

# Cognitive Automation

## Applying Analytics and AI to tasks within the Software Development Lifecycle

### Abstract

The use of purpose-built Artificial Intelligence solutions has already started fulfilling the promise of business process automation across industries. And while many Engineering organizations are busy implementing AI-based solutions for the marketplace, some are beginning to realize the potential that these capabilities have in transforming their own Software Development Lifecycle (SDLC) processes. The application of AI techniques to processes and tasks within the SDLC represents the next generation of Automation.

This paper shares insights and recommendations for other Engineering organizations considering the adoption of Analytics or AI-inspired solutions by highlighting the importance of identifying organization-specific pain points, data readiness, addressing the data science skillset question, and the criticality of stakeholder engagement. The paper outlines several tasks within the SDLC where Dell EMC is leveraging AI-enabled solutions to aid in the delivery of quality products and solutions.

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## Revisions

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## Executive summary

The application of Artificial Intelligence-based solutions has already started to fulfill the promise of business process automation across industry after industry. As Engineering communities begin to realize this potential and implement AI solutions to transform their own internal Software Development Lifecycle (SDLC) processes, they should pay heed to the risks of underperforming against high expectations and over-simplification. Initiatives such as these call for the identification of **organization-specific** pain points that, once optimized, can be readily mapped into business value gains such as enhanced time-to-market, capacity scaling, or increased quality through improved coverage. The importance of data readiness is often understated, leading to unexpected project impacts due to data curation needs and process changes. It is also atypical for Engineering organizations to have Data Science skillsets on their bench, but this skillset is critical to any Analytics or AI-based implementation. Finally, Stakeholder engagement and ongoing alignment through the formulation, implementation and deployment of AI-inspired solutions is essential to achieving business value goals.

Using the approach outlined here provides Engineering teams with a means of managing the optimistic and sometimes unrealistic expectations of their leaders and their Subject Matter Experts with a pragmatic, yet goal-oriented, approach to realizing the benefits of AI-based solutions within their SDLC.

### Key findings:

- AI-inspired solutions in the form of Analytics Modeling, Machine Learning, Computer Vision, and Natural Language Processing are beginning to be applied to engineering processes across the SDLC
- The application of AI techniques to processes within the SDLC represents the next generation of Automation. We call this Cognitive Automation.
- Due to the proprietary nature of the data, processes, and tools found within any Engineering organization, most tasks in the SDLC that are considered ripe for Cognitive Automation, are likely to require some form of customization that will require the teaming of Subject Matter Experts and Data Scientists
- Data Science is a skill set that is essential to AI initiatives but is not a skillset that has yet established a foothold within Engineering organizations.
- Your organizations data and processes have a high likelihood of not being ready to be leveraged for analytics. Moving from highly manual, intuition-based processes directly to analytics-based processes is a multi-step process.

### Recommendations:

AI-inspired techniques offer the potential for automating highly Cognitive tasks across the Software Development Lifecycle and tasks once thought to be firmly in the domain of humans. Engineering organizations that have already instilled a culture of continuous improvement and automation, through prior adoption of Agile, Test Automation, and DevOps practices, are the best suited to begin the exploration of the application of AI-based solutions to their Engineering SDLC processes. They should proceed optimistically, but thoughtfully:

- Start with Why by evaluating and pinpointing the areas within their SDLC that provide the most value for effort.
- Establish and maintain the deep stakeholder engagement that is necessary for projects of this visibility and complexity.
- Skill-up in Data Science or select a partner who can guide the implementation of the appropriate models to your specific tasks.
- Data Science skill sets must be combined with existing run-the-business practices and domain-specific skill sets. Forming new, co-skilled, teams is required.

- Approach these initiatives with the full understanding that data and existing process is the elemental resource to success. Your data's cleanliness, maintenance, ongoing capture, and retention is going to necessitate the adoption of enhanced business processes.
- Plan for useful and valuable improvements along the project path. As your target project comes online, and improvements to your existing practices come to be realized, these achievements should be advertised, and continually built upon to capture emergent enhancements to adjacent tasks or end-users.
- Ensure that leaders in the organization understand the cost-benefit of any AI-inspired solution. Manage their expectations along the journey given the challenges described above.

# 1 Problem Statement

Businesses are undoubtedly at the cusp of “AI everything”. Industries as diverse as [Motorsports and Medicine](#), have started collecting data for the purpose of analyzing, predicting, and maximizing organizational performance. AI has been silently churning behind the scenes keeping our credit cards and identity protected. AI has moved seamlessly into our homes with the advent of Amazon’s Alexa and Nest. And today, AI is on the verge of overtaking an everyday task in the form of autonomous vehicles.

Some in the Engineering community have concluded that the time is now to understand how we can apply this exciting capability to remove even more mundane and manual tasks from our engineering job.

Many Engineering organizations that have already instilled a culture of continuous improvement through automation with their prior adoption of Agile, Test Automation, and DevOps practices, are the best suited to begin the exploration of the AI-inspired solutions to the Engineering SDLC processes.

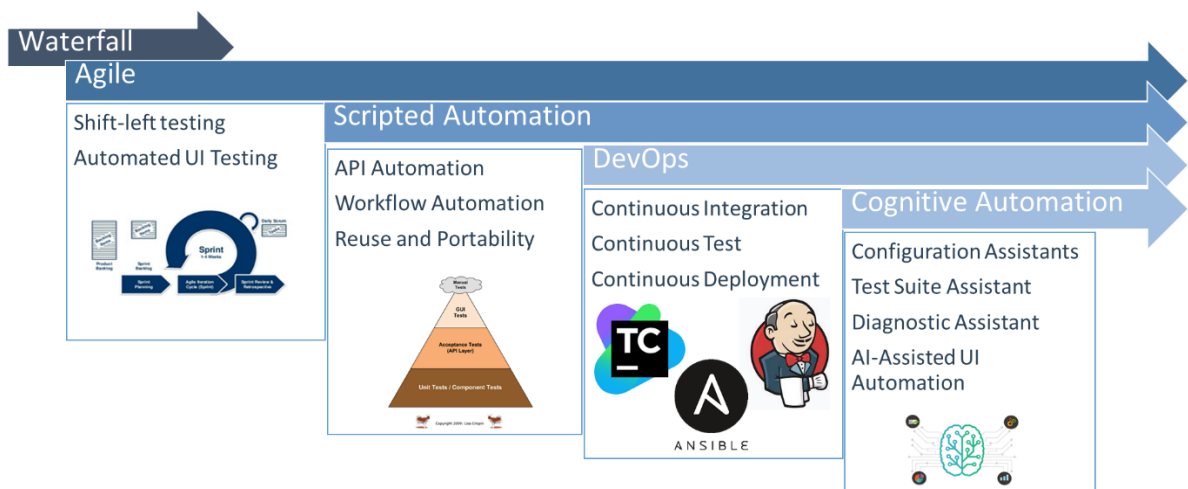


Figure 1- Evolution of Automation in the SDLC

The next generation of Automation within the Engineering SDLC comes to us in the form of AI-inspired approaches: Analytics, AI and Machine Learning. **We call this Cognitive Automation.** It offers the promise of the automation of tasks that up until now could **only** be performed by humans.

Practitioners going down the path of Cognitive Automation should proceed with caution due to the combination of excessive hype and unprecedented complexities as compared to prior stages of automation. There’s certainly a wealth of similarities to prior stages of the automation evolution:

- During Agile adoption, organizations experienced massive process and cultural changes across Marketing, Development and Test organizations.
- During the adoption of Scripted Automation, organizations had to re-skill their Test workforce with programming skills.
- During DevOps transformations, the culture and program skillsets were in place, but new tools for provisioning and cloud-hosting powered the enablement of this stage.

For AI and Cognitive Automation, however, there's several **new** factors at play and all need to be dealt with simultaneously to achieve the dividends of a successful rollout:

- Data Science is a new skill set that most likely doesn't exist in many functional teams.
- Data is the elemental resource of AI. The capture, cleanliness, and ongoing health of data demands constant attention and changes in business processes.
- A noteworthy challenge of AI-inspired Cognitive Automation is the proprietary nature of the data, processes, and domain tasks. Don't expect there to be many general-purpose AI tools available to you on this journey. Be prepared to develop proprietary, or to customize pre-existing, solutions.

## 2 The SDLC Opportunity Landscape

Ben Pring, of Cognizant's Future of Work Division and author of ["What to do When Machines do Everything"](#) likes to frame AI and the future of work in this way: "X + AI". X is EVERY task that you perform. Your job is to figure out what X is in your organization or project context, then take the lead on assessing the potential improvements to that task that AI can provide.

### Assessing AI Opportunities across the SDLC

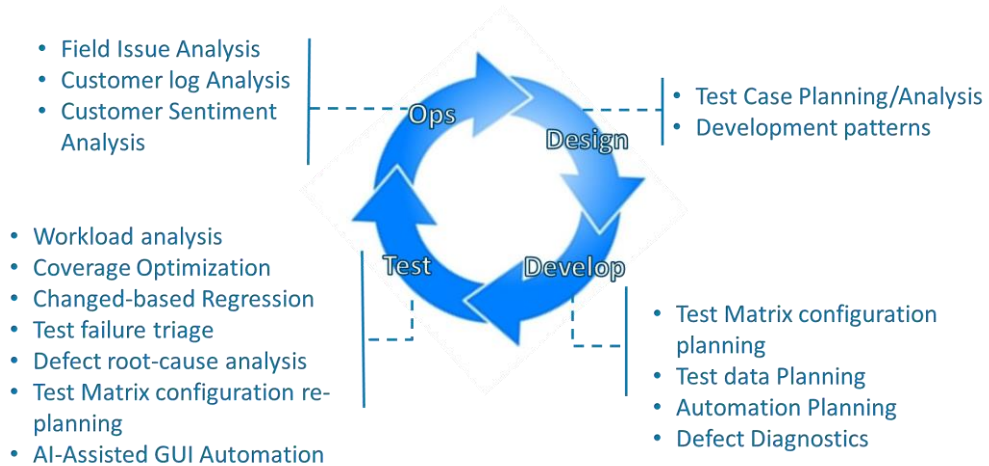


Figure 2 - Assessing SDLC Opportunities for AI

Figure 2 provides an inventory of some of the day-to-day Engineering tasks that you find in many organization's SDLC that require brainpower, generally rely on reference data, and are then combined with deep domain knowledge and prior experience to complete the task at hand. These are just some of examples that span the SW Development Lifecycle, and given the challenges in your organization, might be considered as candidates for Cognitive Automation.

Automating any one of these tasks within an organization is likely to involve a heavy lift, because of the proprietary nature of the data, process, and domain.

Dell EMC Server Validation has been busy experimenting with and implementing Cognitive Automation solutions in the Testing phases of the SDLC. This next section captures the experiences of several of those efforts and demonstrates the proprietary nature of the data, processes, and tasks that lead to 'customizations' of implementations in this space.

### 2.1 AI-Assisted User Interface Automation

One of the challenges with established practices of automating Graphical User Interface (GUI) Testing is the dependence on the Document Object Model (DOM) of the underlying Application Under Test (AUT). When these elements with the application change, the associated test scripts must change too, resulting in maintenance costs of existing test scripts.



There is a new class of Test Automation tools for GUI applications that have emerged in recent years that leverage AI techniques such as Computer Vision and Natural Language Processing (NLP). These tools support the testing of mobile and browser-based applications. They offer the promise of increased coverage across a broad range of test categories including: Functional, Performance, Usability, and Workflow Testing. All of this purportedly comes at a dramatic decrease in automation script maintenance costs as compared to conventional scripted GUI Automation test suites. With these tools, rather than encode both the intent (the 'what') and the precise steps (the 'how') of a test scenario using Python, Java, or C#, the Tester first trains the bot on how to navigate and label the AUT. Next, the Tester authors the intent of each test scenario in a language understandable by the bot. It leaves the 'how' of navigating the AUT to the bot which is abstracted away from any changes to the DOM of the underlying AUT. Vendors such as Test.AI, Pinklion.AI, Retest, MABL, and Testim.IO are making strides in reducing the maintenance costs faced by many UI Automation engineers.

## Testbots are here

### AI-assisted UI Automation

Meet your newest testers.



- Increases UI test coverage
- At substantially less cost of creation *and* maintenance

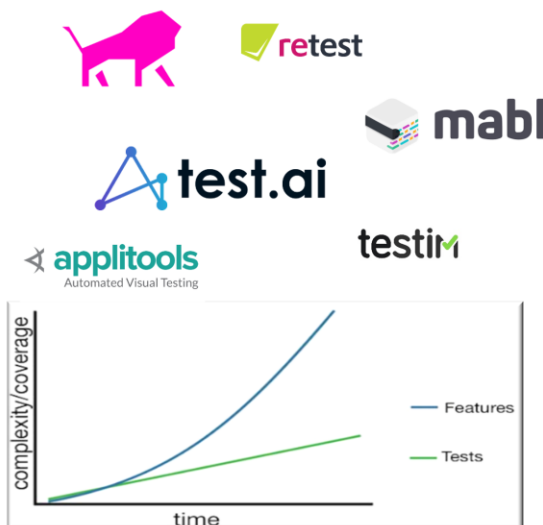


Figure 3 - AI-Assisted UI Automation

While this is encouraging to those testers among us facing the maintenance challenges of GUI Automation, at present, this appears to be one of the few areas where we see Off-The-Shelf, AI-enabled tools making inroads in Testing tasks.

## 2.2 Test Matrix Planning

Organizations that develop Embedded Solutions face complexities with an untenable number of Hardware and Software configurations for their test efforts.

At Dell EMC Servers, one case that we've applied Analytics and ML to is the Test Matrix Configuration Planning process. This is a deep-think task, relying heavily on the past experiences of our Test Leads and their ability to analyze large amounts of historical sales and historical test data. After accounting for all of the valid combinations of new and existing subsystems that go into a new Server, our Test leads face the possibility of having to test **465 trillion** configurations to achieve full test coverage. Of course, due to cost and time, the realistic number that can be address given time and cost constraints, is closer to ~500 unique configurations during a new Server release.

# Test Matrix Configuration Planning Model

System Under Test

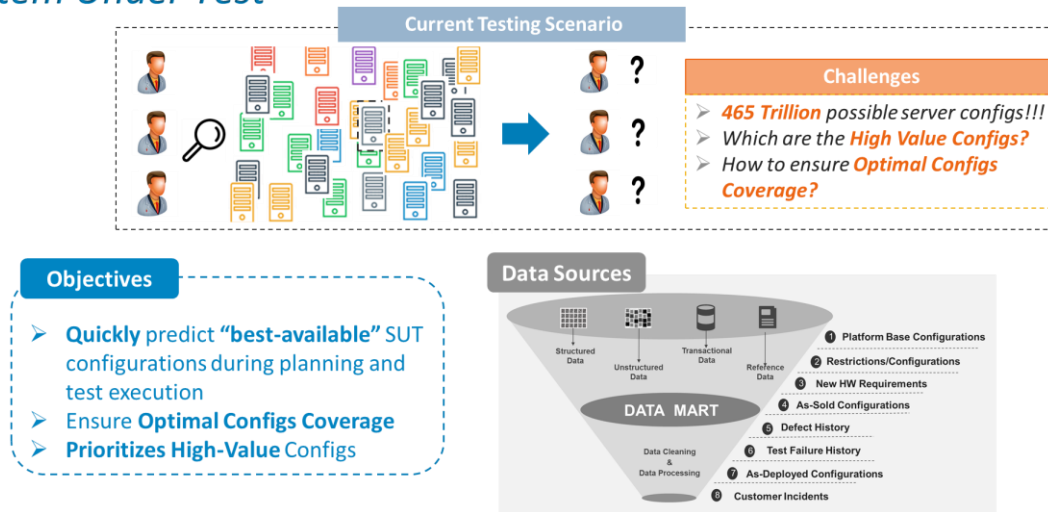


Figure 4 - Test Configuration Planning Model

This planning task is usually undertaken by two to three lead engineers and takes over two weeks to complete. The goal of this planning task is to determine the fewest number of configurations (contain cost), that provide the highest test coverage of the newest features and previously delivered functionality, accounts for most-sold configurations, and factors in the historically challenging configurations. The Test leads perform this analysis manually and refer to large amounts of proprietary data sets as highlighted in the funnel chart in Figure 4.

Tasks with this sort of profile are now addressable by Analytics and ML-based solutions. By combining Analytics with ML-based algorithms, the value that can be derived from automating this highly cognitive and analytical task is twofold:

- 1) The six-person weeks' worth of effort is reduced to hours.
- 2) It enables the team to **quickly** re-plan a test run when materials or features are delayed at the last minute.

## 2.3 Test Suite Planning

Another cognitive testing task that we've been working on automating is the Regression Test Suite Planning model. This analytics-based model uses test case execution history, defect data, and historical SUT configurations to recommend regression Test Cases & Suites at any given time. It offers a smarter way of testing that is informed by prior test execution data, and that helps us answer questions such as:

Which manual tests are most effective, and should be automated?



What manual test cases rarely fail, but are frequently run, with high levels of effort?

Which test cases should we re-factor or retire?

Am I over-testing or under-testing?

We've started referring to this capability as **Precision Testing**. And the more data sets that we add to it (as-tested configurations, change sets, etc.), the more precision it provides in its recommendations. With insights such as these, we're able to justify our calculated risks and in some cases earn ourselves an **Efficiency Dividend**:

- 1) Shorten the test cycle (and possibly the release cycle)
- 2) Re-allocate the testing capacity to higher-value efforts such as exploratory testing
- 3) Re-allocate the testing capacity to deliver more features

## 2.4 Other SDLC tasks

Other tasks that are on the radar of our Dell EMC Engineering teams include the application of Analytics or AI solutions to assist with the:

- **Prediction of duplicate defects** from automated test runs, so that we can avoid wasting valuable time triaging a previously known defect that simply has not yet been resolved.
- **Triage of Test Case Failures** to aid in the rapid identification of root-cause, down to and including, the offending source code module or developer check-in.
- **Prediction of high-risk areas of code** where additional testing, exploratory or otherwise, is warranted.

### 3 The AI SDLC Playbook

This leads us to recommend the following Playbook for organizations to use when navigating the application of AI-inspired solutions to tasks in their SDLC. Using the approach outlined below provides Engineering teams with a means of countering the optimistic and sometimes unrealistic expectations of their leaders and their Subject Matter Experts with a pragmatic, yet goal-oriented approach.

## Playbook for Applying AI within the SDLC

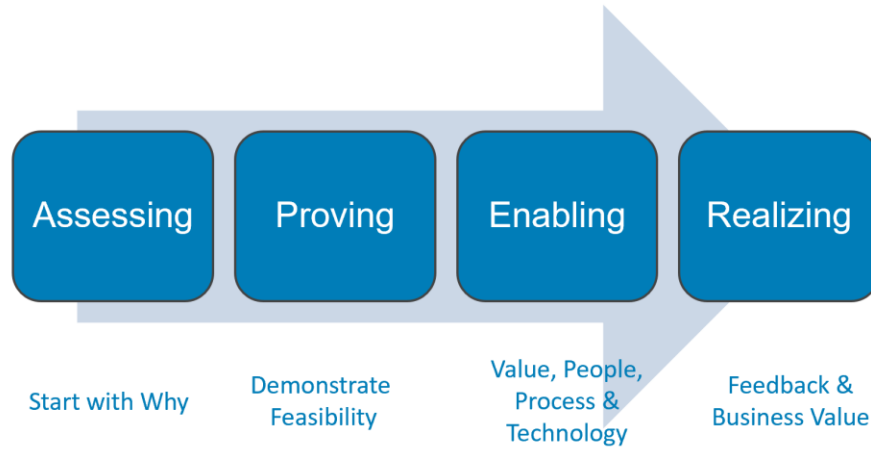


Figure 5 - Playbook for AI across the SDLC

### 3.1 Assessing

The first step in the Assessing phase is to pinpoint the pain points within your organization's SLDC that have the potential for delivering significant business value. As Ben Pring refers to it as, finding your 'X'. The reason for this is multifold. First, obtaining the buy-in of the stakeholders who perform this task today and possess the

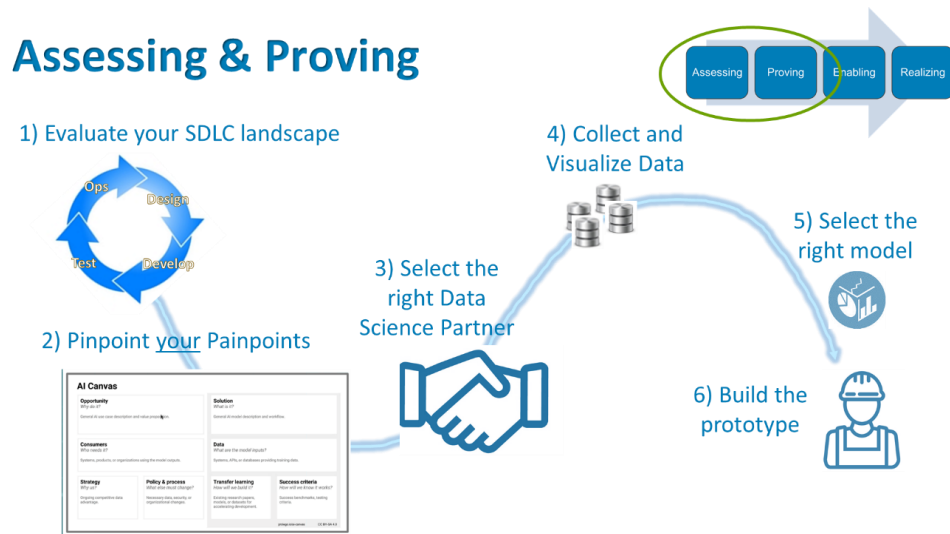


Figure 6 - Assessing and Proving Phases

subject matter expertise is essential to the solution implementation. Second, with their help, the business value can be derived to develop the business case of the solution. Lastly, understanding your specific pain point(s)

becomes especially important if you require the assistance of Data Science skills not currently residing on your team. Why? Because if the data science skills are coming to you via Consulting Services providers, there's a natural inclination for them to recommend solutions that they've previously implemented, which may or may not be top priorities for your organization.

Once the context of your SDLC landscape is well understood, it's essential to assess the value and effort that an AI-inspired solution has to offer. It's necessary at this stage to enlist and engender deep Stakeholder engagement at this early stage because their domain experience and availability will be called upon throughout

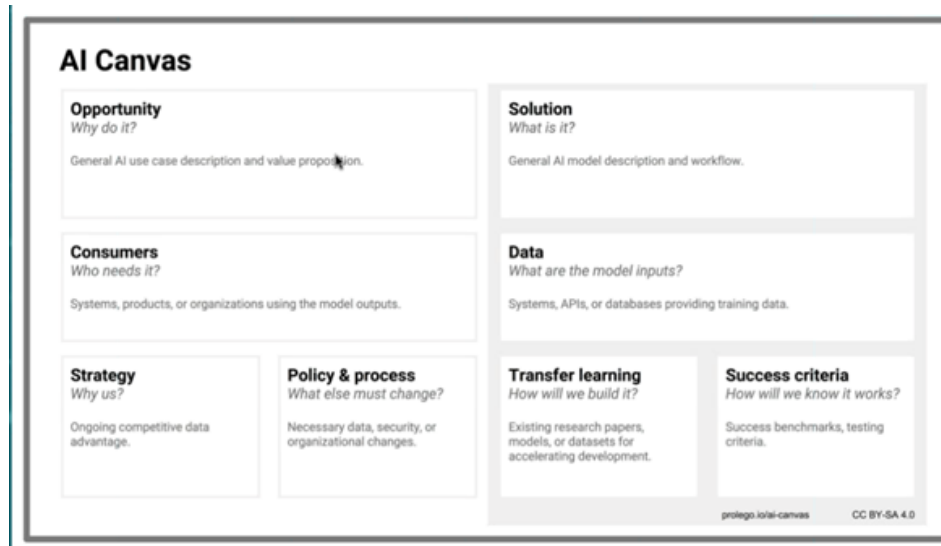


Figure 7 - The AI Canvas Planning Tool

the project. Brainstorming sessions, accompanied by analysis with the help of [AI Planning Canvas tools](#) such as the one in Figure 7, can help your team comprehend the stakeholders, data required, and value of each proposed initiative. Prioritizing the initiatives is the final step prior to engaging your data science partners.

Once you've begun work with your data science partners, their education begins on your domain-specific business problems and available data. Part of any proof-of-concept in this space generally begins with an assessment of the data and simple visualizations of that data for anything of use or insight.

Your data science partners will be the ones to recommend the appropriate modeling approach, whether it be an Analytics-based solution, or any number of algorithms powered by Machine Learning, Computer Vision, or Natural Language Processing. Sometimes an Analytic model is all that is needed to start deriving value from Cognitive Automation. Analytics may offer a more transparent and straightforward debut to the adoption of Cognitive Automation practices since it also depends on the same practical enablers of AI: Data Collection, Data Curation, and changes to Business Process and Tools.

## 3.2 Proving

As you begin to build out your proof-of-concept, be prepared to have your Subject Matter Experts available for ongoing engagement. This should be an iterative, and highly engaged process. In parallel to the development of the prototype, the team will be assessing the viability of the critically dependent data, the processes involved in the capturing and retention of that data. So, as an additional deliverable of the Proving phase, the team must be prepared to deliver an assessment of the data and business process gaps, along with recommendations to close during the Enabling phase.

### 3.3 Enabling

In a typical Software project, this phase would be called the Develop phase. However, Cognitive Automation initiatives carry additional activities that need to be done in coordination. We call this the Enabling phase.



Figure 8 - Enabling Phase

Monitoring and calibrating the efforts of your project’s efforts using the guideposts provided by the pre-defined Value and Business Case is done throughout this phase.

Maintaining the excitement and engagement of the Stakeholders during this phase is essential because so much of an AI project’s success is dependent not just on the domain knowledge of the stakeholders, but their availability.

As discussed earlier, most Cognitive Automation projects within an Engineering organization are going to be custom due to the proprietary nature of the data, processes, and tools ecosystem. During the Enabling phase, the team needs to act on the recommendations from the Proving phase and curate, cleanse, and maintain the cleanliness of the data through enhanced business processes.

Lastly, we have the typical ‘development’ that comes with projects such as this. The design of the algorithms or analytics models, the development of databases and services to access that data, and any coding to simplify end-user access to the models, reports, and recommendations.

## 3.4 Realizing

Once the Enabling phase has completed with the development of the algorithms, the establishment of your data sources or data marts, revamping your business processes, and automating the data feed, you are ready to begin the adoption rollout. If you've nurtured deep stakeholder engagement throughout, this is where your investment in that engagement will start to pay off. Your early stakeholders are your trusted champions and should be at the forefront of extolling the benefits of adoption.

As you begin to roll out the models and algorithms across the various Engineering teams there will likely be project-specific tweaks, so you need to engage them, listen to their feedback and make necessary adjustments.

What you do with the dividends gained from this level of Cognitive Automation are likely to have already been accounted for, and in some cases already incorporated into project forecasts.

Lastly, as the adoption of tasks enhanced by Cognitive Automation progresses through the organization, you want to maintain the positive momentum through Minimum Viable Product (MVP) releases of improved functionality or start to tackle new tasks altogether.

## 4 Summary

The most important thing to do when embarking on an AI-inspired, Cognitive Automation initiative is to **Start with Why**. Pinpointing **your** pain points that provide the most value to your organization also provides the foundation and North Star to establish deep stakeholder engagement.

**Capture, Manage and Retain your data.** Start capturing data now and be thoughtful of the data that you retire or eliminate.

**Pick your Partner.** Find out if your company has an internal analytics or data science function and explore that path first. If not, knowing your pain points before any external engagement is essential to delivering value to your priorities.

**Maintaining Deep Stakeholder engagement** is essential because they are the domain experts. They are going to be fielding many queries and clarifications from the data scientists, and it's critical for them buy into the goals, the tenacity to believe in the effort, and ultimately be the mouthpiece to drive successful adoption across the organization.

**Re-imagine Engineering** by finding your 'X' and keep improving by working the next opportunity for Cognitive Automation. Either by providing more precision in the models of the current project or by moving onto the automation of the next Cognitive task in your list of priorities.



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## 6 Recommended Reading

### 6.1 Books

- Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die: [https://www.amazon.com/dp/B019HR9X4U/ref=dp-kindle-redirect?\\_encoding=UTF8&btkr=1](https://www.amazon.com/dp/B019HR9X4U/ref=dp-kindle-redirect?_encoding=UTF8&btkr=1)
- What To Do When Machines Do Everything: <http://www.whenmachinesdoeverything.com/>
- Race against the Machine: [https://books.google.com/books/about/Race\\_Against\\_the\\_Machine.html?id=IhArMwEACAAJ](https://books.google.com/books/about/Race_Against_the_Machine.html?id=IhArMwEACAAJ)
- Super Freakonomics: <http://freakonomics.com/books/>
- Humans are underrated: <http://geoffcolvin.com/books/humans-are-underrated/>
- Life 3.0: Being Human in the Age of Artificial Intelligence: <https://www.amazon.com/Life-3-0-Being-Artificial-Intelligence/dp/1101946598>
- The Four: <http://www.thefourbook.com/>

### 6.2 Research

- When will AI Exceed Human Performance: <https://arxiv.org/pdf/1705.08807.pdf>
- World Quality Report 2016-17 (Capgemini): <https://www.capgemini.com/thought-leadership/world-quality-report-2016-17>
- World Quality Report 2017-18 (Capgemini): <https://www.capgemini.com/thought-leadership/world-quality-report-2017-18>
- The next era of Human|Machine Partnerships: <https://www.delltechnologies.com/en-us/perspectives/realizing-2030.htm>
- Towards a Reskilling Revolution: A Future of Jobs for All: [http://www3.weforum.org/docs/WEF\\_FOW\\_Reskilling\\_Revolution.pdf](http://www3.weforum.org/docs/WEF_FOW_Reskilling_Revolution.pdf)
- Special report: Tech and the future of transportation: [http://b2b.cbsimg.net/downloads/Gilbert/SF\\_feb2018\\_transport.pdf](http://b2b.cbsimg.net/downloads/Gilbert/SF_feb2018_transport.pdf)
- How AI Will Change Software Development: <https://www.slideshare.net/WillyDevNET/how-ai-will-change-software-development-and-applications>
- 21 Jobs of the future: <https://www.cognizant.com/whitepapers/21-jobs-of-the-future-a-guide-to-getting-and-staying-employed-over-the-next-10-years-codex3049.pdf>
- 21 MORE jobs of the future: <https://www.cognizant.com/whitepapers/21-more-jobs-of-the-future-a-guide-to-getting-and-staying-employed-through-2029-codex3928.pdf>
- Wait but why: Artificial Intelligence Revolution Part 1: <https://waitbutwhy.com/2015/01/artificial-intelligence-revolution-1.html>
- Wait but why: Artificial Intelligence Revolution Part 2: <https://waitbutwhy.com/2015/01/artificial-intelligence-revolution-2.html>
- What's Next | Artificial Intelligence Part 1: <https://www.youtube.com/watch?v=2br8yji-rcM>
- What's Next | Artificial Intelligence Part 2: <https://www.youtube.com/watch?v=WKyIGBYFrU>

### 6.3 Articles

- Dell to double data scientist headcount: <https://www.thehindubusinessline.com/info-tech/dell-to-double-data-scientist-headcount/article9414013.ece>
- The Future of Jobs: [http://www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf)
- This Technology Will Upend the Entire Automotive Industry: <https://moneywise411.com/new-automotive-technology/?ppc=743242>
- 5 ways AI will change software testing - <https://techbeacon.com/5-ways-ai-will-change-software-testing>

- What's Everybody So Afraid of: <http://www.popularmechanics.com/technology/robots/news/a28645/googles-alphabet-astro-teller-ai/>
- Robots Are Coming for Jobs of as Many as 800 Million Worldwide: <https://www.bloomberg.com/news/articles/2017-11-29/robots-are-coming-for-jobs-of-as-many-as-800-million-worldwide>
- The 10 Biggest AI Failures of 2017: <https://www.techrepublic.com/article/the-10-biggest-ai-failures-of-2017/?ftag=TRE684d531&bhid=24345184115902224026945549370599>
- Technology has created more jobs than it has destroyed: <https://www.theguardian.com/business/2015/aug/17/technology-created-more-jobs-than-destroyed-140-years-data-census>
- The tech industry needs one million workers now: <https://www.yahoo.com/finance/news/tech-industry-needs-one-million-workers-now-130452775.html>
- Towers Watson & Oxford Economics: Global Talent 2021: <https://abhishekmittal.com/2012/08/04/towers-watson-oxford-economics-global-talent-2021/>
- How AI will change software development processes: <https://jaxenter.com/ai-change-development-processes-148462.html>
- How reinventing software testing can transform your business: [https://techcrunch.com/2018/03/13/how-reinventing-software-testing-can-transform-your-business-and-change-the-world/?utm\\_content=68756890&utm\\_medium=social&utm\\_source=linkedin](https://techcrunch.com/2018/03/13/how-reinventing-software-testing-can-transform-your-business-and-change-the-world/?utm_content=68756890&utm_medium=social&utm_source=linkedin)
- Infrastructure for AI: We're doing it wrong: <https://jaxenter.com/infrastructure-ai-wrong-151099.html>
- Understanding the differences between AI, machine learning, and deep learning: <https://www.techrepublic.com/article/understanding-the-differences-between-ai-machine-learning-and-deep-learning>
- AI in software testing has arrived. Here's why robots rule: <https://searchsoftwarequality.techtarget.com/feature/AI-in-software-testing-has-arrived-Heres-why-robots-rule>
- Turning Testers into Machine Learning Engineers: <https://www.linkedin.com/pulse/turning-testers-machine-learning-engineers-jason-arbon/>
- Where will automation and AI go in 2019?: <https://jaxenter.com/automation-ai-predictions-2019-153267.html>
- What's to do when Machines do Everything?: <https://www.forbes.com/sites/brucerogers/2017/04/06/what-to-do-when-machines-do-everything/#2a8c71487561>