will first take a look at the attainable benefits after successful implementation.

Resilience and Elasticity: Application and information are evenly distributed across all servers, meaning if one server fails, there is no data loss or down time. In addition, cloud computing can offer better computing power and memory storage, allowing software to perform faster than traditional IT systems (McKay).

Flexibility and Scalability: Cloud services are able to provide on-demand and unlimited virtual storage space. This allows businesses to scale up or down depending on specific needs. This provides exponentially more flexibility for businesses compared to traditional IT systems which come with a fixed storage space and fixed server speeds.

Automation: A large convenience factor of cloud computing is how the cloud services are managed. Any software updates, hardware updates, and installations are all done online, letting business save time and keep working through these service changes without even noticing a change.

Costs: The payment methods for cloud computing are much more cost effective than traditional systems. In traditional IT infrastructure, equipment and extra server space is often purchased when the extra space will not even be used. In contrast, cloud computing users only pay for what is used.

Productivity: A large percentage of companies and regions which implement cloud computing see an increase in productivity. According to isaca.org, "on demand access to scalable data and computing resources can enhance productivity, boost innovation and improve service delivery in both the public and private sectors of emerging economies" (Ahmed).

Barriers in Developing Countries

The cost effectiveness offered by cloud computing has led to a growth in cloud interest, however the main barrier to world-scale spread remains data security. According to Stanford University's blog on Cloud Computing, "India is one of several countries with strict data sovereignty laws that require all data centers handling Indian data to be located within the country's borders" (Garlick). In other words, India will only be able to use cloud computing if data centers are located on Indian soil. Decisions similar to this will severely limit the access and application of cloud services in developing countries since constructing several new data centers in foreign countries would not be logical or cost effective for most cloud providers.

Storing information in offshore servers does expose data to increased risk of theft from cyber criminals. Thus, developing countries have valid desires to only store data in centers within their borders. Other security risks include snooping from large intelligence services and the country who stores the data having an upper hand in the terms of agreement. The optimal way to ensure almost complete safety of data storage is to create one's own cloud service. Until then, developing countries will be wary to trust cloud computing as a whole with its radical technologies.

In developing countries with lower capital, the cost effectiveness of cloud computing is still not low enough for businesses and governments to invest in the upcoming technology. Developing countries simply don't have the expenditures to pay for cloud services when there are other higher priority expenses to take care of first.

These "predominant expenses" can be grouped with another obstacle developing countries face: fewer resources and institutions than first world countries. With fewer resources and institutions, services like cloud computing or computing in general are not on the forefront of government and businesses' minds. According to a research paper from the University of South Africa, "rural communities in developing countries lack basic infrastructure such as roads, telecommunications, electricity, and water. These infrastructures are the backbone of any development initiatives. This is not helping in the fight to bridge the digital divide. The absence of such infrastructure leads to the unavailability of internet infrastructure and escalating costs of such services and the cost of devices to access internet" (Mujinga & Chipangura). Without basic necessities like food, water, and shelter, implementing cloud services will remain the highest mountain to climb in locations which do not yet contain even WiFi or cellular services.

INTERVIEW SUMMARY

Interview with Justin Rice (DSCOVR GDS Lead at NASA Goddard).

During the interview, we discussed a range of topics surrounding cloud computing. Topics ranged from NASA and cloud computing, to cloud computing in developing countries.

NASA and Cloud Services
- NASA will never go full cloud
  - This is due to data security risks
- NASA is approved to work with AWS
- By the time NASA gets more involved with cloud computing (10-20 years in the future), something newer and better will likely be available

Cloud Services in Developing Countries
- Governments will study resources and changing economic environments in developing countries to make cloud services available in the future
  - Just as they currently study climate change and industries in developing countries
- Privacy, security, training, vendor lock-in, and Egress (amount of data transferred in and out of cloud) are all barriers to cloud adoption in developing nations

OPPORTUNITIES FOR CBP TO EXPLORE
- Are computing services already available in the developing country?
  - Current pricings?
- Does the nation have interest in cloud services? How high are these interests?
- What laws are in place for where data centers can be held?
  - Must be within borders or can be outside country?
- What types of data are to be stored on cloud?
  - Is the data public, private, or security sensitive?
- What resources are available in developing countries?
  - Are food, water, shelter, and other basic necessities already available?
  - Are internet, cellular, and WiFi services available?
- How widespread?
- How strong is the coverage?
- What expenditures are available to invest in cloud services?
  - From governments, business, and consumers

RESOURCES NEEDED TO PURSUE
- Government cooperation
- Business cooperation
- Economists
- Politicians and business owners
- Cloud computing experts

RECOMMENDATIONS FOR NEXT STEPS
1. Research which developing countries have interests in cloud computing as well as their intended use for cloud computing.
   a. ie: private data, public data, government data
2. Figure out what resources those developing countries have already and which will be needed.
   a. ie: do they have food, water, shelter
   b. do they have Cellular services, WiFi
   c. what is their current computing infrastructure?
3. Research the laws surrounding cloud computing in the developing countries.
4. Determine how much or how little aid from outside government or organizations they will need to implement cloud services.

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INTRODUCTION TO THEORY OF CHANGE (Zac Marks)

ABSTRACT

Theory of change (TOC), when used with a sufficient logic model, is an extremely useful tool for achieving a desired impact. A TOC is an effective tool for strategic planning and is currently being used by one of the Capacity Building Program elements, SERVIR. Using this tool as a navigation tool for strategic planning is a best practice due to the mitigation of both time spent re-planning the strategic process as well as the ambiguity of the early stages in the process. Steps can be taken to virtually move forward incorporating a TOC into the new strategy development.

EXECUTIVE SUMMARY

What is a Theory of Change (TOC)?

A TOC is a goal-oriented approach to planning, specifically connecting inputs to end targets and outputs. In strategic planning, a TOC can effectively map how the user will achieve the goals set forth. Here is an example of how a TOC may be structured:

1. Inputs > 2. Activities > 3. Outputs > 4. Short-term outcomes > 5. Long-term outcomes

(U.S. Department of State Bureau of South and Central Asian Affairs).

1. Inputs are what we are going to invest into the activities to achieve our goals.

2. These are the activities that will take place to ensure the desired outputs will be attained.

3. An output is the direct result of the actions taken (i.e. if trainings are the action, then capacity can be an output)

4. Short-term outcomes are achievements not in the direct control of TOC users. However, they are heavily influenced by the process (i.e. if capacity is the output, then new informed policies can be a short-term outcome).

5. Long-term outcomes are the "big-picture" down-the-road achievements that are largely out of the direct control of the TOC user.

A key to success for implementing a TOC is to identify any risks and assumptions involved in any step. Exclusion groups can be detrimental to achieving goals and may include a lack of communication to a ministry, gender, social class, etc. A contingency plan may be necessary in the event of a foreseen or unforeseen risk (i.e. a pandemic)

Steps to form a TOC:

Please see slide 18 of 2019 CBP strategy retreat (link provided below).

INTERVIEW SUMMARY

I had the opportunity to speak with Kathleen Cutting-Project Analyst with SERVIR and Zoltan Milic-Monitoring and Evaluation Specialist with USAID. Our discussion consisted of two main talking points: 1. How is TOC used? 2. What is the benefit of using a TOC?

1. How is TOC used?

A TOC is used to establish user needs and goals, then sustain those goals post intervention. This can be used in many different scopes from program wide strategies to projects, it can also be used to bridge expectations between programs. The scope of implementation is extremely wide, making it a valuable tool for any organization. A good practice when creating a TOC is to develop it backwards, starting with the outputs or outcomes and finishing by addressing the required inputs.

2. What is the benefit of using a TOC?

A TOC is flexible in how the impact can be achieved which is helpful in keeping the plan adaptable without needing to rework the entire process. This flexibility is important because it keeps the project/strategy simple and straightforward. This simple target-oriented tool can be easily replicated across all of the CBP easing and improving the efficiency of any planning process.

OPPORTUNITIES FOR CBP TO EXPLORE

CBP can implement a TOC wherever there is a need for navigation to a target. TOC can also be incorporated as a best practice for use at any level and on any scope, as it provides both a good sense of direction towards a goal and a means to monitor and evaluate progress. There are trainings available, including the one by Guidehouse (link provided below). There is also a resource on the SERVIR website, the Service Planning Toolkit, which is immensely helpful in learning how to use a TOC (link provided below)

RESOURCES NEEDED TO PURSUE

The only resource needed to pursue using a TOC is the time spent learning how to use the tool as well as the time required to make the tool.

RECOMMENDATIONS FOR NEXT STEPS

To proceed with using this tool it would be beneficial to host an in-depth training on the subject with direct applications to each element. This would include an explanation of how it is formed, how to be target-oriented in the process, as well as why it is beneficial to use a TOC.

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THE ART AND SCIENCE OF DATA VISUALIZATION (Kylee Hartman-Caballero)

EXECUTIVE SUMMARY

Data visualization, according to the *International Encyclopedia of Political Science*, has the objective of providing graphical displays for summarizing and, in turn, reasoning about quantitative information (Zinovyev, 2011). When we think about where data visualization fits on the spectrum of science to art, we find it does not fit nicely in one box or even in one area of the spectrum. It fluctuates from one extreme to another depending on the context, the intended audience, and even the person creating the visualization. When one talks about "the science of data visualization" there are two implications. Either one is referring to how data visualization is a science or how data visualization depicts science. Considering the former is very dependent on how a person defines "science." That being said, the latter implication can be summarized in three points: visualization helps informatively illustrate quantitative information, helps formulate or confirm hypotheses, and guides statistical analysis (Tang, 2020). However, when discussing the "art of data visualization" there is only one implication, which is that visualization in and of itself is an aesthetic process. Topics that beg thoughtful consideration when aiming to visualize a set of data is the functionality of the visual, its pleasure to the senses, and its reliability (Li, 2018). Professional perspectives on the art and science of data visualization are presented below:

INTERVIEW WITH CHRIS LESTER, CHIEF CREATIVE OFFICER, U. GROUP

Lester, as the Chief Creative Officer at U.Group describes his role as being to lead all the creative activities, to set the standards, and to guide processes. A key part of his work is making sure that what is produced by the company is of exceptional quality. The process that Lester has for determining whether a creative idea or vision is worth exploring or a passing thought is based largely on the kind of work that is being done. For example, if the purpose is to help position an organization, whether a business, campaign, etc., a key step is understanding the underlying strategy, which comes from asking the right questions. He says, "[There is] a lot of strategy work that is done that is not strategic." Meaning that non-strategic strategy work misses the key to looking for where the real opportunity is to making distinction. He boils down his view on pursuing a vision to two key steps: getting the idea right and believing in it enough to make it come alive. When asked about how he uses data and the important qualities of its visualization, Lester emphasizes the aesthetic necessity of such visualizations. He makes the point that data is subjective and can be shaped to be very misleading and so it is up to the visualizer to make sure that they are aware of the purpose of what is trying to be presented. Is it a story? Is it just factual presentation? Is it a creative avenue? He notes that even in these various purposes, it is important to understand that there is nothing entirely objective about the human experience and one must be careful about the bias presented. Lester finishes his perspective with arguing that the more data we are able to see, the more we are able to think independently.

INTERVIEW WITH ANDREW GODBEHERE, LEAD DATA SCIENTIST, U. GROUP

Looking more at the science side of data visualization, Andrew Godbehere, the Lead Data Scientist at U.Group, was able to provide some insight. He explains the difference between science and art by noting that the scientific method coming into being was a natural phenomenon but a human artifact. He states that it used to be that to gain scientific knowledge, one had to be "in the room where it happened." So, in order to communicate what happened in this hypothetical room, a person must ask themselves if the visualizations they are creating communicate the knowledge effectively. Godbehere finishes his explanation of this topic by pointing out that visualization in science is an intersection between art, philosophy, and communication, and that art entails questioning assumptions, which is also key in scientific discourse. When asked about how, in his perspective, data and its visualization is an art, Godbehere starts with discussing visualization. He emphasizes that the visual aspect of visualization can be very emotional, beautiful, and meaningful. Thus, the most effective visualizations requires the engagement and thought of the viewer. It is easy to make a bad visualization and it easy to be deceitful. He

opines that there are no set principles to visualization beyond its necessity to be legible and not deceitful. Regarding data, Godbehere states that data can be used as a source to create art, as well as being used as a new way to explore space (that is, the concept of an area occupied by a body, i.e. not necessarily "outer space") and its physicality.

NEXT STEPS

In his interview, Andrew Godbehere mentioned the work of Edward Tufte, a professor emeritus of political science, statistics, and computer science at Yale University. Tufte's 1983 book *The Visual Display of Quantitative Information*, though published 37 years ago, provides insight to making visualizations that is still pertinent today. Tufte says in the final section of his book, "Graphical elegance is often found in simplicity of design and complexity of data" (Tufte, 1983). Using Tufte's outlook in this statement, below are suggested steps to take in creating effective data visualizations. This list is non-exhaustive and can be expanded upon or altered with further research:

1. Identify a story behind the data. That is, consider the purpose behind conveying the information.
2. Consider the following question: how simple is too simple? Meaning, what is the bare minimum to include in the visualization such that the viewer can still gather the story being told? This step also begs consideration by the ones making the visualization as to the background knowledge of the target audience. What may be seem obvious for the producer may not be obvious for the audience.
3. In the same vein, consider how complex is too complex. Once again, this is answered by understanding the audience. As a realistic example, a doctoral candidate would not speak to a kindergartener with the same vocabulary they use to speak to a peer. Doing so would likely confuse the kindergartener, and more notably, make them lose interest.
4. Ask oneself: how much bias of the producer is in the visualization? A way to analyze this is to have outside parties view the visualization and identify what seems to be presented less objectively and more subjectively. What can be boiled down to a matter of opinion and what cannot?

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DATA CUBES AND ANALYSIS READY DATA (Andy Velez)

FUNDAMENTALS OF A DATA CUBE

In an increasingly data-reliant world, the need to gather and process data efficiently is always growing. This phenomenon, by extension, affects the world of spatial data analysis and earth sciences. Every year, new generations of satellites generate increasing amounts of complex data, but handling, storage, and the use of inefficient methods of analysis remain a looming obstacle for potential users and researchers. From the need of fast and efficient analysis of large amounts of satellite data, the Open Data Cube was born.

The Open Data Cube (ODC) is an Open Source Geospatial Data Management and Analysis Software project that facilitates the use of satellite data. This project, an evolution from past Geoscience Australia projects, was created by the Committee on Earth Observation Satellites (CEOS) and is as an open source software architecture that supports analysis ready satellite data (ARD) packaged into "cubes", utilizing modern computing to effectively minimize data preparation complexity.

At its core, the ODC is a set of Python libraries and PostgreSQL databases that help you work with geospatial data. The objective of the Open Data Cube is to promote the use of satellite data and increment its impact by providing an open source, accessible exploitation tool, while developing a community to sustain, develop and grow the breadth and depth of its applications.

DATA CUBES IN SPATIAL DATA ANALYSIS

Data cubes form a 3-dimensional array composed of two spatial dimensions (latitude and longitude) and one temporal dimension (time). Cells inside data cubes have a constant spatial size, and there is no temporal overlap between cells. For every combination of dimensions, each cell has a vector of attributes and information, which may come from multiple satellites at once. Using data cubes, we can stack multiple satellite images on top of each other to study and analyze spatial data.

CEOS and the ODC community have facilitated the beginning and advancement of 15 operational country-level data cubes around the world, and more are in development and negotiations that will likely result in an increase of country-level data cubes in the coming years. The global impact of the ODC is nearing 106 countries in total, and hopefully more and more countries will become partners in research utilizing Open Data Cubes.

With each advancement, the ODC code and associated application algorithms are routinely released on GitHub as open source software. Achieving a global network of connected regional data cubes, that are self-sustaining and share core ODC code and applications algorithms among a bright community of users is the decisive vision of the ODC Partners.

Having the opportunity to interview Dr. Brian Killough provided great amounts of insight into CEOS's efforts and the ODC. Dr. Killough has been working with NASA for 33 years, and currently leads the CEOS Systems Engineering Office (SEO) The SEO supports the international CEOS organization, which includes 60 different Space Agencies and organizations working with satellite earth observation data.

The efforts of Dr. Killough have had a significant role in ODC's global reach initiative to promote the use of large amounts of satellite analysis ready data. He is the author of over 20 technical papers and received the NASA Exceptional Service Medal in 2016 as an example of his spirit and dedication.

Apart from providing an overview of the concepts of data cubes and analysis ready data, he also shared with me some experiences showing live application of ODC and ARD. One of this experiences is how the development of the African Regional Data Cube (ARDC) and the use of ARD had a lasting impact on various situations. The ARDC was developed as a prototype for 5 different countries in Africa. The team

was able to maintain contact with some of the end-users that were essentially prototype testers that could provide valuable feedback. One of these users was a farmer in Ghana, who was interested in seeing if he could measure the variability in his fields and the impact on his corn crops in the last 3-5 years, having changed seed varieties, while also considering weather variations due to climate changes. He was astounded by the results, and expressed that, what the CEOS team had taught him in the span of a few weeks, would've taken him months to grasp and use, letting him realize tasks that would take him months in mere days.

Another example of the impact of the ARDC and the use of ARD would be the experience of another prototype tester in Kenya. The user was a conservationist who was trying to undertake the task of moving a group of giraffes which belonged to a certain species that was protected, from an island in the middle of Lake Baringo. The island had become infested with python snakes and was suffering other issues which affected the food supply and the health and safety of these giraffes. The satellite data from the ARDC allowed him to examine all the surrounding land around the lake to find the most suitable home for these giraffes that would cause no disruption to their experience.

The user was very thankful and even showed further interest in applying the same use of satellite data for other species.

ANALYSIS READY DATA WITH DATA CUBES

In order to effectively deploy Open Data Cubes, you must prepare and process your data for use. The core component of any data cube deployment is analysis ready data (ARD). Before 2019, CEOS began an initiative to develop specifications for ARD and promote its production and use. They formally defined ARD as "satellite data that has been processed to a minimum set of requirements and organized into a form that allows immediate analysis with a minimum of additional user effort and interoperability both through time and with other datasets".

Upon reaching this definition, the CEOS Land Surface Imaging Virtual Constellation team (LSI-VI) developed the CEOS ARD Framework, which includes a total of three elements: the definition, the Product Family Specifications, and the Product Alignment Assessment. This would later serve as the basis for the CEOS ARD initiative. In October 2019, CEOS Plenary gave its endorsement to the CEOS ARD strategy, which seeks to ensure the ongoing use and development of ARD data from CEOS agencies. The development of these ARD specifications created new opportunities and has received significant support from global data providers.

ARD provides data that is prepared for consistent and reliable multi-temporal analysis of satellite images. It provides optimal results and easier implementation, while meeting the geometric and radiometric standards for the ODC. The use of data cubes, along with ARD, can be applied to a wide variety of situations to assist research studies and solve countless problems worldwide.

CONCLUSION

To create a better future for Data Cubes and Analysis Ready Data, I urge CEOS to maintain their efforts to implement Data Cubes all around the world and promote their use to influence decision-makers in creating a better future for our planet Earth. The normalization of Data Cubes through the Open Data Cube is a campaign that should be backed with full effort. Additionally, promoting the effective creation of Analysis Ready Data throughout partner organizations and interested parties will streamline the production of Data Cubes across the globe. Utilizing correctly prepared and organized ARD will not only increase the rate at which Data Cubes can be deployed, but also provide more accurate results to make informed decisions and solve problems worldwide.

The sheer impact that the use of satellite data can make on decision making is a powerful asset to have, and in doing so, we advance towards a smarter future. In a data-dependent world, we must use all the tools we have to break barriers and achieve the best outcome possible, for us, and for our planet Earth.

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AGILE PROJECT MANAGEMENT (Hannah Wetzel)

ABSTRACT

CBP should consider the exploration of incorporating Agile into their projects and processes. Although there are many methodologies on how to use Agile, at its core these methods all focus on quickly adapting to changes and delivering the best product possible to its users. Whether it's Scrum, XP, Lean, Kanban, some new method to Agile, or even a mix, there are plenty of benefits. NASA has sometimes been guilty of rigidly sticking to traditional ways of project management, but Agile is something that can introduce innovation. Openness to change and trying something new is the first step that CBP should take. It doesn't matter what method is used as long as the process is started. Agile is the new age of project management and being able to adapt will allow CBP to improve and prosper.

EXECUTIVE SUMMARY

Agile Management

Agile project management is an iterative approach to delivering a project throughout its life cycle. It's an efficient, responsive, and well-organized system to project management. Traditionally, the goal for organizations was to create a lasting value that could handle the changes in the market. Today, it is much different, the pace requires a nimble or agile response. In order to be agile, there needs to be the ability to detect changes and one must respond quickly to excel in today's constantly shifting circumstances. There's an Agile manager that must focus on work to make sure everyone involved has the means to use this Agile approach to their projects. It's typically handled by small teams that communicate easily amongst themselves. If the manager doesn't have access to several small teams, they must adapt by creating a large Agile team that's made up of multiple small Agile teams.

The beginning to agile project management is the realization that the goal is to optimize return on investment by providing the right functionality when needed. It values individuals and interactions rather than processes and tools; collaborating with users rather than contract negotiating; and responding to changes rather than sticking to a plan. This allows adaptation that addresses the uncertainty and variation that comes with projects. Agile is a group of delivery methods, principles, and practices that effectively delivers software that promotes collaboration and user feedback. At its core, agile is about delivery, collaboration, reflection, and improvement. Additionally, agile uses iterative processes that deliver small increments of value in a shorter time span, which are known as sprints or iterations. They typically are 2 or 4 weeks long. However, the iterative process needs an incremental delivery of value. Without any of the user's value at the end, each iteration becomes useless.

Agile Methodology

The different methods for Agile are endless. They all relate to what Agile is at its core. These methods suit different teams, there is no one true way to agile. Once the delivery methodology is based on the four values above, and there is a deliberate focus on delivery, collaboration, reflection and improvement, that's when one becomes agile. Some of the most common methods are: Scrum, Extreme Programming (XP), Lean, and Kanban; however, there are many more that aren't listed.

Scrum is broken down into the functional requirements for Agile projects, which are collated with the work that needs to be done. Tasks are then grouped together to create sprints based on the dependency, priority, and resource capacity each task has. Resource capacity is determined by how quickly a task can be completed. Iterations are then made until it meets the user's needs. SCRUM is based on transparency, inspection, and adaptation. It shows the project progress, objectives, and the users responsible for the end result. There are also check-ins and milestones for the project progress as it works towards the end goal. Check-ins provide an opportunity for any problems or changes needed to be identified throughout the project. The response to the changes allows the project to adapt to the needs of the user (Botha, 2018).

Extreme Programming (XP) aims to produce higher quality software by having rigorous, team-oriented practices. It's the most specific of the agile methods when it comes to engineering practices for software development. Some examples of these practices are: Test Driven Development, Continuous Integration, and Pairing that pushes teams to deliver this higher quality software through iterations. The five values of XP are communication, simplicity, feedback, courage, and respect. Software development requires a team to communicate with one another in a face to face discussion, typically with a white board or something similar. XP tries to avoid waste and creates a simplistic design that only includes what's necessary. Teams can improve their software through feedback by making adjustments moving forward. Courage is also needed to discuss the team's effectiveness and how it can improve; as well as, accepting feedback and being able to change how work is getting done. Lastly, members of the team need to respect one another in order to communicate, give and receive feedback that doesn't damage the team, and work together to find simple designs and solutions. XP also uses cycles in which work needs to get done in that time frame for the user. There's also low priority tasks added, which is called slack, that can be dropped if the team is behind. The team has 10-Minute Builds in which they have to set up and test everything in ten minutes. Once the build is made and tested, the team uses continuous integration. This is where code changes are immediately tested when added to larger sets of code. Most teams avoid the problems in their code as long as possible, but XP does the opposite. They integrate their code more to identify the errors more quickly. XP also uses the practice of Test-First Programming which is where they write failing automated tests -> Run failing tests -> develop code to make tests pass -> run tests -> repeat. Everything in XP requires a lot of teamwork to get tasks done, so there are many steps to make the process as seamless as possible (The Agile Alliance, 2019).

Lean is a method that grew from the Toyota manufacturing Production System (TPS). It's meant to optimize the whole and eliminate any waste. Quality is also something that is built upon in this process. The team constantly learns, delivers fast, engages everyone, and works to keep improving. Lean has five principles it focuses upon. The first one is value from the user's perspective. There's only a small percentage of time, effort, and resources in an organization that adds value to the user. If the value chain can be mapped out, then the steps that do not provide value can be removed from the process entirely. The product and the service that comes with it should flow to the user without any waiting, this is how the user's value is delivered. Responding to the user's demand is also important to the delivery of what the user wants. Any waste is identified and removed from the product to pursue perfection. This is done by communicating frequently with the user to ensure that what's being delivered adds value to the user (Botha, 2018).

Kanban, much like Lean, is a process that was developed by TPS back in the 1940s and it follows the same model that supermarkets used to stock up the shelves. Supermarkets would check on the shelves to see what consumers were buying and would stock more up to meet that demand. Since the inventory levels followed the consumption patterns, the supermarket was able to gain significant efficiency in inventory management because they decreased the amount of excess stock. Toyota applied this same method to their factory floors and workers would pass on a card, or "Kanban", to let the next group know what materials were needed. Much like Toyota, software teams use Kanban by matching the work in progress to the team's capacity. This allows teams to be more flexible, give faster output, have a clear focus, and are transparent throughout the development cycle. Kanban is able to visualize the work that needs to get done by using Kanban boards. It typically shows three categories: To Do, In Progress, and Done. This allows teams to be on the same page and to see what needs to get done. Kanban cards are added under these categories and they include the tasks that need to get done for the project. Time cycles can be shortened to smoothly work through the flow of the project. Fewer bottlenecks are made due to the limited amount of tasks that can be put in progress. Multitasking kills efficiency, so focusing on a few tasks at a time decreases any issues that may arise with more tasks. The visualization of a team's work can show their efficiency and effectiveness. Any issues or bottlenecking can quickly be spotted and resolved, as well. Kanban is able to constantly deliver and optimize the flow of work to the user (Radigan, 2020).

INTERVIEW SUMMARY
Anish Parikh

After interviewing Parikh, a TEAMS3 contractor at the Langley Research Center, I was able to learn a lot more about agile. Although Parikh stated that he was no expert on the matter, he was able to provide a lot of insight about agile and other approaches to project management. What role does agile play in his work? Well, to put it simply, Parikh doesn't use agile too much. However, he does explain to young engineers how they can set up a sprint or Scrum setup as a project manager. Sees what works, what doesn't and then improves upon it. Since it's broken down in smaller parts, it makes work a lot easier. I asked Parikh if he found agile useful and this was his response, **"Yes it is useful. If it's a big project that needs procedure, then you can't. However, NASA is pretty agile and innovative. They do new things every time. Why would a company want to go to Mars? NASA is able to go there because they get something out of Mars. They want to keep the old management, but they're open to change a lot more. They're allowing private companies to come in and help them because they know it's cheaper and faster and they bring in new ideas."**

NASA has used the waterfall method, but they want new ideas on how to plan projects. Parikh said, **"NASA has the reputation that they have old workers, so they can't have fresh ideas. They try to get the new workers to become the project managers to have new minds. They want something innovative, and agile is really popular and well known."** For agile, if something works then it's delivered to the user. If it doesn't, stop and go back to the drawing board. It can be difficult for NASA to be agile, because their projects are multimillion dollar ideas. They want ideas that are more cost effective. SpaceX is a good example, because they're ready to be agile and not afraid to try new things. They designed the boosters to be reusable, which saves them money. Agile has brought innovation into software. Being able to meet with users to show them something on a smaller scale to make sure it's right is a lot more cost effective. Agile understands the user's cost effects, but is able to show different options to improve upon what the user wants within their budget. Show software to the user before working and then suggest additions during the design process. They emphasize the user and are able to adapt to their needs. After the process, documentation can be created to show what's been done.

Parikh and I went on to discuss the future of agile in the Capacity Building Program (CBP) and he'd like to see anything new that could work. He encourages people to adapt to situations. As long as rules are being followed, the opportunities to create something are endless. Especially with software, it's so easy, because code can be changed so quickly.

Since we are unable to see person to person, NASA has been forced to adapt. **"With teleworking, everyone has to adapt, which causes NASA to be agile. Things are adapting to the situation, but change is good,"** Parikh explained. Agile is already being used at NASA whether they realize it or not. There are no negatives, it's just a matter of how much agile can be used in projects. He encourages the CBP to have a discussion and look at early career people who know about agile and bring them in for new ideas (Wetzel & Parikh, 2020).

OPPORTUNITIES FOR CBP TO EXPLORE

With Agile, the CBP would be able to stay relevant by innovating and increasing the user's value. It empowers people, builds accountability, encourages a wide range of ideas, allows the early release of benefits, and promotes continuous improvement. Decisions are tested early, so if something doesn't work, it can be improved upon before wasting time and resources. This is something that isn't as evident in waterfall methods. Agile also helps deliver change when the user's needs are unclear. User engagement is built upon by focusing on what's most beneficial to them and then incrementally improving upon the product. It also helps with decision making as feedback loops are cost effective and allows the team to re-invest the money saved. However, agile focuses on small incremental changes that can be challenging for more big picture projects. In order to implement agile, the CBP must be realistic: the objective is not necessarily to be agile but to provide good delivery to the users, and a measured assessment of the preferred approach is essential to achieve that. Each project type, its objectives, and its environment should all be assessed when making these decisions. Agile isn't something that's set in stone for organizations, in fact, many practice the principles without even realizing it. Collaborative working will always improve the benefits, increase delivery, improve quality, satisfy users, and show efficiencies

(Association for Project Management, 2020). Looking into the different kinds of methodologies can provide insight to the CBP on what approaches they could bring into project planning.

RESOURCES NEEDED TO PURSUE

As previously mentioned, looking into different types of agile is a good starting point. Look for those new in the workforce who have an understanding of agile and bring them in to have new ideas brought to the table. These people can work their way up to being project managers, and the CBP would have a brand new generation of leaders who can bring in innovation. Be open to change, that's when improvements can be made.

RECOMMENDATIONS FOR NEXT STEPS

Pick a method and start. It doesn't matter what the CBP starts with, it just matters that they're beginning the process to incorporate agile into projects. What is important is that there needs to be a process that focuses on consistently improving delivery, collaboration, and reflection. Reach out to users to get their feedback to see what they want and work with them to create a workflow that improves their satisfaction and delivers their end goal. It is an iterative process, so it's not always possible, but even incorporating agile on a smaller scale can be beneficial to the CBP.

HELPFUL LINKS

https://medium.com/@cliffberg/spacexs-use-of-agile-methods-c63042178a33

https://www.federaltimes.com/it-networks/2019/11/26/how-nasa-upended-internal-processes-to-prepare-for-its-next-lunar-mission/

https://www.govtech.com/computing/Could-Spiral-Tech-Development-Lead-to-the-End-of-Agile.html

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