

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

A 9-part series to walk through an agile development project
from concept to launch

The Complete Steps



By Dorian Simpson and Gary Hinkle

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 1 of a 9-part series to walk through an agile development project from concept to launch

Step 1:

Starting Your Agile Project



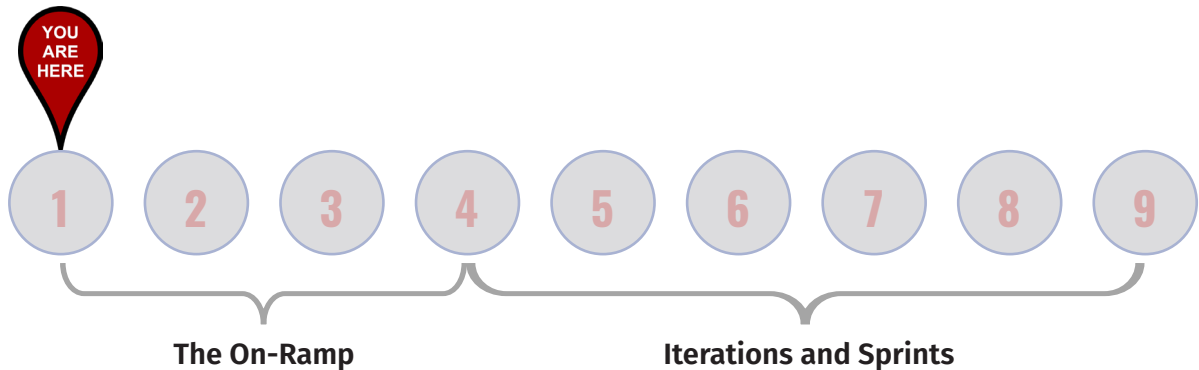
By Dorian Simpson and Gary Hinkle

A Quick Intro to MAHD

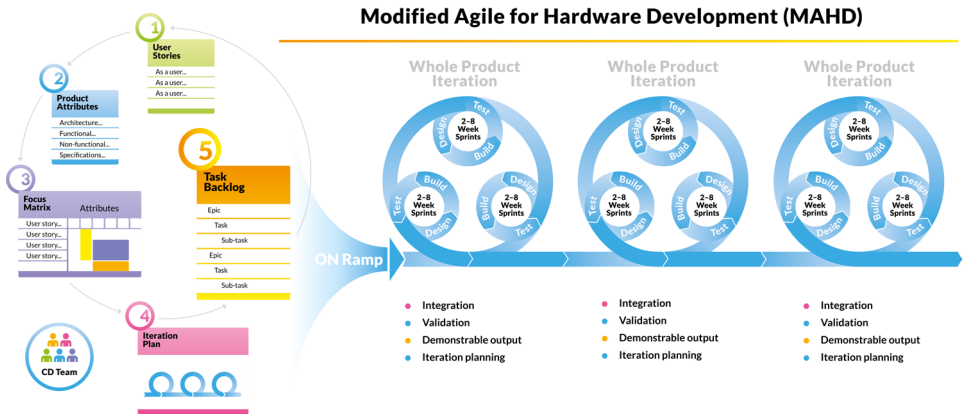
Agile methods have proven superior over traditional product development processes to quickly adapt to customer needs, reduce waste and accelerate development. However, the application of agile requires significant changes to support the needs of hardware products. This led to the development of the Modified Agile for Hardware Development (MAHD) Framework – an open-source initiative to embrace the principles of agile while recognizing hardware’s unique needs.

THE COFFEE MAKER PROJECT: STEP-BY-STEP AGILE IN NINE STEPS

To help hardware development teams visualize agile in action, we have developed a series of nine articles to explain how agile methods can be used for physical products, who should be involved, the deliverables for each step and how to overcome challenges. We hope you'll join us on this journey as JavaBrew uses the MAHD Framework to develop an innovative new coffee maker.



INTRO TO MAHD



The MAHD Framework: Similar to Agile for Software, but with Important Differences

Learn More

To learn more about the MAHD Framework, download related ebooks and whitepapers, or sign up for e-learning opportunities, visit www.agileforhardware.org.

Step 1: Getting Your Agile Project Started

THE SITUATION

Lynda is a Product Manager for JavaBrew Coffee. They are makers of premium coffee-making devices who target high-end consumers. JavaBrew is behind in the “smart” category of the market – coffee makers that leverage smartphone apps, connectivity and emerging voice capabilities. To catch up, they need to develop a new line of smart coffee machines. Lynda is ready to kick off the project to develop the first product on the roadmap.

However, Lynda has a problem. At JavaBrew, developing a coffee maker typically takes over two years from project start to first production. She needs a product that includes a significant advancement in technology in 18 months to hit the 2020 holiday season. To shorten their development cycles, JavaBrew is adopting agile principles using the MAHD Framework. While some people in the company are skeptical, many believe that with agile, they can hit the schedule with the right product.

To kick off the agile project, it is now Lynda’s responsibility to help the team understand the project and provide information the development team will use to get started. Her first task is to develop an “Agile Product Brief” to summarize the market situation, clarify the customer, establish project goals and begin to define the product through user stories. To get started, she identified the high level value drivers that lead to purchase in the market she is targeting. She knows that "smart" cannot just be about technology, but must focus on delivering new capabilities that customers will find valuable.

The Team

Throughout the steps, you'll meet a variety of team members involved in the project:

Lynda - A seasoned product manager who owns success of the product.

Jordan - An experienced project manager who owns the project, deliverables, schedule and budget.

Jim - The VP of Engineering who has spent his career developing appliances.

Juanita - The CEO charged with delivering growth to her stakeholders.

Alec - The Director of Software and Apps who recently acquired new responsibilities for "smart" applications.

Frank - Head of Design and Mechanical Engineering.

Value drivers (reason to buy):

- Attractive design: Pleasing, fit with decor, clean, modern
- Quality of coffee: Taste, consistency, flexibility
- Long term experience: Maintainable, functional, durable
- Smart: Easy, cool, intuitive, new use cases

AGILE ACTIVITIES

The project is just getting started with the MAHD Onramp. While JavaBrew would typically develop a detailed Product Requirements Document (PRD) that might take two to three months (or longer as they negotiate product features with the R&D group), agile requires a faster, lighter approach to getting the project started. Lynda starts by developing a deep understanding of the market and customer. Instead of a PRD, she develops a short Agile Product Brief (shown in Exhibit 1) to communicate the market situation and project goals.

In each future step, the team knows that to stay on track and be "agile," they must also consider each of these elements. We'll revisit these in each step.

Prototypes: The team will need a rapid prototyping strategy to validate attributes and features from both technical and customer acceptance perspectives.

Customer Engagement: Target customers must be identified and engaged early in the process to learn quickly if they are on the right track.

Decisions: Tough decisions will need to be made throughout the development process as tradeoffs are made and the product is refined.

STEP 1: OUTCOMES

The following two Exhibits show the documents Lynda prepared for the agile project kick-off discussion. She knows her information is not perfect, but has confidence the details will continue to get refined throughout the agile process.

Exhibit 1: Agile Product Brief

The Agile Product Brief describes the target market and customer value drivers as well as business goals such as price, margin and sales targets.

Exhibit 2: User Stories

The users stories describe the product from the *customer's* perspective. As Lynda worked on these user stories, she wondered, "Are these too high level? I know these are what customers want, but will the R&D team have enough information to get started? They don't even describe the "smart" attributes of the product!" She decides to keep them high level for now to begin the discussion.

NEXT STEP

Once Lynda has successfully gained management support for the product's goals, she is ready to work with the project manager, Jordan, to set up an agile project kick-off meeting. In this upcoming step, the development team leaders will review Lynda's product goals and user stories, organize the team and prepare for iteration planning.

Exhibit 1: The Agile Product Brief

Describing the Market, Project Goals and Target Customer

Market Overview	
<ul style="list-style-type: none"> Voice-enabled devices are growing. After 2 years are already in 24% of US homes Amazon Echo dominates the market with 75% penetration Smart coffee maker category growing 22% YOY Many makers are adding “smart” features – only one is voice-enabled today 	
Target Customer	
<ul style="list-style-type: none"> US home consumer (to start) Primary target: Male, 25 to 40 years of age, household income >\$150K/year Tech savvy: Premium smart phone owners, smart device users Coffee lovers: Drink 2-5 cups of coffee/day. High quality. Personal bean preference. 	<p>Value drivers (reason to buy):</p> <ul style="list-style-type: none"> Attractive design: Pleasing, fit with decor, clean, modern Quality of coffee: Taste, consistency, flexibility Long term experience: Maintainable, functional, durable Smart: Easy, cool, intuitive, new use cases
Launch Goals:	
<ul style="list-style-type: none"> Retail Price: \$299 Wholesale price: \$170 Target cost: \$100 JavaBrew Margin: ~40% 	<ul style="list-style-type: none"> Target launch: July 31, 2020 2020 Unit target: 15,000 units
Product-market Positioning	
<ul style="list-style-type: none"> Initial JavaBrew product to enter smart market, roadmap adds product SKUs High value, premium product based on intelligent functionality and design not just being “smart” "JavaBrew's Smart Coffee Series delivers amazing coffee exactly how you want with an intelligent and intuitive design" 	<p>The chart illustrates the product-market positioning. The vertical axis represents Consumer Price, with markers at \$150, \$300, and \$450. The horizontal axis represents Quality/Performance/Features, with markers for Low and High. Three concentric circles represent product tiers: 'NINJA' (bottom-left), 'JavaBrew V1' (middle), and 'bonaverde' (top-right). A red arrow points from 'JavaBrew V1' towards the 'Roadmap Target' area, which is located at a higher price and higher quality than the current product.</p>

EXHIBIT 1

Exhibit 2: User Stories

Describing the JavaBrew Smart Maker from the customer perspective

As a...	I want...	So that...	Pty.
Consumer	... an attractive appliance	... it looks good on my counter and I can be proud of my investment	H
Consumer	... a choice in colors	... it matches my tastes and decor	M
Consumer	... to easily clean the appliance, or better, not have to clean it at all	... I can save time and energy	M
Consumer	... to automatically add coffee and water as needed	... I don't have to fuss with these when I want coffee	H
Consumer	... to avoid using filters	... I don't need to worry about buying them or running out	H
Consumer	... the appliance to be reliable	... I don't spend time "debugging" my coffee maker	H
Consumer	... the coffee to stay hot (and not burn it.)	... it's ready when I want at the perfect temperature	H
Consumer	... to control the strength of the coffee	... I can decide the taste for myself and others in the house	M
Consumer	... to make as many cups as I need	... to not waste coffee or have enough based on the situation	M
Consumer	... to easily control all functions of the maker	... I don't need to read the manual, waste time or get frustrated	H
Consumer	... to control the timing	... I can have coffee exactly when I want it	H
Consumer	... set the maker from anywhere in my home	... I can make coffee while working, watching TV or anything else	H
Consumer	... set the maker while I'm not at home	... I can have coffee ready for me when I want and set it whenever I want	M
Consumer	... to add coffee and water easily	... I save time and ensure the maker is ready when I want it	M
Consumer	... to ensure the coffee and water are fresh	... I always have the best quality coffee possible	H
Retailer	... to have no product returns	... I don't have the expense and headache of returns	H
Retailer	... the maker to be self-explanatory	... I don't have to take time to educate consumers	M
Retailer	... accessory sales	... I can make money after the initial purchase	L

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 2 of a 9-part series to walk through an agile development project from concept to launch

Step 2:

The Agile Project Kickoff Meeting



By Dorian Simpson and Gary Hinkle

Step 2: The Agile Project Kickoff Meeting

THE SITUATION

Lynda, a product manager at JavaBrew is preparing to kick off an agile project using the Modified Agile for Hardware Development (MAHD) framework for the first product in a roadmap of “smart” coffee makers – The JavaBrew Smart Maker 2020. In the previous step in this series, Lynda prepared an Agile Product Brief along with high level user stories. She is now ready to gather the team to explain the project’s goals, user needs and get the project started with the development team.

In this step, she has called a meeting with the key stakeholders to kick off the project with several goals in mind:

1. Communicate the target market and business objectives for the product
2. Review the Agile Product Brief and user stories for clarity
3. Brainstorm the major product attributes as part of the MAHD On-ramp
4. Identify all of the major project elements using an Agile Project Checklist
5. Identify any preparation needed for the next step – Iteration Planning

It’s now Tuesday afternoon and the team has gathered in their project room ready for action.

AGILE ACTIVITIES

At this point, it's important to involve all project team leaders including R&D leads, designers, testing leads, production managers and other functional leads. It is not necessary to include all team members now since the leadership team is still working on the big picture. The systems engineering lead, Jordan, has agreed to serve as the agile project manager, splitting his time between engineering work and project management responsibilities. His role as the agile project manager is to drive the agile process and ensure the team meets all objectives and goals described in the Agile Product Brief. Lynda’s role as Product Owner is to represent customers and senior management, making team decisions as needed on behalf of stakeholders as well as providing updates about customer and business needs.

Once the team meets, Lynda leads the team discussion and starts by presenting the market situation, target customer and product goals. Next, the team reviews the user stories for clarity and they discuss any story that is unclear and what it might mean for customers. They then begin to brainstorm the anticipated major attributes and requirements not described by user stories that are necessary to deliver the product. They use the remainder of their meeting time to complete an Agile Project Checklist.

They leave the meeting with more questions, than answers, as shown in the exhibits below, but they know questions will be answered through the agile process.

STEP 2: OUTCOMES

The Exhibits on the following pages show the results of the Agile Kick-off Meeting.

Exhibit 1: Kick-off Meeting Notes

Lynda and Jordan captured team member concerns ranging from cost, to schedule to market acceptance along with comments and major action items. Many of these will likely become part of the backlog they'll develop in an upcoming step.

Exhibit 2: Product Attributes and Requirements

The team decided to categorize attributes by functional discipline. They discussed whether to group them by product function, such as “Human Interface” which might include elements across disciplines, but since each team leader would be responsible for their own deliverables, they felt the categories shown would be easier to manage and assign tasks.

Exhibit 3: The Agile Project Checklist

The team agreed that all elements on the checklist are needed, except that deviations/waivers should not be required for compliance. They will include these planning elements in their backlog and work towards completing the plan in their early sprints.

NEXT STEP

The team will meet again in one week to complete their initial Iteration Plan that will outline the milestones and key deliverables, estimate the project duration, develop a prototype plan and consider the major dependencies that determine the schedule. Early focus areas will also be considered, including opportunities for creating differentiation through innovation, how to manage the project risk, and identify the key questions that need answers.

Before the Iteration Planning meeting, each functional lead will review the Agile Product Brief more deeply to identify concerns and determine if major attributes/requirements need to be added. They will also think about their functional approach and be prepared to contribute to the overall plan.

Exhibit 1: Meeting Notes

Capturing the ideas, concerns and issues of the project

After reviewing Lynda's Agile Project Brief, the team had a wide range of comments and concerns.

1. The major concern was the target release date. The team had not completed a project of this complexity in 18 months. With so many unknowns, was this possible? They agreed to review this as part of Iteration Planning (the next step).
2. The cost target of \$100 seemed unreasonable, especially with the new smart features. Their current premium maker already had a cost of over \$100 and they think the new features will add significant costs.
3. The user stories were too high level. Lynda needed to supply more details for the R&D team to focus faster and not waste time getting clarity where needed. She promised more details by the end of the first iteration once the team had learned more.
4. The team was excited to work on this new product. The R&D team has been thinking about smart features and was anxious to incorporate their work into a real product. (Privately, Lynda had concerns the R&D team would focus more on the cool features they were working on rather than real customer needs.)
5. There was much debate on the value and implementation of using voice control on a coffee maker. One of the respected designers, Kevin, stated, "I don't think customers really want this. It just adds complexity and we could do much better with a phone app." The team agreed this would need to be resolved quickly in the agile process.
6. Resources and access to team members with the right skills was raised as a big concern. The team was unsure of how to estimate the number of people they would need until the product was more defined.

Exhibit 2: Product Attributes and Requirements

Describing the JavaBrew Smart Maker from the product perspective

Category	Attribute/Requirement	Discussion
Physical Design	Color Choices	OK with one color option for first product? TBD
	Material	Stainless steel has higher perceived value, but might not hit price target.
	Industrial design	Develop a whole series “smart” design? TBD. High-end product must be reliable.
	Coffee grinding	Blades are cheaper, but less consistent and more prone to breaking. Current premium using grinding. Blades if cost target critical?
	Flexible size control	Reuse existing designs?
	Filter type	Innovative re-usable design.
	Water reservoir	Size requirement? Designer to review optimal.
	Carafe style/design	Insulated? Glass? TBD
	Interface?	If voice/app controlled, do we need a full interface on the device?
Electrical Design	Grinding/water control	Using previous designs should be OK. TBD
	Button/touch interface	Physical buttons? Touch? Ideally the interface matches the mobile app. TBD
	Wireless interface	WiFi required. Bluetooth option?
	Electrical Compliance	2020 launch U.S. market only?
Software	Coffee control	Can reuse much of current code.
	Mobile App	Keep it simple.
	Voice Control	How much control do Alexa commands allow? Needs research.
Packaging/Materials	Retail package	Premium product will require premium package.
	Manual	Keep it minimal – Download the app!
	Legal disclaimers	Reuse previous – new privacy language.
Other	Molds	TBD
	Testing	Can our team test smart features? Review skill set. Reliability testing critical for high-end product.

Exhibit 3: Agile Project Checklist

Identifying the project needs beyond user stories and attributes

Element Needed?	Project Plan Elements
Project Description	
Done – Product Brief	Project overview
Done – Product Brief	Flexibility matrix (Scope/time/cost prioritization)
No	Policy exceptions, process deviations, waivers...
Yes – “Smart” tech terms	Glossary of terms
Ongoing – Product Brief	User stories
Yes – revisit each sprint	Features not included or supported
Yes – need reuse plan	Reuse
Yes	Product / system architecture / major components
Document smart features	Theory of operation
Yes – challenging target	Production cost estimates
Resource Plan	
Yes – staffing concerns	Project staffing and cross-functional support
Yes	Roles and responsibilities
Yes	External resources
Yes – smart features	Training plan
Done – Product Brief	Financial resources and budget
Yes – manufacturing	Capital expenses, equipment and tools
Project Management Plan	
Yes	Iteration plan
Yes	Communication plan
Yes	Quality assurance plan
Yes	Risk Mitigation
Yes	Project metrics and KPIs
Standard procedures	Revision/document control and configuration management
Yes	Change management
Yes	Project reviews
Yes	Defect tracking
Development Plan	
Yes	Technical approach and innovation
Yes	Manufacturing considerations
Yes – DFM/E/R	Design for “X” (DfX)
Yes	Documentation plan
Yes – patents	Intellectual property management
Yes	Product attributes
Yes	High-level test/verification/validation plan
Yes	Release/launch plan

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 3 of a 9-part series to walk through an agile development project from concept to launch

Step 3: Iteration Planning



By Dorian Simpson and Gary Hinkle

Step 3: Iteration Planning - Creating the Big Picture

THE SITUATION

In the previous step, Lynda, the Product Owner and Jordan, the Agile Project Manager, kicked off their smart coffee maker agile project. Lynda shared an Agile Product Brief and high level user stories with her team. The team also captured product attributes, requirements and planning elements to sufficiently to get the project going in the right direction.

For step 3, the team must come together to develop an Iteration Plan that will outline the overall project plan and guide progress toward the final product.

Once completed, their Iteration Plan will include these elements:

- Project milestones
- Timing of key deliverables
- An estimate of the entire project duration
- A prototype plan
- Major dependencies that determine the schedule
- Early focus areas (opportunities for innovation, risks to manage, key questions, etc.)

The Iteration Plan will take all the high-level information developed about the project so far, including user stories, product attributes, requirements and planning considerations, to determine areas of early focus. The results will be a rough timeline for major goals on the path toward the finished product. Each major goal will become an iteration. As learning occurs, future iterations will be re-assessed. Sprints, which will be described in a later step, are the agile mechanism for getting work done in short cycles to complete the objectives of the iteration. Each sprint will also have its own sub-goals leading to success of each major iteration.

Based on the previous step, the team has concerns about the release date given the scope of the project as well as concerns about voice control, skills and if they can hit the cost target. The Iteration Plan must include steps to resolve these concerns.

It's Tuesday afternoon and the team has gathered in their project room ready for action.

AGILE ACTIVITIES

Once the team meets, Jordan explains that the goal of the meeting is to build consensus for the overall project milestones, preliminary schedule and where to focus in terms of risk, questions that need answers and opportunities for innovation. He kicks off the meeting by leading the team to develop a focus matrix to identify the most critical areas of risk and areas where innovation must happen to satisfy critical user stories.

Once the critical areas of are identified, as shown in Exhibit 1, the team is ready for Iteration Planning. The team draws a table on a large whiteboard that looks something like the diagram shown here:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Major Deliverables				
Prototypes				
Key Questions				
Milestones/ Approvals?				
Risk Mitigation				
Target Date				
# of Sprints				

The team then identifies the major goals for each iteration, including:

- Major milestones they want to define, plus any required approvals
- Major risks to mitigate
- Key questions they need answered by customers, users and stakeholders
- Their prototype plan for each iteration
- Major deliverables that aren't "prototypes"
- Consideration of training, management buy-in and other activities that might be needed

Using markers and sticky notes, the team works through each goal, writes down ideas and places them roughly where they think they should occur. Initial thinking is very rough, such as early, late or in the middle of the project. As they add more detail they rearrange activities and establish the number of iterations needed. To determine the project timeline and the timing of each iteration, they start with a rough estimate of how long the project should take using past experience and data

about previous similar projects. As the Iteration Plan is developed, they reach consensus about the feasibility of the timing for each iteration and whether the entire plan fits within the overall timeline needed. On this project they have a business need for a release date in 18 months, which is shorter than previous projects that had less complexity. When they agree that the timeline isn't achievable as is, they attempt to figure out how to make the plan realistic to meet the necessary launch date.

Jordan leads the team through consideration of the Triple Constraint – a project management method for prioritizing scope, time and cost. Since time is fixed and clearly most important, they look for ways to achieve success by possibly reducing scope or adding resources. The team has lively discussion about the how resources could be added and intense debate about reduction in scope.

Lynda, the Product Owner, is reluctant to give in on major attributes at this point since she knows little about what the team can deliver and if they can create a smart experience customers will love. However, she realizes the team has serious concerns about the project feasibility and is open to reduction of scope as they learn more from customers. The team discusses the concept of a Minimum Viable Product (MVP) and classifies additional features as nice to have. Lynda will help by clarifying and reprioritizing user stories in the Agile Product Brief.

After discussion about reduced scope to achieve the MVP, the team has major questions that need answers, yet they complete their Iteration Plan with an adequate level of confidence to get started. The last step in this planning is to consider the duration of their sprints and how many sprints will be needed to complete each iteration. They decide that sprints will be two weeks, knowing that they can easily change sprint duration later if needed. They are now prepared to develop their backlog and will quickly be able to start their first sprint toward completion of the first iteration.

STEP 3: OUTCOMES

The Exhibits on the following pages show the results of iteration planning.

Exhibit 1: Focus Matrix

Jordan led the team to highlight critical relationships between user stories and product attributes. Matrix thinking – a common product development practice – helped the team to quickly determine work that must be done early in development. The red and yellow areas in the matrix are areas of concern where work is needed to resolve questions and remove risks. The team has many questions about what “ease of use” means and what smart features users will truly value. It’s questionable whether a physical interface is needed, and if voice control would be widely used. They know decisions about the smart features and the app must be made soon. They must also learn how the grinding mechanism and water dispensing attributes will effect product cost and what tradeoffs will be acceptable.

Exhibit 2: Iteration Plan

Since the team used a project room and whiteboard shared with another team, they took a picture of their Iteration Plan and then captured it in Excel. Later they will use an online agile management tool, Jira, to plan sprints and track their progress. The Iteration Plan will be used as the overall plan to communicate progress to management and they'll continue to refine it as they learn.

Exhibit 3: Risk Mitigation Plan

The team quickly brainstormed major risks, determined probability and impact on a 1 to 3 scale, prioritized accordingly, then came up with a plan for the highest priority risks. Note that all identified high-priority risks are management and team member execution risks. These types of risks might not have surfaced, or might have been disregarded as “typical problems” without this emphasis on risk mitigation as part of the overall planning process.

NEXT STEP

They are nearing the end of the MAHD On-ramp and almost ready to dive into execution. However, before they begin, all the work described at the high level in our first three steps must be captured in the project backlog.

The team will meet again next Tuesday to develop their initial backlog. Before they meet, each functional lead will think about all of the tasks needed to complete the project with an emphasis on the first iteration. Soon they will need to define their first sprint and begin execution.

Exhibit 1: The Focus Matrix

Areas of concern between user stories and potential attributes

		Attributes				
		Grinding mechanism	Water reservoir	Physical interface	Smart phone interface	Voice control
User Stories	Easily control all functions					
	Set the maker from anywhere in my home					
	Set the maker while I'm not at home					
	To automatically add coffee and water as needed					
	To control the strength of the coffee					

EXHIBIT 1

Exhibit 2: The Iteration Plan

Preparing the big picture in readiness for sprint planning

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Iteration 6
Major Deliverables	<ul style="list-style-type: none"> Preliminary concepts Preliminary features scoped 	<ul style="list-style-type: none"> Cost estimates, initial industrial design, electronics design Smart features defined – app/voice 	<ul style="list-style-type: none"> Coffee making mechanism design with smart control for testing 	<ul style="list-style-type: none"> Integrated device with ~80% target feature set Smart app 90% complete 	<ul style="list-style-type: none"> Mechanical and electronics designs complete Packaging design complete BOM complete 	<ul style="list-style-type: none"> Production drawings, user guide, website, materials, packaging Forecasts, marketing plan
Prototypes	Preliminary brochure	3D video highlighting smart features and ease of use	Rough working prototype – smart features + physical design	Fully working prototype	Production-ready prototype	Production starts
Key Questions	<ul style="list-style-type: none"> Is value proposition right? Which features drive value? Physical interface needed? 	<ul style="list-style-type: none"> Value of voice control? App features? Can cost meet targets? 	<ul style="list-style-type: none"> Do customers love it? Any design show-stoppers? Can we hit the market window? 	<ul style="list-style-type: none"> Can we really lock down features? Are retailers on board? Can we create demand? 	<ul style="list-style-type: none"> Is it ready for production? Is the quality “good enough?” Are costs under control? 	<ul style="list-style-type: none"> Are retailers ready to take orders? Can we hit the forecast? Is sales engaged?
Milestones/ Approvals?	Concept and plan approved	Cost estimates approved	Major feature lock-down	Design/feature lockdown, prototype tooling approved/ordered early in iteration	BOM complete, launch plan, final tooling, compliance & certifications	Pricing, sales and channel ready
Risk Mitigation	<ul style="list-style-type: none"> Team momentum – need committed resources. Early customer engagement. 	<ul style="list-style-type: none"> Schedule risk – team velocity on target? FCC compliance. 	Design approvals	<ul style="list-style-type: none"> Prototype tooling approvals. Final feature set approval. 	<ul style="list-style-type: none"> Production tooling approvals. 	<ul style="list-style-type: none"> Sales and marketing risks. Engage with channel partners.
Target Date	3/15/19	5/24/19	8/2/19	12/6/19	4/10/20	7/3/20
Number of Sprints	3	5	5	9	9	6 (2 sprint buffer for 7/31 launch)

Exhibit 3: Risk Mitigation Plan

Identification of major risks, prioritized with risk reduction strategy

Priority	Description	Probability	Impact	Plan
1	Necessary team members not available when needed	3	3	Full commitment by start of iteration 3
2	Schedule is not achievable based on our history	3	3	Agree on MVP by end of iteration 2
3	Customer/user feedback will be too slow	3	3	Commitment from key customer/user group by start of iteration 2
4	Tooling won't be ready when needed	3	3	Understand lead times early and get approvals in time
5	Manufacturing cost too high	3	2	Determine cost of MVP in iteration 2
6	Stakeholder disagreement about necessary features	3	2	TBD
7	FCC Compliance	2	3	Schedule testing in iteration 2
8	Marketing won't reach or resonate with target customers	2	2	TBD
9	"Attractive" appliance is too subjective and might not have market appeal	2	2	Early feedback about design concepts

EXHIBIT 3

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 4 of a 9-part series to walk through an agile development project from concept to launch

Step 4: Building the Backlog



By Dorian Simpson and Gary Hinkle

Step 4: Developing the Initial Project Backlog

THE SITUATION

In the previous step, Jordan, the Agile Project Manager (APM), led the team to develop their Iteration Plan, which describes project milestones, their prototype plan, timing of key deliverables, and early focus areas. The team also identified risks, questions to be answered, and opportunities to engage with customers. This was an important step of the MAHD On-ramp which gave them a well-planned outline for the entire project, including a critical draft of the overall schedule and clear objectives for the first iteration.

From previous steps, the team had a major concern about the overall schedule that Iteration Planning helped resolve... at least for now. They still have a lot of questions about the value of voice control, how much effort to put into the mobile app, how all the interfaces will work together and especially how to ensure customers will actually love the product. These are all important questions and concerns that will need to be addressed throughout the agile project.

In step four, the team is now ready to develop their backlog — the prioritized list of work items that need to be done. Since the team is still engaged in On-ramp planning (and haven't even started their first sprint), they will take a high level approach to capture large work items, knowing that each will be broken down further into more detailed tasks during sprint planning. User stories, requirements, product attributes, tasks, risks, resources and the progress toward completing the iteration successfully will all be reassessed by the team with each sprint.

Once the team has a well-established backlog, after a few sprints the team will reach a steady cadence that will keep the agile process moving smoothly toward completing iteration plan milestones and the overall project.

It's Tuesday morning and the team has gathered in their project room ready for action.

AGILE ACTIVITIES

When the team meets, Jordan explains the goal for the meeting — to identify and clarify the work items to be placed into the backlog, organize them and appropriately prioritize each item.

Looking at their product attributes, project plan outline, Iteration Plan and risks from the previous on-ramp steps two and three, the team describes the major project elements that need to be done in simple, concise terms and adds these work items to their backlog. Initially they use Excel to quickly capture and organize the backlog but agree they will use Jira, an agile management tool, to capture the backlog, manage sprints and track progress (more on this in Step 5.) When the team is satisfied that work items are captured, they add a prioritization of 1 to 3 (1 being high) for each item. Jordan will transfer the backlog to Jira before planning their first sprint and diving into task details.

At this point, the team also had to consider how to quickly get feedback on the preliminary concepts. They knew they needed access to customers, but how? Linda, the product manager, agreed to develop a customer engagement plan as part of the first sprint.

STEP 4: OUTCOMES

The exhibit on the following page shows the initial high-level backlog in a simple spreadsheet format. Prioritizing the major tasks was not easy! There was great debate on whether it was important to focus on things like cost estimates early when they had no idea what the product would be or if they should think about mobile phone app as a priority 1 item or wait until they had the functionality further defined, etc. etc.

To make these decisions, it was critical that they used the Iteration Plan from the previous step to guide prioritization. They agreed that they had to get the concept right first! This meant early iterations (and sprints) must focus on the overall physical design, but they couldn't ignore the app or voice control since it would be critical to the overall customer experience. Many items would need to be considered in parallel.

Exhibit 1: Project Backlog

Jordan led the team to organize work items based on their effort in the previous steps. The team realizes this is high-level at this point and each cross-functional team will be responsible for breaking down large work items, such as "Define Product Architecture" into tasks that can be accomplished in two-week sprints.

NEXT STEP

The team will meet again in two days to plan the first sprint. They will begin by estimating the priority 1 tasks. Every work item in the backlog must eventually be estimated in terms of effort, with only the near-term work estimated with granularity and accuracy. The estimate for the entire project will become more accurate when the backlog no longer changes significantly.

Exhibit 1: Project Backlog

Identifying the work items to be refined into sprint tasks

Priority	Task Description
Mechanical Design	
1	Create conceptual drawings
1	Define product architecture
1	Develop initial production cost estimates
1	Decide about grinding mechanism
2	Innovative filter design
2	Determine color options
2	Determine carafe and housing materials
2	Determine water reservoir size
3	Prototype tooling
3	Production tooling
Interface, Electronics, Smart Features, Software	
1	Define interfaces - voice, physical and app
1	Research voice controlled interface
1	Learn about need for physical interface - Decide
1	App for coffee maker control - iOS/Android
2	Physical interface electronics
Other Elements	
1	Develop prototype brochure for feedback
1	Determine first release MVP
1	Get full resource commitments
1	Get customer input about voice control
1	Customer engagement plan
1	Define roles and responsibilities
2	Change management plan
2	Patents filing
2	Compliance testing
2	Refine initial production cost estimates
2	External resource plan
2	Capital expense approval
2	Verification and validation plan
2	Wireframe 3D video
3	Retail package design
3	User documentation and disclaimers
3	Communication plan
3	QA Plan
3	Release/launch plan

EXHIBIT 1

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 5 of a 9-part series to walk through an agile development project from concept to launch

Step 5:

Planning Your First Sprint



By Dorian Simpson and Gary Hinkle

Step 5: Planning Your First Sprint

THE SITUATION

In the previous step, Jordan, the Agile Project Manager (APM), led the team to develop their initial backlog – the prioritized list of high-level work to be done. The team categorized the work very roughly and identified major buckets such as mechanical design work, electronics/software/interfaces, and other elements as temporary placeholders to organize tasks. Jordan captured the work items during their meeting using Excel.

In this step 5, the team will further refine their backlog and identify the tasks that team members will **commit to in their first sprint**. The team agreed that each sprint duration will be two weeks, starting on Monday and ending 10 business days later on Friday. The high-level work buckets identified in step 4 will now need to be broken down to tasks each team member can be fully execute during the sprint., especially those tasks where the team needs to make immediate progress.

It's Thursday morning and the team has gathered in their project room ready for action.

AGILE ACTIVITIES

Before the sprint planning session, Jordan made sure that every team member had access to the project backlog so that each development lead could work through the major tasks and break down the priority 1 items into smaller work items. This effort won't be done until the team meets since only the task owner can actually commit to completing it.

Jordan is now displaying the project backlog so that all team members can participate in planning their sprint. As the meeting gets started, Jordan explains that the meeting has three goals:

1. All team members will have enough work defined for the sprint, with clear ownership and commitment to get it all done in the two-week period.
2. Agree on acceptance criteria for every task in the sprint so it's clear how the tasks will be defined as completed.
3. Some tasks for the next sprint will be defined so that team members can get more done if they finish early, or if they get stuck they can keep progress going on other priorities.

After tasks are broken down as needed, task owners are identified. The team estimates these tasks together when possible or lets the subject matter expert estimate the task. E.g. only the electrical engineers could really estimate how long it would take to define the circuitry needed for the physical interface. Once the task is defined, they then agree on acceptance criteria.

One major area of discussion is whether to use person-hours for task estimates, or “points” – a relative scale commonly used by agile teams. They decide to use hours because it seemed difficult to determine what a "point" meant for the wide range of tasks from concept design to app development.

Jordan knows that it's good practice to have the next two sprints also broken down to task level so that if team members are unable to complete tasks planned for the current sprint (if they are blocked by external dependency or other factor), they have other high-priority tasks that can be completed. This also gives team members who finish all their tasks in the sprint clear direction for additional work that can be completed. Another reason is that it makes the each sprint planning meeting faster by always looking a couple sprints ahead.

They agree that every *planned* work item in the backlog must eventually be estimated roughly in terms of effort, but only the near-term work would be estimated with granularity and accuracy. The estimate for the entire project will become more accurate when the product is fully defined and no major changes are planned. Of course there will be many items in the backlog that will never get done for this project since all feature requests and ideas go into the backlog as a low priority.

For now, the team only estimates tasks for the first sprint (plus a few for the next sprint) so they can start delivering value right away. They are ready to get going!

STEP 5: CONFLICT AND RESOLUTION

In the first four steps (a real time effort of just several weeks) the team was in early planning mode. As in most companies, once a project has been approved, there is not a lot of team conflict since the tough decisions don't need to be made for quite awhile. In traditional projects, this may be months away since the product manager will define the product, write a product requirements document, pass it over to the development team for review and everyone ramps up slowly to meet the requirements. This is sometimes referred to as the project honeymoon period.

With agile, this honeymoon period is much shorter, but with good communication and rapid learning, should provide a much better environment for long-term success. Even now, as the team transitions into project execution with the first sprint, a great deal of debate has started on the major coffee maker features. Should the new maker have voice control? Does it need a physical interface? How will a hardware company manage consumer apps? All good questions that must be answered quickly and accurately. Does this team have the agile skills for success?

STEP 5: OUTCOMES

The exhibit on the following page shows the team's early backlog using a simple spreadsheet format.

Exhibit 1: Backlog and Sprint Plan in Table Format

While the JavaBrew team will eventually use an agile project management tool such as Atlassian's Jira, Excel spreadsheets are fine to get started. The table format shown illustrates that special tools are not needed to manage agile backlog and sprints. Many teams use readily available tools for agile planning, management and communication such as Excel, whiteboards, sticky notes, etc. The number on the right of each task is the estimate in hours. Large tasks requiring more than one sprint of effort, often considered epics (such as the task "Create conceptual drawings"), is broken down into smaller tasks. The tasks highlighted in green are committed for the first sprint and given acceptance criteria. Those not highlighted are planned for later sprints.

As progress is made, task owners will advance their tasks to the appropriate status. For every task completed the team will get credit for completing the hours estimated. However, tasks that don't get completed do not get partial completion – they carry over to the next sprint. This provides motivation to complete a task (as determined by the acceptance criteria) and drive commitment. E.g. completing 90% of a task is very different than completing a task!

This concept is important for determining the team's velocity, which will be established after completing several sprints. Their velocity will be 383 person hours per sprint solely based on the estimate for this sprint, but that will change as they learn what they can actually complete, and as team members move in and out of the project. When their average velocity is established and all planned work is roughly estimated, they'll know if they are on track to complete iterations and the entire project on schedule.

NEXT STEP

The team will meet again in two weeks to conduct a review of sprint one and to plan for their next sprint. With each sprint, they will also evaluate their progress and determine if they are on track to achieve their iteration goals as well as their overall project objectives. Join us for Step 6 and let's see how they are doing. Will the JavaBrew team embrace agile methods and learn to manage a complex project without the perceived certainty of a detailed schedule or will they quickly fall back to their previous project management practices?

Exhibit 1: First Sprint Tasks

Using a simple tool to manage a backlog and sprints.

Each team member had 80 hours of capacity for the sprint. Any task requiring more than 80 hours needed to be broken into sub-tasks to ensure they would fit within a sprint.

Pty.	Task Description	Est. (Hrs)	Owner	Acceptance
Mechanical Design				
1	Create conceptual drawings	80	Frank	
1	1 Develop 3 unique designs	40	Frank	Team review
1	1 Finish conceptual drawings	40	Frank	
1	Innovative filter design	48	Chenghao	Report
1	Investigate options for materials	32	Chenghao	Report
1	Refine initial production cost estimates	8	Jordan	Team review
1	High level block diagram	16	Jason	Design review
1	Decide about grinding mechanism	8	Frank	
1	Define product architecture	300	Jason	
2	Determine water reservoir size	16	Chenghao	
2	Prototype tooling	200	Frank	
2	Finalize carafe and housing materials	70	Chenghao	
3	Determine color options	8	Lynda	
3	Production tooling	400	Frank	
3	Other design tasks	TBD	TBD	
Interface, Electronics, Smart Features, Software				
1	Define SW interfaces – embedded & app	36	Jason	Design review
1	Electrical interface initial plan	28	David	Design review
2	Research voice controlled interface	16	Jason	Report
2	Research iOS & Android control methods	12	Jason	Report
2	Control and power electronics	80	David	
2	Physical interface electronics (if needed)	TBD	David	
2	Physical interface firmware (if needed)	TBD	Jason	
3	Develop control apps (iOS and Android)	320	Alec	
Other Elements				
1	Develop prototype brochure for feedback	20	Lynda	Team review
1	Get full resource commitments	6	Jordan	Updated plan
1	Customer engagement plan	60	Lynda	Team review
1	Setup configuration/change management	8	Jordan	Admin review
1	Define roles and responsibilities	4	Jordan	Team review
1	External resource plan	8	Jordan	Management Review
1	Add risk mitigation tasks to Jira	1	Jordan	Team review
1	Get customer input about voice control	20	Lynda	
1	Get input about need for physical interface	20	Lynda	
2	Complete 3D video	80	Frank	
2	Setup bug/defect tracking	8	Jim	
2	Determine first release MVP	24	Lynda	
2	Capital expense approval	24	Jordan	
2	Patents filing	40	Jason	
3	Retail package design	120	Frank	
3	QA plan	80	Jim	
3	User documentation & disclaimers	160	TBD	
3	Compliance testing	80	Jim	
3	Final product verification & validation	TBD	Jordan	
3	Manufacturing ramp-up plan	80	Jim	
3	Release/launch plan	120	Lynda	
3	Compliance testing	80	Jim/Ops	
3	Manufacturing ramp-up plan	80	Jim/Ops	
3	Release/launch plan	120	Lynda	

EXHIBIT 1

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 6 of a 9-part series to walk through an agile development project from concept to launch

Step 6:
Sprint One
Complete



By Dorian Simpson and Gary Hinkle

Step 6: JavaBrew (Almost) Completes Their 1st Sprint

STEP 6: THE SITUATION

Through the first five steps, the JavaBrew agile team completed the MAHD On-ramp for their new advanced Smart Coffee Maker. They established clear project objectives, wrote user stories, developed an iteration plan with project milestones, identified a rapid prototype plan and prepared the project backlog. In the previous step (Step 5), they planned for their first sprint. It is now two weeks later, and the team has been working on their committed tasks. As this was their first sprint (ever) for an agile project, they naturally ran into problems. While the team successfully completed a little over 50% of their tasks, some of the more critical items were left unfinished. Two notable incomplete tasks include:

1. Lynda committed to developing a customer engagement plan. She got started but found that finding 30 end-consumers to be part of their feedback panel was harder than she thought and would take at least another three to four weeks.
2. Frank committed to having three unique concept designs ready for internal review. He's made good progress, but the designs would need at least another week to complete.

For the first sprint, many of the tasks were related to investigations to define the product, identify committed resources and prepare for success. Frank blamed his delay on another high priority project, while Lynda just didn't have time to work through the details of how they would get access to potential target customers. Now the whole team is behind and it's only the first sprint! Can they get back on track to complete a successful iteration?

It's Friday afternoon and the team gathers in their project room for their sprint review. Jordan, the Agile Project Manager will facilitate the meeting and lead the retrospective discussion. After the current sprint review, they will go right into sprint planning for their second sprint.

STEP 6: AGILE ACTIVITIES

Jordan displays the team's sprint tasks and status on the screen as the team files in. As eyes scan the results, there is jovial banter as each person ponders what the big "50% complete" on the bottom of the slide really means.

Before diving in, Jordan explains that the sprint review and retrospective meeting has three goals:

1. All team members will share their outcomes from their tasks including what was completed, any roadblocks and next steps.
2. They will review overall project status and determine if they risk missing the iteration goals.
3. They will share what worked and what didn't from a team perspective and brainstorm ways to improve.

The Current Sprint Review:

David, the electronics lead went first. He shared his interface plan with a diagram and document. He received acceptance from his peers but noted that it could not be complete without having a final product definition. All good. Next, Lynda shared her progress. She was able to complete the prototype brochure to get early feedback on the concept by working closely with Frank (their lead designer.) Working on the brochure was valuable but became the primary reason that Frank fell behind on his tasks. However, Lynda could not get any feedback on the concept except from the internal team since she was unable to identify and contact customers. She had asked sales to give her contacts at their retailers but was not given a response. For now, everyone accepts her status.

This continued with each team member sharing their successes and failures.

The Retrospective:

After the sprint review, Jordan lead a discussion on what went well in their first sprint and what might be improved. They went around the room and each person provided one item that went well and one idea for improvement. They could add a fresh idea or build on a previous one. The main themes discussed were commitment and estimation. All agreed these two themes were highly related. Both Lynda and Frank agreed that they had overestimated what they could accomplish in the first sprint. With no clear solution, all decided to think more deeply about their tasks, try harder to estimate accurately and commit to completing the task even if it meant extra hours.

Sprint Two Planning:

After reviewing the backlog and iteration plan again the team dove into planning for the next sprint. To refresh the team, Jordan shared Iteration 1 goals:

Prototype	Key Questions	Milestones
Preliminary Brochure	<ul style="list-style-type: none"> • Is the value proposition right? • Which features drive value? • Is a physical interface needed? 	<ul style="list-style-type: none"> • Concept approved • Plan approved (including resources)

They had planned three sprints to achieve these goals, but with only one sprint allocated to finish the iteration they had concerns. If Lynda fails again they will surely continue to fall behind. Lynda quickly agrees to call a review with the right people to figure out how to develop the customer panel and remove the roadblock.

STEP 6: CONFLICT AND RESOLUTION

In the first five early planning steps the team worked through the MAHD On-ramp. Life was fine since they could work at a high level and defer details. This quick start is a key advantage of agile, but as the team got started, they realized they must manage this uncertainty. Big questions still loomed. Management wanted a schedule and committed delivery date... complete with a full product definition. Several senior managers (whose names would not be disclosed) felt that the product must include voice control to take advantage of a big trend. In fact, they had already started talking with partners and retailers, nearly promising them that these features would be available. But the team, including Lynda, was not convinced voice control was needed or be desirable with customers and would just add cost, time and complexity to the new coffee maker.

To manage this conflict, the team focused on their priorities. They needed to validate with real customers whether the product should have a physical interface and/or include voice control. To answer these questions to the satisfaction of management, they needed to scope out the technology as well as get validation with real customers. But how could they do this without having a fully working prototype?

To remove this roadblock, Lynda immediately set up the meeting as she promised in the sprint review. After intense discussion, the team agreed on three things:

1. They would extend Iteration 1 another two sprints to meet the goals. This didn't affect the overall schedule since they could continue working on important tasks, but allowed them more time to get more clarity with customers to satisfy management needs.
2. Management agreed not to talk about voice control until the team had a chance to validate the technology and get feedback from customers.
3. To remove Lynda's roadblock of finding customers, they agreed to create a panel of customers using social media. They would have customers opt-in to be part of their project feedback loop and asked each participating customer to sign a non-disclosure agreement (NDA).

STEP 6: OUTCOMES

The outcomes from step 6 were as follows:

Exhibit 1: An Updated Iteration Plan

They team agreed to extend Iteration 1 by three sprints and shorten Iteration 2 from five sprints to three sprints as shown in Exhibit 1 below. So far, the overall plan did not change, but milestones and priorities did.

Outcome 2: Team Learning and Refinement

They team learned a lot in their first sprint. They committed to work on estimation accuracy and completing assigned tasks.

Outcome 3: Updated Agile Artifacts

They team continued to add to the backlog, estimate longer-term major tasks and breakdown the major tasks into sprint-by-sprint execution tasks. This will never end until the project is

NEXT STEPS

The team will continue to complete sprints every two weeks. After each sprint they will update the backlog and review their progress against the overall plan with an intense focus on hitting the current iteration's milestones. In Step 7, we'll see how they are doing after their first iteration. This will be an important time for the team to determine if they are finding agile useful, have learned how to manage the uncertainty of projects without formal project plans and to evaluate how they are doing versus their overall project goals.

Exhibit 1: Updated Iteration Plan

The plan JavaBrew developed is close to the original plan highlighted in Step 3, but Iterations 1 and 2 now allow more time to set up their customer panel and get feedback on the product definition.

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Iteration 6
Major Deliverables	<ul style="list-style-type: none"> Preliminary concepts Preliminary features scoped Establish customer panel 	<ul style="list-style-type: none"> Cost estimates, initial industrial design, electronics design Smart features defined – app/voice 	<ul style="list-style-type: none"> Coffee making mechanism design Integrated device with smart control for testing 	<ul style="list-style-type: none"> Integrated device with ~80% target feature set Smart app 90% complete 	<ul style="list-style-type: none"> Mechanical and electronics designs complete Packaging design complete BOM complete 	<ul style="list-style-type: none"> Production drawings, user guide, website, materials, packaging Forecasts, marketing plan
Prototypes	Preliminary brochure	3D video highlighting smart features and ease of use	Rough working prototype – smart features + physical design	Fully working prototype	Production-ready prototype	Production starts
Key Questions	<ul style="list-style-type: none"> Is value proposition right? Which features drive value? Physical interface needed? Value of Voice Control 	<ul style="list-style-type: none"> Value of voice control? App features? Can cost meet targets? 	<ul style="list-style-type: none"> Do customers love it? Any design show-stoppers? Can we hit the market window? 	<ul style="list-style-type: none"> Can we really lock down features? Are retailers on board? Can we create demand? 	<ul style="list-style-type: none"> Is it ready for production? Is the quality “good enough?” Are costs under control? 	<ul style="list-style-type: none"> Are retailers ready to take orders? Can we hit the forecast? Is sales engaged?
Milestones/ Approvals?	Concept and plan approved	Cost estimates approved	Major feature lock-down	Design/feature lockdown, prototype tooling approved/ordered early in iteration	BOM complete, launch plan, final tooling, compliance & certifications	Pricing, sales and channel ready
Risk Mitigation	<ul style="list-style-type: none"> Team momentum – need committed resources. Early customer engagement. 	<ul style="list-style-type: none"> Schedule risk – team velocity on target? FCC compliance. 	Design approvals	<ul style="list-style-type: none"> Prototype tooling approvals. Final feature set approval. 	Production tooling approvals.	<ul style="list-style-type: none"> Sales and marketing risks. Engage with channel partners.
Target Date	4/12/19	5/24/19	8/2/19	12/6/19	4/10/20	7/3/20
# of Sprints	5	3	5	9	9	6 (2 sprint buffer for 7/31 launch)

EXHIBIT 1

Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 7 of a 9-part series to walk through an agile development project from concept to launch

Step 7:
**Iteration One
Complete**



By Dorian Simpson and Gary Hinkle

Step 7: JavaBrew Completes Their First Iteration

THE SITUATION

It's been ten weeks since the JavaBrew agile team started development on their new smart coffee maker and they are now competing sprint five. This also marks the completion of their first iteration — a major milestone. As you may recall, the MAHD Framework uses two levels of rapid iterations. The first level consists of short, task-based sprints, while the second, higher-level iterations focus on key project milestones, prototypes, questions and dependencies. Through each of the five previous sprints they followed the agile framework as closely as possible to pull tasks from the backlog, plan two-week sprints, validate deliverables and track progress. A lot has happened in the last 10 weeks! As the team focused on completing backlog tasks, they also had to adapt to management requests, get comfortable with uncertainty and adopt a new "agile" way of approaching projects.

It's now time to review their situation and determine if they achieved their planned Iteration 1 goals as shown here:

Prototype	Key Questions	Milestones
Preliminary Brochure	<ul style="list-style-type: none"> • Is the value proposition right? • Which features drive value? • Is a physical interface needed? 	<ul style="list-style-type: none"> • Concept approved • Plan approved (including resources)

One of the major outcomes of their first sprint, as discussed in Step 6, was the need to engage with customers to hit these goals. Lynda, the Product Manager, struggled at first to identify these customers. To resolve this in Sprint 2, the whole team agreed to contribute in an unconventional way using social networking. Through their current Facebook page followers, the team identified 30 customers that match their target market who agreed to be part of JavaBrew's feedback panel. Each participant agreed to sign a non-disclosure agreement and provide candid feedback.

This customer engagement strategy worked well. In subsequent sprints, the team was able to conduct several activities to gain insight and prioritize features by using early drawings, product descriptions and customer feature voting techniques.

They learned several important things during the first iteration:

- **Coffee selection was more important than strength flexibility.** Consistency and quality were very important, but customers wanted a choice in beans when making coffee. They decided that multiple chambers for beans is desired so that users can load them with 1, 2 or 3 types of coffee. Of course, this would add complexity to the design!
- **"Smart" was generally confusing to customers.** They didn't immediately see the value of this concept since traditional coffee makers are so simple. Add beans and water. Press start.

Wait. Pour. Drink. Once they understood how a connected app might work to enable new use cases to start coffee from anywhere, see progress, set timed coffee-making, etc. they loved it. However, they wanted it to *be* smart, but not *look* smart. They want an attractive design that didn't look "geeky." It was also clear that "voice control" was not desired or necessary. It was cool, but "just added complexity if it didn't work perfectly." But would JavaBrew's management agree?

It's Friday afternoon and the team has gathered in their project room ready for their sprint and iteration review. Jordan, the Agile Project Manager will facilitate the review and lead the retrospective discussion. After this meeting, they will first review their overall iteration plan then dive right into sprint planning for the next sprint.

AGILE ACTIVITIES

For Step 7, the team must engage in two separate reviews. Jordan explains the goals:

1. Review iteration 1 goals and progress against each one.
2. Review the overall iteration plan for the project and clarify goals for iteration 2.
3. Plan for the next sprint.

To kick off the discussion, Jordan first shares the overall project goals as shown in Figure 1 that was developed during the project kickoff in Step 1.

Iteration Review and Planning:

They then review the status and next steps for each iteration milestone and key question:

1. **Preliminary Brochure?**
Successfully completed and used to gain valuable customer feedback.
2. **Is the value proposition right?** Yes! While many details remain, customers love the overall "smart" concept (once they understood the value) and they are moving in the right direction.
3. **Which features drive value?**
This is mostly understood but they still need to prioritize key features such as the importance of "multiple bean options." The good news is that they believe voice control can be removed.

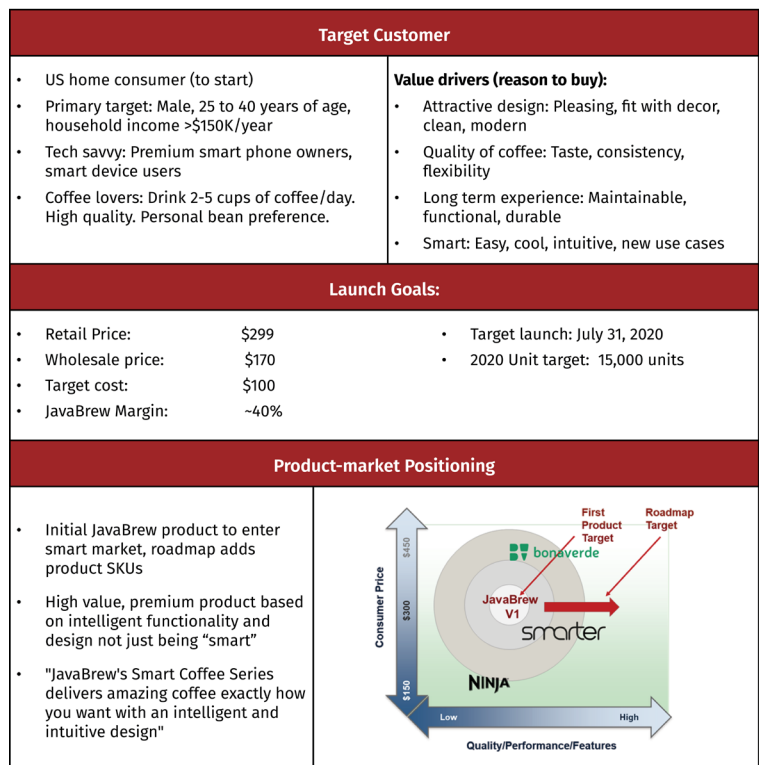


Figure 1: Project Goals from Step 1

4. **Is a physical interface needed?** Customers don't need this if it's "smart."
5. **Concept approved?** Not yet. They have a good working concept, but questions remain.
6. **Plan approved (including resources)?** Almost. They need to review the overall concept and P&L with management, but they believe this will be no problem.

Iteration 2 Planning:

The kickoff for planning their next iteration started with Frank, JavaBrew's head of Design and Mechanical Engineering. He has analyzed the manufacturing cost with the finance team as the product is now defined and is very concerned. The team doesn't see how they'll be close enough to the target cost to get management approval. If they add the desired "multiple bean options" feature that customers want, they realize they need design innovation to reduce cost while maintaining design for manufacturability. Iteration 2 must tackle this! They absolutely must eliminate the physical interface to meet the target cost. Customers were OK with this, but so far, management is uncomfortable with this path. The team spends a few minutes brainstorming solutions, they decide to move forward with the concept with no physical customer interface and verify with their customer panel by getting feedback from their 3D animation and their smart app prototype. They realize there is risk if customers don't agree and management pushes back, but so far it seems in the right direction.

They continue to review their overall milestones, prototype plan, major questions and dependencies. They agree to keep the current iterations but refine the milestones.

Next Sprint Planning:

Once the team agrees on the update to the overall Iteration Plan and Iteration 2 goals, the team begins their normal planning for the upcoming sprint. They continue to review the top items in the backlog, estimate tasks and commit to the sprint.

CONFLICT AND RESOLUTION

In the process of getting the manufacturing cost approved, Jim, JavaBrew's VP of Engineering, doesn't like that the physical interface has been removed and isn't even convinced the "multiple bean option" should be added. He asks a good question, "Can't the multiple bean feature be included in a higher-end next-generation product?" While Jim hasn't been a part of the project's day-to-day agile team discussions, he's aware of the customer feedback so far but refuses to approve moving forward with that concept. For the physical interface, the team tries to explain that they have input from enough users who don't need it, but he isn't satisfied. He directs the team to move forward with two concepts to test – one with and one without the interface. Jordan points out that this is extra work that will set them back further. Jim argues that it will accelerate learning and shouldn't be a big deal from a design perspective.

With this official direction, the team is concerned, but soon realizes that making a 3D animated video showing both versions won't be much additional work, and they easily come up with a slick way to get input on the multiple design concepts. The video will also demonstrate the prototype smart phone app, which they think is simple and looks clean – exactly their goal. They also agree to further understand the importance of a multiple bean feature. Jim may be right and it could be removed and added to the next generation product.

OUTCOMES

The outcomes from step 7 were as follows:

Outcome 1: An Updated Iteration Two

They team updated their overall Iteration Plan with a revised Iteration 2 as shown in Exhibit 1.

Outcome 2: A Learning Directive

It wasn't only Jim that had questions about the physical interface and multiple bean feature. If the team was to have a solid product that had the acceptance of all stakeholders — customers, retailers and management — they knew they needed ongoing customer feedback as they refined the product. These were big decisions that needed to be made quickly.

NEXT STEPS

After having a full iteration behind them, the JavaBrew team will continue to complete sprints every two weeks, revise the Iteration Plan as needed and keep resolving conflicts as they arise. In Step 8, we'll jump forward several iterations until the team is almost ready to start production and enter the market. Were they be able to stay on schedule? Who won the war of the physical interface and how many other compromises did they need to make to hit their target date?

AUTHORS' NOTE

If you've come this far on our step-by-step journey, you may be wondering, "How exactly is JavaBrew's agile approach really different from traditional project management?" While we have attempted to clarify this throughout our steps, it may not be obvious if you haven't seen a project unfold in real-time. The following table highlights several key project success attributes and how agile differs. The bottom line is that agile projects start faster, learn faster and adjust faster to new information.

	Traditional Project	Agile Project
Time Frame - Start	2-4 months to start	2-3 weeks to start
Project Refinement	6-9 months before big questions arise and refined after major crisis points	4-6 weeks before big questions arise and continuously refined
Functional Collaboration	Eventually	From Day 1
Customer Engagement and Learning	After 80% of project complete (too late to take seriously)	Built in to the process (used to redirect quickly)
Executive Engagement	Before project begins and after big problems identified late in the schedule	Throughout
Schedule	Gantt Chart: Months to develop (it's wrong - PM updated)	Iteration Plan: Hours to develop (it's a target - team updated)
Project Tracking	Weekly PM Update "On schedule!" (Until it's obvious you're not)	Sprint Update "Our % of completion" (Updated as project evolves)

Exhibit 1: Updated Iteration Plan

Iteration 2 Plan: Updated to show a renewed focus on answering critical product questions.

	Currently Planned Iteration 2	Updated Iteration 2
Major Deliverables	<ul style="list-style-type: none"> • Cost estimates, initial industrial design, electronics design • Smart features defined – app/voice 	<ul style="list-style-type: none"> • Cost estimates • Initial industrial design options (with and w/o physical interface) • Preliminary electronics design • Smart features defined – app
Prototypes	<ul style="list-style-type: none"> • 3D video highlighting smart features and ease of use 	<ul style="list-style-type: none"> • 3D video highlighting smart features, physical interface options, multiple bean option and ease of use
Key Questions	<ul style="list-style-type: none"> • Value of voice control? • App features? • Can cost meet targets? 	<ul style="list-style-type: none"> • App features? • Can cost meet targets? (with multiple bean option) • Is physical interface needed? • Is multiple bean option needed?
Milestones/ Approvals?	<ul style="list-style-type: none"> • Cost estimates approved 	<ul style="list-style-type: none"> • Cost estimates approved • Value proposition approved • Product definition approved
Risk Mitigation	<ul style="list-style-type: none"> • Schedule risk – team velocity on target? • FCC compliance 	<ul style="list-style-type: none"> • Schedule risk – team velocity on target? • FCC compliance
Target Date	5/24/19	5/24/19
# of Sprints	3	3

EXHIBIT 1

Step-by-Step

MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 8 of a 9-part series to walk through an agile development project from concept to launch

Step 8:

Iteration 5 Complete: Launch Readiness



By Dorian Simpson and Gary Hinkle

Step 8: JavaBrew Prepares for the Product Launch

THE SITUATION

In our last step (Step 7), the JavaBrew team just completed their first iteration that focused on defining their new smart coffee maker, refining their value proposition and getting organized. During the team's MAHD On-ramp planning they originally planned for a total of six iterations (and many associated sprints) to complete the project. Overall, the team has been able to keep to this iteration plan but made a lot of adjustments along the way (as to be expected with agile). This step jumps forward ten months to the end of Iteration 5 where they will need to make several tough decisions concerning the product's readiness for production and market launch.

It's now time to review their situation as well as prepare for Iteration 6. This final project iteration will focus on executing their product launch. To recap what has happened up to this point:

1. After Iteration 1, the team knew they were on the right track with their smart coffee maker but had some big questions concerning the overall project schedule, management acceptance of the project and which features would drive customer demand.
2. Through each subsequent iteration the team developed incremental prototypes including a preliminary brochure, a 3D animation, rough product mockup and several functional prototypes at different levels of functionality (along with their mobile phone app) to gauge customer and retailer interest. They used a customer panel of 30 consumers and 4 targeted retailers to gain feedback from each prototype.
3. It is the customer feedback based on the last prototype that concerns the team now. Is the product really ready for launch or must they delay the launch in order to fix a big problem?

It's Friday afternoon and the team has gathered in the project room ready for their iteration review. Jordan, the Agile Project Manager will facilitate the review and lead the discussion.

AGILE ACTIVITIES

In this step, the team will plan two levels of reviews as is typical at the end of a MAHD Iteration. The first review will focus at the higher iteration level to review the status and results of the overall project and Iteration Plan, and the second review will define specific tasks for the next sprint. Since the looming question is, "Are we ready to begin executing a product launch?", let's focus on this challenge.

To begin the meeting Lynda (the Product Manager for their new coffee maker) shared the overall project goals along with the most important user stories. As with every iteration review, they discussed the status against these goals as shown in the following two tables.

Project Goals Vs. Status

Value Drivers	Status	Next Steps
Attractive Design: Pleasing, fit with decor, clean, modern.	On target.	Finalize packaging to match.
Quality of Coffee: Taste, consistency, flexibility.	* Bean option feature problem.	Fix and test.
Long Term Experience: Maintainable, functional, durable.	* Bean option feature problem.	Fix and test.
Smart: Easy, cool, intuitive, new use cases.	On target.	Refine and test.

(*) The gating issue preventing a successful launch

Top User Stories Vs. Status

User Stories		Status	Next Steps
As a consumer, I want... So that...	So that...		
... to automatically add coffee and water as needed	... I don't have to fuss with these when I want coffee	Met. Customers are OK with manually loading water.	Next generation add water source connection.
... set the maker from anywhere in my home	... I can make coffee while working, watching TV or anything else	Met. Customers love the app, but some work left to make it simpler.	Prioritize the use cases and update. Test on all phones.
... to control the timing	... I can have coffee exactly when I want	Met.	None
... to select the type of coffee based on the app user's profile *	... each person in the home can have their preference	App implemented. Fix bean contamination problem.	Redesign and test.
... the appliance to be reliable	... I don't spend time "debugging" my coffee maker	OK. But won't know until bean selection fixed.	Continue testing
... an attractive appliance	... it looks good on my counter and I can be proud of my investment	Met. Customers love the design.	None
... to enjoy hot, fresh coffee the way I like it *	... I can always enjoy coffee without compromise	This is a problem! Grinder not clearing out previous selection.	Redesign and test.

(*) These were added and prioritized after various prototype and customer feedback cycles. Note that some "high importance" user stories were also lowered in priority after feedback such as "... to avoid using filters."

Jordan also shared Iteration 5 goals and status as shown here:

Prototype	Key Questions	Milestones
Product Ready Prototype	<ul style="list-style-type: none"> • Is it ready for production? • Is the quality “good enough?” • Are cost targets met? 	<ul style="list-style-type: none"> • BOM complete • Launch plan complete • Final tooling • Compliance testing plan • Certifications submitted

A Brief History of Decisions

To clarify the current problem, Lynda walked through a bit of history. Based on their prototypes and customer feedback, including a 3D animation based on the graphic of the coffee-maker as shown in Exhibit 1, they made several important decisions throughout the preceding iterations:

1. They confirmed that customers were fine with the absence of a physical interface so the decision was made to remove it. This feature was seriously debated inside JavaBrew, but both customers and retailers loved the sleek design that included only an on/off switch. The team and executives were convinced there was no need for an expensive LED display or complex array of controls.
2. While customers thought the *idea* of voice control was cool, they did not think it was important and would even add unnecessary complexity. The decision was made to kill it.
3. Customers loved the “smart” features and app. However, the coffee machine needed to do more than just make coffee, provide status, set timing, etc. At the top of their list was the desire to choose from a variety of beans. For example, one might want a dark roast in the morning and a Mexican coffee after lunch. And often the consumer’s spouse preferred a different flavor or type of bean.

To satisfy this last customer need, the team decided to include the feature to support multiple types of beans. As discussed in earlier steps, JavaBrew hoped they could defer this feature to a new, higher-end model, but the feedback was clear — this new feature added significant value both to the smart functionality as well as the overall device and customers were OK with a higher price.

However! Now the team faced a huge problem. JavaBrew had not built a machine like this before and were having mechanical problems. As their new maker switched beans, it would leave a residue of the previous bean selection and disrupt the flavor of the new coffee. This was especially a problem if the user only wanted to make a small quantity since the newly made coffee would consist of up to 20% of the old bean. If they released the product with this known problem, it would likely lead to low customer ratings, high product returns and a failed product. But if they take the time to fix it, they will assuredly miss the holiday selling season! *So now what?*

Taking a short aside on how agile methods can deliver better results, the good news is the team was very confident that they had the right product for their market. Early in the development process they were able to strip features that weren’t important, such as the water connection and permanent coffee filter, and add the features most important for success. This provided necessary focus that was often lacking in their previous projects. Also, in the previous iteration,

Frank, their head of mechanical design also identified the new multiple-bean design as a major risk. In anticipation of the problem, he had already lined up an external design firm that had the resources and know-how to help. They could work fast, but it wouldn't be cheap.

To move ahead, the team agreed to develop a quick cost/benefit analysis for the available options so management could make a quick financial decision. The first option was to get design and test from outside. If all went well, this would allow the team to meet their schedule and hit the holiday selling season. A second option would be to fix the problem internally. The mechanical and design group estimated this would add at least a full iteration (about 6 weeks) to the schedule. The team believed the best decision would be to add resources, but of course, their CEO needed to approve the funds.

In addition to preparing for this important decision, the team continued planning for Iteration 6 and the next sprint.

Iteration 6 Planning:

After reviewing the backlog and iteration plan again the team dove into planning for their final iteration as shown in the following table. They knew that if their CEO did not approve funds to get help with the mechanical design, this plan would need to be modified. They would do this in the next sprint planning session.

To refresh the team, Jordan shared Iteration 6 goals:

Prototype	Key Questions	Milestones
Production Units – continue beta testing	<ul style="list-style-type: none">• Are retailers ready to take orders?• Can we hit the forecast?• Is the sales team ready and engaged?	<ul style="list-style-type: none">• Pricing/forecast established• Production ready• Marketing calendar• Sales and channel ready

Iteration 6 is planned to take six sprints. If they can resolve the mechanical issue, finalize the design and order parts by the end of the 2nd sprint, they can hit this schedule. This is a big risk, but with renewed focus, the team is confident this can be achieved.

STEP 8: CONFLICT AND RESOLUTION

During this iteration, with the exception of the multiple-bean contamination problem discussed earlier, there was actually minimal conflict since all the major decisions had been made throughout the agile process. While Jim, JavaBrew's VP of Engineering, is still skeptical that customers will be happy without a physical interface ("What will customers do if they don't have their phone available or WiFi is not working?", he often stated), he is willing to accept the consumer and retailer feedback.

The added multiple bean feature may have easily created serious upheaval in the team. Many people in the company believed this was an unnecessary extravagance and would put the schedule and target cost at serious risk. Some of them even feel their concerns have been validated with the contamination problem that was found so late in development. But they made this decision early in Iteration 3 based on clear customer feedback and executives felt it was the right decision. Luckily, the risk was also assessed early and Frank was instrumental in identifying a solution to the mechanical design problem.

However, the big question still loomed, "Can we fix the bean contamination problem and still keep to the schedule?"

STEP 8: OUTCOMES

The iteration planning results from step 8 were similar to the outcomes of every iteration – the backlog was updated, the Iteration Plan was revised and decisions were made. We will not share all the details since by now you can likely imagine how tasks were selected from the backlog to plan their next sprint and other agile artifacts were updated.

We will, however, share the result of the management discussion for how the team would resolve the contamination problem.

The Schedule/Feature/Cost Tradeoff Decision

Lynda and Jordon took the action to prepare the cost/benefit analysis for each option and present them to their senior team. Several other key players, including Jim and Frank, joined them for discussion. They first prepared for the meeting by asking JavaBrew's CFO and CEO what was most important to them when making this decision based on the company's strategy and situation. The response was "we need to hit the holiday selling season with something exciting that will sell." This seemed obvious enough, but good to hear first-hand.

Working with the CFO's financial analyst, Lynda prepared three pro forma P&L estimates based on fully burdened expected product costs, expected price points and estimated sales forecasts. One scenario included the cost of outsourcing the refinement and test of the bean selection design. This would allow them to launch earlier with lower risk. The second scenario extended the schedule by two months to fix the problems internally. The last scenario was based on removing the multiple bean option. This would lower costs and schedule risk, but also would likely lower the sales price, margin and unit sales.

The numbers were compelling, but inconclusive. The first decision was to eliminate option 3 (removing the bean options feature) since it was clear the feature was a significant value driver

needed to drive excitement and sales. Now it was down to either hiring outsourced resources or delaying the launch. As Lynda explained, the option for outsourcing the mechanical re-design would allow them to hit the holiday season with the added benefit of getting customer feedback faster for next generation products. However, the upfront development expenses would be significant and there would still be risk of having a design issue. The other option of fixing the design in-house would save expenses, but would slow the team down (missing the holiday season). However, this option would also provide valuable technical experience for new designs. Since each option had similar net present values (NPV), the financial expectations did not provide a clear direction. So how should they decide?

As Lynda shared the pros and cons of each option, she closed with the one criterion the CEO and CFO had already furnished Lynda and Jordan – to hit the schedule with an exciting product. This key factor could not be ignored and swayed all to immediately approve the funds necessary to work with an outside vendor and help the team achieve their target.

NEXT STEP

In the final step of this series, Step 9, we'll take a post-project review of JavaBrew's first effort with using agile and the MAHD Framework for developing a new coffee maker. While this project is fictional, the challenges, conflicts and required decisions are based on a blend of many successful and failed real-world projects the authors have experienced. In the next step, we'll take a look at what went well in JavaBrew's first agile project, where it went badly and what might have been improved.

Once the product has launched, the team will continue to use agile methods to manage marketing, sales and customer service tactics.

Exhibit 1: Early Concept

A prototype used for customer feedback in Iteration 3

Customers loved the classic design with many stating something similar to, "I love that it looks cool and simple. Especially that the smart features built in but it doesn't look techy." Of course, many ideas flew on the choice of colors and other details!



Step-by-Step MAHD

Modified Agile for Hardware Development

The Smart Coffee Maker Project

Part 9 of a 9-part series to walk through an agile development project from concept to launch

Step 9:
Project Complete!



Step 9: Project Complete!

STEP 9: THE SITUATION

It has been over a year since the JavaBrew team started their smart coffee maker project. Since this was their first agile project, you can imagine it has not been perfect. Of course there were doubters and the old traditional ways of product development crept into both mindsets and behavior. This was all to be expected. But since the team was committed to changing and realizing the benefits of agile, they diligently worked through the transition challenges.

With each MAHD Iteration and Sprint, the team got better at planning, estimating tasks and keeping each other accountable. The hardest part of their transition was managing to the rough schedule they started with during early MAHD Onramp planning. The team (and management) was not accustomed to working without a detailed schedule and it seemed that for every task they finished from the backlog, another task was added. Initial estimates of major tasks seemed to explode when the tasks were broken down each sprint. While some major tasks were much simpler than expected, this was the exception. And even though they had a set of high priority user stories and product goals, the team had to constantly question whether the product they were designing would achieve the market goals. This required them to learn, adapt and reprioritize tasks with each sprint and iteration review. In other words, it forced them to become agile.

If you look back to the original iteration plan as developed in Step 3 and shown in Exhibit 1, the JavaBrew team was able to follow the overall plan closely, especially the critical prototype plan. However, as you should expect with agile, many details changed throughout the project. After each iteration, the team had to account for dependencies, mitigate risk, question the schedule, make tough design decisions, manage executive expectations and fight off other project priorities.

Let's look at what happened from the first iteration until the last and then we'll look at what worked well during JavaBrew's transition to agile and what didn't work. Finally, we'll identify the key lessons all can take away based on their journey. Note that several of these Iterations and associated challenges have been discussed in our previous steps, but of course there were many project details we could not include.

The MAHD On-ramp: In the first five papers in this series, the team worked through each step of the MAHD On-ramp. They developed product goals, wrote user stories (Step 1), identified major product attributes, clarified areas of focus (Step 2), developed the initial iteration plan as shown in Exhibit 1 (Step 3), built their product backlog (Step 4) and prepared for their first sprint (Step 5). The team was learning, excited and focused. Of course, reality would set in soon as execution began.

Iteration 1: Validating the Value Proposition

The first iteration was initially planned to consist of three, two-week sprints (Step 6), but this didn't work. They team quickly fell behind, missed tasks and had to rethink their plan for getting early customer feedback. This was the period that Lynda (the new coffee maker's product manager) was on the hook to find customers and build a feedback mechanism (Step 7).

Iteration 2: Refining the Product Concept

In the second iteration, questions loomed as to which features should be included or removed. Resources were still an issue and costs were unknown, but early indications were that costs were out of control. Management also created demands and had expectations that may or may not be consistent with market needs, such as the inclusion of voice control features. The schedule was also a big concern since undefined tasks started to balloon as they learned more about the project details.

Iteration 3: Nailing Down the Product Definition

Through early customer engagement and prototyping the team was able to finalize the desired feature set. This was good and bad. It created focus, but the “final” product definition created significant resource, cost and schedule concerns. The team had to continue to prioritize tasks and create contingency plans, especially if the early prototypes showed the product would need significant changes, such as the need to add a multiple-bean option as shared in Step 8. Customers loved the ability to select beans as well as the retro-looking industrial design of their early concept, but getting to the final design wasn't easy.

Iteration 4: Design Lockdown and Early Manufacturing Readiness

In Iteration 4, the team was able to test with nearly working prototypes. The product worked but needed major refinement. They were supposed to have the product design completed at 100% but this was not possible since the product was still being tested. Management was nervous about the cost and manufacturing was concerned about the Bill of Materials (BOM). This forced the team to rethink how they approached supplier management in an agile environment. While the team continued their innovation efforts in order to reduce cost and meet customer needs, managing the uncertainty across the company became a critical challenge for the agile project team.

Iteration 5: Product Complete and Production Ready

Everything started coming together in Iteration 5, but with the problem they identified implementing the product's “multiple bean” feature, the whole project was in serious jeopardy (see Step 8 for details). This forced the team to make the typical project tradeoffs of whether to add resources, extend the schedule or reduce scope. They decided to add external resources, but this highlighted that traditional project challenges never go away in an agile environment. However, this critical risk was identified early so it could be managed.

Iteration 6: Market Launch

In the final iteration the focus changed from product readiness to market readiness. While production challenges still consumed time and resources, other elements such as sales, marketing and channel factors came critically into focus. The agile team expanded with new team members which create new challenges for Jordan (the Agile Project Manager.) The added team members were often new to agile and it took time to explain the importance of planning tasks and managing to sprints. Major new tasks such as international regulatory compliance, privacy policies and even patent conformance also created many “fires” that were

not anticipated. While these items were in the backlog, they didn't rise to high importance fast enough to manage easily. All normal for teams transitioning to agile.

STEP 9: PROJECT RETROSPECTIVE: LESSONS LEARNED

Many teams follow a similar path to JavaBrew when starting a transition to agile and adopting the MAHD Framework. As we shared in earlier steps, while the above iterations might look a lot like a traditional waterfall project plan, the way the team worked together, validated work-in-progress, updated plans and made decisions was far different. The major iteration milestones gave the team structure and clear interim goals but did not represent any form of “gate” that had to be passed before moving forward. Learning and feedback was built into every step and any time there was a roadblock or information needed, the task was always prioritized and work continued on other important items.

After Iteration 6, the final iteration, was complete, Jordan gathered the JavaBrew team to lead a project retrospective discussion. The team came to the following conclusions:

What worked well

1. Overall, the team was happy with their transition to agile. They were able to kick off the project fast with minimal product definition and project planning.
2. Developing user stories up front provided a clear customer focus but the process for updating them consistently and tracking progress to ensure the top user stories were satisfied was not obvious. After several iterations, this became easier.
3. Team collaboration worked well, but it took some time to optimize. As the range of tasks grew, it was difficult to bring in new team members that were only partially committed to the agile team.
4. Having a solid, updated MAHD Iteration Plan was critical to success. Without this, the team realized that working only from the backlog of tasks without this big-picture structure would have been frustrating. In addition, the uncertainty of milestones, schedules and dependencies would likely have caused the team to fall back to traditional project management techniques.
5. Identifying risks and planning contingencies early worked well. If Jim had not found an outside firm that could help the team with the mechanical design, the outcome may have been far less successful.

What Didn't Work

1. Generally, all areas of agile had a learning curve. Nothing was insurmountable, but more time could have been allocated to learn. The team may have started using agile with a less mission-critical project.
2. Jordan was a bit overloaded. His role as the Agile Project Manager was essential, but he had to prepare for every meeting and hold pre-meetings with each functional lead to refine their tasks, prioritize all work items, manage the releases, etc. This role could have been more distributed with functional leads taking more responsibility for preparing for sprint meetings or taking some of the scrum master role.
3. Management did not completely buy into the role of customers in the development process — at least not at first. Executives had their own vision, which was great, but they needed to trust that the designers and development team were experts and were using real customer feedback to guide decisions.
4. Velocity tracking was difficult! It took almost four iterations to fully define the project and really understand if the team was on track. With experience, the team believes this can be improved.

What Could Be Improved

Some areas the team agreed they should work on for their next project include:

1. Spend more time in Iteration 1 to define the project, set up the customer feedback mechanisms and identify the right resources.
2. Train new team members on agile techniques and mindset before they start participating in sprints and refinement meetings.
3. Ensure all stakeholders – production managers, executives and even partners – are familiar with the agile development approach so they know what to expect when they see a prototype, iteration plan or other agile artifact that may not look like what JavaBrew delivered in the past.
4. Share the scrum master role with others. Let functional leads help coach, prepare for meetings and share the responsibility. This will not only help them grow, but allow the Agile Project Manager to focus more on critical project tasks.

PROJECT OUTCOME

While the JavaBrew project is based on a variety of real-world projects, it focuses on a fictional product. The authors could obviously give it any ending they wanted. Some of the possible outcomes were discussed in the previous step included; 1) delaying the project to fix the “coffee bean option” feature, 2) using an external vendor to accelerate delivery, or 3) de-featuring the product to hit their release target date. These would all be good outcomes, but we all know projects can have a variety of far worse outcomes. For example, management might have been frustrated with the project problems and decided to just kill the product. or the outside vendor Jim selected may have created a disaster and designed a coffee bean selection mechanism that had more problems than the original design.

In JavaBrew’s case, the team had a successful outcome. They were able to launch the product successfully, but of course it was not perfect. Since the team was new to creating apps and smart technology, they needed to manage unique customer inquiries such as “I can’t download your app!” and “Why is it making coffee at 1 in the morning?!” With the right agile mindset and customer focus these are details that can always be worked through.

For JavaBrew’s next project, they will learn from their previous experiences and continue to refine their MAHD process. As with every business improvement, the transition is always a journey more than any specific event. It will take time, continuous learning and a concentrated effort to reap both short and long-term benefits.

NEXT STEPS AND THANK YOU

Agile methods, including the Modified Agile for Hardware Development (MAHD) Framework, is not a panacea for perfect development. However, the authors know from experience that agile methods provide significant benefits over traditional waterfall development projects, including:

1. Agile ensures a fast, successful start to a project, including large projects with many unknowns.
2. Agile provides the mechanism for continuous customer engagement, learning and adjustments.
3. Agile provides early awareness of major technical and market problems — enabling you to remove risk before it becomes critical.
4. Agile allows you to see real-time progress for both teams and individuals.
5. Agile creates a collaborative environment where communication is central to success.

If you made it this far into our agile journey, we are both thankful and impressed. Hopefully by now you also see the benefits agile can provide, but also that agile as defined for software must be modified for physical products.

If you'd like to learn more about the MAHD Framework, train your team on how to implement MAHD, or just want to share your own journey, we'd love to hear from you.

Best of luck to you!

Gary and Dorian

Exhibit 1: Initial Iteration Plan

Preparing the big picture in readiness for sprint planning (From Step 3)

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Iteration 6
Major Deliverables	<ul style="list-style-type: none"> Preliminary concepts Preliminary features scoped 	<ul style="list-style-type: none"> Cost estimates, initial industrial design, electronics design Smart features defined – app/voice 	<ul style="list-style-type: none"> Coffee making mechanism design with smart control for testing 	<ul style="list-style-type: none"> Integrated device with ~80% target feature set Smart app 90% complete 	<ul style="list-style-type: none"> Mechanical and electronics designs complete Packaging design complete BOM complete 	<ul style="list-style-type: none"> Production drawings, user guide, website, materials, packaging forecasts, marketing plan
Prototypes	Preliminary brochure	3D video highlighting smart features and ease of use	Rough working prototype – smart features + physical design	Fully working prototype	Production-ready prototype	Production starts
Key Questions	<ul style="list-style-type: none"> Is value proposition right? Which features drive value? Physical interface needed? 	<ul style="list-style-type: none"> Value of voice control? App features? Can cost meet targets? 	<ul style="list-style-type: none"> Do customers love it? Any design show-stoppers? Can we hit the market window? 	<ul style="list-style-type: none"> Can we really lock down features? Are retailers on board? Can we create demand? 	<ul style="list-style-type: none"> Is it ready for production? Is the quality “good enough?” Are costs under control? 	<ul style="list-style-type: none"> Are retailers ready to take orders? Can we hit the forecast? Is sales engaged?
Milestones/ Approvals?	Concept and plan approved	Cost estimates approved	Major feature lock-down	Design/feature lockdown, prototype tooling approved/ordered early in iteration	BOM complete, launch plan, final tooling, compliance & certifications	Pricing, sales and channel ready
Risk Mitigation	<ul style="list-style-type: none"> Team momentum – need committed resources. Early customer engagement. 	<ul style="list-style-type: none"> Schedule risk – team velocity on target? FCC compliance. 	Design approvals	<ul style="list-style-type: none"> Prototype tooling approvals. Final feature set approval. 	<ul style="list-style-type: none"> Production tooling approvals. 	<ul style="list-style-type: none"> Sales and marketing risks. Engage with channel partners.
Target Date	3/15/19	5/24/19	8/2/19	12/6/19	4/10/20	7/3/20
Number of Sprints	3	5	5	9	9	6 (2 sprint buffer for 7/31 launch)

EXHIBIT 1

To Be Continued...

GET THE SERIES

To see the previous steps and receive each new step of this project as it is published, visit www.AgileForHardware.org. Each step will be available for download and sent directly to your email.

ABOUT THE AUTHORS

The MAHD framework is an open-source process, available for all to use, build on and improve. We look forward to hearing from you and your experiences with agile, waterfall and other processes. The MAHD framework was developed by Gary Hinkle and Dorian Simpson to address the needs of hardware development.

To learn more, get involved, or just join our community for discussion, visit:

www.AgileforHardware.org

About Gary Hinkle

Electronics, mechanical and software engineering are all part of Gary Hinkle's background, working in design, management and executive leadership of communication, industrial, telemetry, audio, avionics, computers, test & measurement, among other industries. Today, he's principal consultant at Auxilium, a company he founded to help engineering-oriented businesses increase productivity.

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