SOLVING CRITICAL ENGINEERING CHALLENGES FOR ELECTRIC VEHICLES

Adaptive Corporation
THE DIGITAL TO PHYSICAL PRODUCT LIFECYCLE COMPANY

DASSAULT SYSTEMES
The 3DEXPERIENCE® Company

EXECUTIVE SUMMARY

As an engineer in the mobility manufacturing space, you and your company are facing one of the most radical transformations in the transportation industry since mass production.

Modern manufacturers are rewriting the rules of vehicle operation as they shift from manual, mechanical platforms to autonomous, electric ones. A few of the innovations include:

- High-performance propulsion systems driven by densely packed battery arrays.
- Autonomous and safety systems powered by complex radar and vision systems.
- Vehicle connectivity through machine-to-machine communication with powerful antennas and sensors.

These new systems present tremendous challenges for engineering.

Manufacturers are looking to resolve big problems with many variables, like boosting battery life and capacity, raising the power generated from electric motors, avoiding thermal runaway of battery fires after a crash, and testing complex radar and vision systems.

Simulation can help you gain an accurate view of which design variables affect performance. But enabling early, frequent, and pervasive analyses of physics to see which satisfies the requirements in these electrification scenarios is no simple task.

Most organizations use a disjointed and manual approach involving a cobbled-together combination of spreadsheets, documents, shared drives, computer-aided design (CAD) applications, and simulation tools.

You are left with a high probability of inaccuracies due to manual entry and propagation of revisions, unclear requirements, and no connectivity between tools. You also have no controlled process to share near real-time information with engineers in other disciplines, such as in electrical and electronics.

In the end, you end up with multiple rounds of revisions, project delays, and costly errors. You can lose hours, if not days or even weeks, of your time and productivity while missing the product release deadline.

Digital Design Simulation is a powerful tool to help you uncover solutions to all of these challenges. With this process you can make a significant difference in creating optimized designs. But instead of just telling you, let's walk you through the process.

This white paper takes you on a trip through the three design development phases with two fictional suppliers who are designing an electric powertrain. One uses Manual Design Development, while the other is powered by a Digital Design Development approach.

By the end of this white paper, you will be able to compare the differences side-by-side between a Manual Design Development cycle and a Digital Design Development cycle in all three of the design development phases. You will also be able to compare the challenges to the key advantages in each of the phases and reflect on your own current processes.

Pervasive simulation, applied early, often, and efficiently in the design cycle, can save valuable time and eliminate costly errors in your development and manufacturing processes.

INTRODUCTION

Today, the mobility industry is going through a radical transformation. Manufacturers are rewriting the rules of vehicle operation as they shift from manual, mechanical platforms to autonomous, electric ones. Densely-packed battery arrays drive high-performance propulsion systems. Complex radar and vision systems power autonomous and safety systems. Powerful antennas and sensors connect vehicles to other things through machine-to-machine communication. The industry is experiencing—and will continue to experience substantial change.

All these changes, and more, present tremendous challenges for engineering. Manufacturers are investing in significant design efforts and resources to solve big, new problems. They are searching for the means to boost battery life and capacity and extend the range of vehicles. They are hunting for methods to raise the power generated from electric motors. They are seeking new ways to avoid the thermal runaway of battery fires after a crash.

When it comes to solving these engineering challenges, simulation can be a powerful tool. Early, frequent, and pervasive analyses of the complex physics in electrification scenarios arm designers with an accurate view of which design variables affect performance. That, in turn, leads to better decisions. And when engineers string better decisions together in succession, they discover powerful, innovative answers for these complex engineering challenges.

Manufacturers are investing in significant design efforts and resources to solve big, new problems

However, it is no simple task to enable early, frequent, and pervasive analyses in design. The process involves requirements, design models, multiple sets of loads and boundary conditions, a variety of solvers, and much more. It is critical to track which measures and analyses satisfy which requirements. Most organizations use a disjointed approach involving a cobbled-together combination of spreadsheets, documents, shared drives, computer-aided design (CAD) applications, and simulation tools. To do all this in a way that gets the right information to engineers is extremely problematic.

However, a simulation process powered by Dassault Systèmes' **3D**EXPERIENCE Platform is markedly more successful. The platform automatically tracks all the relevant information for analysis. This provides the right context of the simulation, so the engineer gains the insight they need at the right time. This single, unambiguous view of design performance empowers engineers so they can make a string of better decisions in succession.

The intent of this white paper is to shed light on the differences between these two approaches and what it means to modern manufacturers. For contrast, it will examine the development processes for an electric powertrain of two fictional suppliers. Mobility Corporation uses a disjointed approach to their simulation process. Vehicle Dynamics leverages Dassault Systèmes' **3D**EXPERIENCE Platform. We'll compare them, side-by-side, throughout the design cycle.

CONCEPT DESIGN AND ARCHITECTURE

Process Overview and Objectives

In this first phase of the design, the goal is to find the design architecture for the electric powertrain that best satisfies the OEM's objectives. The first task in the process is to identify the OEM's requirements, often provided as part of a contractual specification, and place them under configuration control. This step is key: it acts as the measure of success or failure when evaluating design architectures. In this case, the OEM has provided 54 initial requirements that cover power efficiency, durability, life expectancy, crash test constraints, and much more. Configuration control over these requirements is important if and when the OEM later requests changes.

With control established, the engineer will define sub-requirements derived directly from the OEM's requirements. These act as more granular constraints the design architecture must satisfy. The OEM's power efficiency must translate into 15 sub-requirements that each measure this constraint in a more detailed way. In all, the OEM requirements and sub-requirements collectively represent the problem the engineer must solve.

From here, the engineer can start defining potential design solutions. They develop candidate architectures for the electric powertrain that span mechanical, electrical, electronic, and embedded software domains. The architectures might include functional or logical definitions, but will always include a physical aspect of the architecture. This represents which bill-of-material items will be included in the design. During these activities, the engineer ensures that the candidate architectures comply with the form and fit requirements. As an example, one of the design architectures for the electric powertrain is composed of a second-generation compact electric motor, a gearless differential, and an electromagnetic transmission.

Mobility Corporation

5 KEY CHALLENGES

- High chance of human error with manual entry and propagation of changes.
- Unclear if the 69 requirements are the most recent and accurate.
- No controlled process to share information with all the engineers in the design process.
- Too many relationships to accurately explore and manually track in a timely manner leading to errors.
- Engineers only explore a handful of architectures and often select those with the least risk.

Vehicle Dynamics

5 KEY ADVANTAGES

- Requirements and changes are automatically entered and extracted eliminating human error.
- Requirements can be individually managed and changes easily tracked .
- Linking requirements is powerful for understanding how an OEM's request for a change affects the overall design.
- Engineers can explore tens or hundreds of different architectures and verify performance.
- Higher potential to uncover truly innovative options in less time with fewer errors.

1 CONCEPT DESIGN & ARCHITECTURE:

Satisfy OEM's Objectives

54 OEM Requirements | 15 Sub-Requirements = 69 Requirements

Mobility Corporation	Vehicle Dynamics
1. OEM REQUIREMENTS Engineers manually copy & paste the 54 requirements into a Master Spreadsheet.	**1. OEM REQUIREMENTS** The contract specification is opened in the platform extracts the 54 requirements as individual teams.
2. SUB-REQUIREMENTS 15 sub-requirements are manually added as indented entries in the spreadsheet.	**2. SUB-REQUIREMENTS** These are automatically seen as individual items that can link to other requirements.
3. DEVELOP CANDIDATE ARCHITECTURES Engineer uses diagramming tools to develop architectures and manually enter component relationships into requirements spreadsheets. There is no link between them to automatically track changes.	**3. DEVELOP CANDIDATE ARCHITECTURES** Each one has functional, logical, and physical representations within the same model with clear relationships to each. Allocating a sub-requirement to the candidate architecture completes a traceable chain.
4. CALCULATIONS AND SIMULATIONS Both are conducted and entered using spreadsheets or expert analysis tools. Accuracy needs to be verified.	**4. CALCULATIONS AND SIMULATIONS** Setting up analyses is part of the same model for the architecture, including simple formulaic calculations, 1D simulations, or complex 3D analyses.
5. TRACKING ANALYSIS THROUGH TO REQUIREMENTS Engineers use a spreadsheet to attempt to manually track analysis to the simulation case and candidate architecture along with the requirements they satisfy.	**5. TRACKING ANALYSIS THROUGH TO REQUIREMENTS** Requirements satisfaction and digital verification through simulation is part of the same candidate model and is automatically tracked.

With numerous options, the engineer tests the architecture candidates against functional requirements, often involving one or more domains of engineering physics. This can include structural stresses and response to excitation. This can include thermal loading and fluid dynamics. It may also include electromagnetic interference of control systems. Finally, it may include trade studies that vary specific design parameters to understand how it affects a performance measure for a requirement.

With an understanding of how the candidate architectures measure against the requirements, the engineer chooses one to move forward to the next phase of development: detailed design and implementation.

MOBILITY CORPORATION: THE DISJOINTED APPROACH

At Mobility Corporation, the process starts by copying and pasting requirements from the OEM's specification into a master requirements spreadsheet. Sub-requirements, as defined by the engineer, are simply indented entries in the same spreadsheet. Unfortunately, this step in the process has several shortcomings. Manually copying and pasting requirements introduces human error into the process and enables the operator to skip some or all of the requirements. Furthermore, it requires manual propagation of changes to the OEM's requirements, extending the risk of human error and undermining configuration control. At Mobility Corporation, it isn't always clear if the requirements in the spreadsheet are the latest or if they are accurate.

Next, the engineer develops candidate functional, logical, and physical architectures with diagramming tools. With the physical architectures, each block represents a major mechanical, electrical, electronic, or embedded software component. In the requirements spreadsheet, the engineer notes which component addresses which requirements. With multiple candidates, the engineer creates a copy of the requirements spreadsheet for each candidate or enters columns for each candidate. Given the change to the candidate architectures and the requirements, the chances of inaccuracies in these allocations are high.

Having defined many candidate architectures, the engineer then uses spreadsheets or expert analysis tools to conduct calculations or simulations. Each requirement demands some check, leading to hundreds of analyses for each candidate. The engineer attempts to use a spreadsheet to track which analysis corresponds to which simulation cases and which candidate architecture, as well as which requirements they satisfy. With so many relationships to track, the engineer is often overwhelmed, knowing that many errors in the documentation likely exist.

In reality, the engineer only explores a handful of candidate architectures. They conduct analyses for only the most promising options, given their best estimates. The engineer often selects the candidate architecture that represents the least risk given the lack of insight gained into the design space.

VEHICLE DYNAMICS: USING THE **3D**EXPERIENCE PLATFORM

In Vehicle Dynamics, the story is very different. Their process starts by opening the contract specification in Dassault Systèmes' **3D**EXPERIENCE Platform, which parses the document and extracts the OEM's requirements as individual items. As a result, engineers can configuration manage each requirement on its own, allowing them to track changes to it quickly and easily.

When the engineer defines sub-requirements, each of those are individual items as well. The engineer can designate that the sub-requirements were derived from another requirement, creating a link between them. This becomes a powerful tool in understanding how an OEM's request for a change to a requirement affects the overall program.

The engineer then begins defining candidate architectures. Each one can have functional, logical, and physical representations within the same model. Engineers can make allocations from a function to a physical item, making the relationship clear. Furthermore, allocating a sub-requirement to some aspect of the candidate architecture completes a traceable chain. A connection exists from OEM requirement to sub-requirement to function to physical component. This means there is a direct link of a performance measure to the physical item that should satisfy the requirement.

Setting up analyses in the **3D**EXPERIENCE platform is part of the same model that contains the definition for the architecture. This may include simple formulaic calculations, 1D simulations, or complex 3D analyses. Furthermore, measures from these analyses can be identified as the measure for requirements satisfaction. This closes the loop between defining a measure for requirements satisfaction and digital verification through a simulation. Because such analyses are part of the same candidate model, the **3D**EXPERIENCE platform keeps track of it all.

All of these capabilities empower the design exploration and performance verification, so the engineer can explore tens or hundreds of different architectures. They gain more insight into the entire range of potential design solutions, increasing the likelihood of uncovering a truly innovative option.

DETAILED DESIGN AND IMPLEMENTATION

Process Overview and Objectives

With the design architecture for the electric powertrain defined, the detailed design phase can start. This work continues with the breakdown of the system into subsystems, each of which involves mechanical hardware, electrical and electronic hardware, and embedded software to varying degrees. With the electric powertrain, an embedded subsystem provides control over the mechanical power delivered through a certain power draw through the battery array. A fluid transmission subsystem delivers the power to the axles. Many more such subsystems are defined and assigned out to multi-disciplinary teams of mechanical, electrical, and embedded software engineers.

A key next step is to further break down requirements into sub-requirements allocated to specific subsystems. These detail how each subsystem delivers the function assigned to it. Configuration-tracking occurs, both individually and as a set, as does the definition of interfaces between the subsystems. This can range from mechanical interfaces such as a mating junction, electrical interfaces such as standard signal definitions and packets, software-hardware interfaces such as sensor signals, and software interfaces such as standard API libraries. All of these become constraints against which those multi-disciplinary teams must comply.

From there, each of the subsystem's multi-disciplinary teams develops their designs against their constraints. Mechanical engineers create 3D models of component and assembly hardware. Electronic engineers generate diagrams and layouts for board systems. Electrical engineers fashion their own diagrams and layouts for routed electrical systems. Embedded software engineers develop software models and write code. These engineers not only need to develop such design solutions but must also document their work so product manufacturing can begin.

7 KEY CHALLENGES

- Manual propagation of changes to other spreadsheets too often leads to human errors and mistyped values.
- Inaccurate information is common because updating spreadsheets happens only on certain days due to workloads.
- Often teams have to revisit, scrap, or restart days of design work due to the wrong reversion in spreadsheets.
- No holistic picture of subsystem design.
- Subsystems exist across a variety of tools and many don't work together.
- Little to no connectivity between information or tools.
- Errors in verification and validation cause significant delays with all stakeholders.

3 KEY ADVANTAGES

- Provides near real-time feedback on design decisions as they occur.
- Human errors are reduced dramatically as users don't need to reenter requirements if changed.
- All artifacts interconnect, eliminating the risk of working against out-of-date information.

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DETAILED DESIGN & IMPLEMENTATION:

Redine the requirements within the de ined constraints in Phase 1.

Mobility Corporation

1. THE HUB: SPREADSHEETS
One spreadsheet helps breakdown system into subsystem requirements. Another allocates those requirements. A third defines subsystem interfaces.

2. TOOLS:
Engineers use their own separate siloed tools.

- Mechanical engineers use MCAD and save their work to a PDM system.
- Electronic engineers use ECAD connected to a central server.
- Electrical engineers use both ECAD and MCAD.
- Embedded software engineers use IDE, SCM, and ALM systems.

3. COMPATIBILITY, PERFORMANCE & VERIFICATION
Some engineers use spreadsheets with homegrown calculations. Some use simplified CAD-embedded analyses. Others run highly complex simulations suited to one engineering domain.

4. SIMULATION
All artifacts are individual files that could be misplaced, forgotten, or accidentally deleted. It's difficult to track changes in a disparate system.

Vehicle Dynamics

1. THE HUB: 3DEXPERIENCE
Provides a centralized and consistent system throughout design development. Engineers can iterate and change requirements that populate wherever they are relevant.

2. TOOLS:
Engineers can create and manage all of their mechanical, electronic, and electrical hardware and software in one platform with connectivity to tools and information.

3. COMPATIBILITY, PERFORMANCE & VERIFICATION
Multi-disciplinary teams can see each other's work and make adjustments quickly and collaboratively, verify specifications, and keeping changes up-to-date.

4. SIMULATION
Everything lives in the **3D**EXPERIENCE platform. Users run and store system simulations, mechanical analyses, and more in the same place as the design models for near real-time feedback.

Each must comply with the requirements for their own work, but it becomes critical at this stage to verify that all of these subsystem aspects work together as a cohesive whole. Board systems must fit into enclosures. Wiring and cabling harnesses must deliver power and signals strong enough that electronic endpoints can read them. Embedded software must read sensor measurements.

In addition to everything simply working together, the subsystems as a whole must achieve certain performance measures as defined by subsystem requirements. For example, the electric powertrain must deliver torque to the axles at or above a certain power curve. Based on an aggressive driving profile, the total power draw must lie below certain levels.

With the designs of the subsystems complete, development moves on to the next phase: verification and validation.

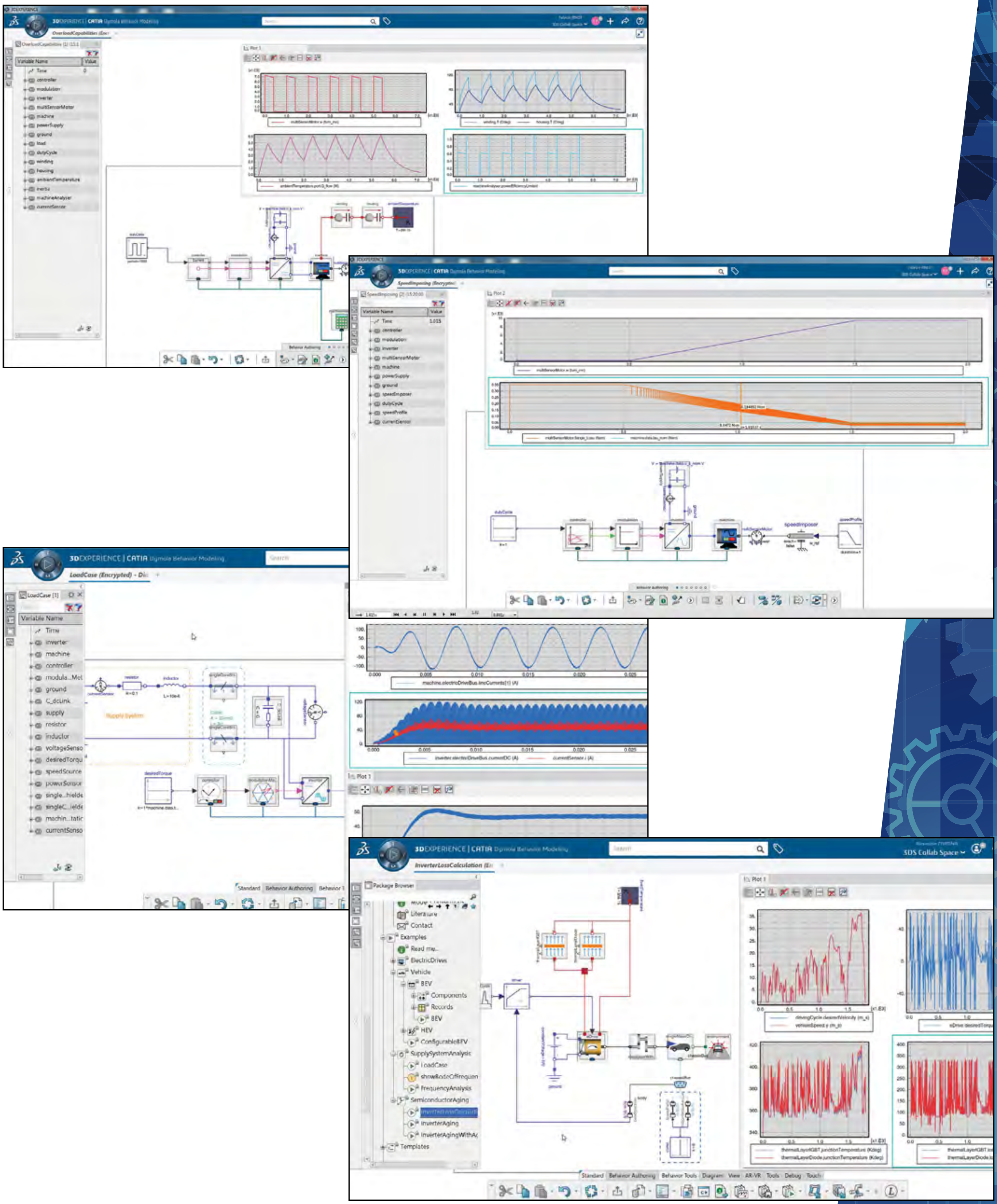
MOBILITY CORPORATION: THE DISJOINTED APPROACH

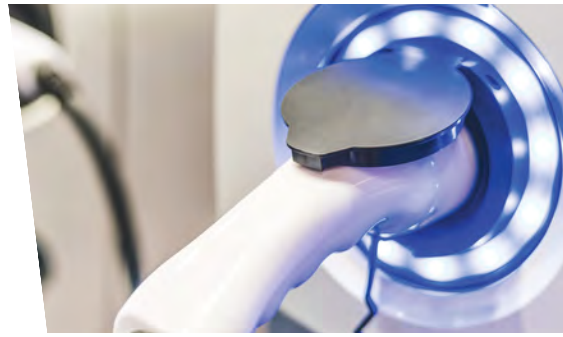
Over at Mobility Corporation, spreadsheets again claim a critical role in development. One spreadsheet helps break down system requirements into subsystem requirements. Another spreadsheet helps allocate those requirements. Yet another spreadsheet helps define interfaces between subsystems. Changes in any one area require manual propagation to the other spreadsheets. Too often, however, reentering the same information in different spreadsheets leads to mistyped values. Frequently, updating the spreadsheets happens only on certain days due to workloads, resulting in inaccurate information. This results in teams having to revisit, scrap, or restart days of design work because of the errors in these spreadsheets.

When the engineers hit detailed design at Mobility Corporation, they go off into their own separate, siloed tools. Mechanical engineers develop their 3D models in a desktop Mechanical Computer-Aided Design (MCAD) application and save their work to one Product Data Management (PDM) system. Electronic engineers build out their diagrams and layouts using a desktop Electrical Computer-Aided Design (ECAD) application connected to a central server. The engineering team working on the electrical system uses both the ECAD and MCAD tools, diagramming in one and routing through a 3D assembly in the other. The embedded software engineers create their software models in yet a different tool alongside an Integrated Development Environment (IDE) environment, Software Configuration Management (SCM) and Application Lifecycle Management (ALM) systems. As a result, the collective definition of the subsystems in Mobility Corporation exists across a variety of tools. There is no single place where one can get a holistic picture of the subsystem design.

When it comes to checking whether everything works together and the design satisfies all requirements, the process is a cobbled-together mishmash of approaches. Some engineers use spreadsheets with homegrown calculations. Some use simplified CAD-embedded analyses. Some run highly complex simulations suited to one engineering domain. None are connected, and management occurs on disparate desktops. Tracking of results is infrequent. Overall, the process exhibits little consistency or standardization, so the results are likewise inconsistent. Errors rear their ugly head and cause significant delays in the start of verification and validation.

Systems Engineering Logical Behavior Model for Electric Drive Power System





VEHICLE DYNAMICS: USING THE **3D**EXPERIENCE PLATFORM

The difference in how Vehicle Dynamics executes this phase of development couldn't be starker. They use a centralized platform, **3D**EXPERIENCE, throughout the process, providing a single, consistent system for all of detailed design.

First, they break down system requirements into subsystem requirements within the **3D**EXPERIENCE platform and manage each of them individually. This lets engineers iterate and change them as necessary while still keeping track of the entire configuration. Users need not reenter requirements information, reducing the chance of error dramatically. Changes to one requirement appear everywhere else it is relevant.

From a design perspective, Vehicle Dynamics creates and manages all of their mechanical, electronic, and electrical hardware in the **3D**EXPERIENCE platform. They connect the **3D**EXPERIENCE platform to their ALM solution. As a result, engineers across the multi-disciplinary team can see each other's work and changes. With such visibility, those engineers can make adjustments quickly, adapting to each other's work in a collaborative way. In the **3D**EXPERIENCE platform, the subsystem has a single, unambiguous definition – a single source of truth.

From a simulation perspective, everything at Vehicle Dynamics also lives in the **3D**EXPERIENCE platform. Users run and store system simulations, mechanical analyses, and more in the same place as the design models. They are simply a different representation of the same thing. So, as the design changes, the team can run the analysis model updates again. This provides near real-time feedback on design decisions as they occur. All artifacts are natively part of the platform, not individual files that might be misplaced, forgotten, or accidentally deleted. All artifacts interconnect, eliminating the risk of working against out-of-date information.

VERIFICATION AND VALIDATION

Process Overview and Objectives

With a complete definition of systems, subsystems, and the product designed, it's time for the next phase of the design cycle: verification and validation. Here, the objective is to ensure that all requirements are satisfied and that the product works as intended and doesn't exhibit unwanted behaviors. This phase primarily relies on physical tests to validate many things.

- One aspect of this involves checking the nominal performance of the product. Does it all fit together? Does it operate? Does it run?
- Another aspect of this is verifying that it satisfies all of the assigned and allocated requirements. Does it meet applicable regulations? Does it supply the necessary power?
- Yet another aspect covers system-level behaviors, which often only emerge after the system has been integrated. Does it deliver the stated battery range? Does it have unexpected spikes in temperature?

For some, this phase starts with simulations conducted by experts. This small team of focused individuals runs deep and accurate analyses that take multi-physics and systems interactions into account. If these simulations show that the item will pass a physical test, then the process proceeds to the next step. If not, it returns to detailed design for more changes. For the electric powertrain, this can include finely detailed Finite Element Analyses (FEA) or multi-body dynamics to digitally test structural failures and dynamic vibrations. It also might include acoustic simulations for radiated noise from the motor's housing. Both of these simulations would be driven by low frequency electromagnetic analysis of the electric motor.

The ultimate measures for success or failures in these tests are the same requirements defined in the concept design and architecture phase and refined in the detailed design and implementation phase. This is one applicable area for requirements configuration management. Throughout the design process, requirements may be changed, either

Mobility Corporation

3 KEY CHALLENGES

- Because of the effort to tweak these design models, multiple rounds of analyses take a lot of time, delaying the project significantly and building costs for the program.
- Entry errors cause inaccuracies of the requirements being tested, the configurations, and even test results.
- No automated or accurate revision control process to accurately verify the latest revisions.

Vehicle Dynamics

6 KEY ADVANTAGES

- Eliminates human entry errors.
- There is no confusion about the state of requirement.
- There is a single definition that is always up-to-date.
- Eliminates non-value-added work of recreating the simulation model after design changes.
- Test engineers get a precise interpretation of information about the product.
- There is a single repository of information about the product that can be accessed by all parties.

3 VALIDATION:

Physical tests and simulations to ensure the stakeholder gets the product they want.

Mobility Corporation	Vehicle Dynamics
1. INPUT AND TRACKING Spreadsheets are used as input for validation and testing.	**1. INPUT AND TRACKING** **3D**EXPERIENCE is the digital backbone of the entire process.
2. SIMULATIONS: A team of experts run simulations using a specialized set of software applications and manage all models, loadsets, and results in a dedicated SDM system.	**2. SIMULATIONS:** A team of experts run analyses using one platform to conduct simulations and to manage results.
3. PROCESS The engineers from the multi-disciplinary team provide their models and documentation to the simulation team.	**3. PROCESS** The experts create associated representation of models in the detailed design phase where they apply simplifications & abstractions. Simulations are automatically managed.
4. DESIGN CHANGES The experts tweak the models, making abstractions and simplifications. It requires a significant investment of time to recreate the model after design changes.	**4. DESIGN CHANGES** **Powerful:** When an engineer changes the original model, the expert's model automatically updates with the abstractions and simplifications still in place. This eliminates recreating the simulation model after design changes.
5. REVISION CONTROL For designs that fail, the engineers make changes and return to the experts who repeat the abstraction and simplification process, which could take several rounds and no accurate control process.	**5. REVISION CONTROL** Test engineers access requirements allocated to test. They develop their testing plans referencing the product configuration to be tested & allocated requirements in the **3D**EXPERIENCE platform.
6. DOCUMENTED RESULTS Physical tests are documented on spreadsheets. They are used to validate requirements, when and how each test was completed, the correct configuration, and the results of the test.	**6. DOCUMENTED RESULTS** Once the test is complete, the test engineer simply has to log the results in **3D**EXPERIENCE, which becomes a single repository of information that can easily be accessed by all parties.

as a request from a customer or from an engineer. Entering this phase, it is critical to have a single accurate view of requirements as they should be tested. For the electric motor, these tests include validating powertrain efficiency against specifications, verifying that actual noise and vibration match expected behaviors, and ensuring motor efficiencies meet expectations.

The output of this effort is to document the outcome of the test. With failure, the team must identify the root cause of the failure, adjust the design, and test the item again under the same constraints. All of this requires documentation for near-term and long-term review to comply with industry regulations and company procedures.

MOBILITY CORPORATION: THE DISJOINTED APPROACH

At the start of the verification and validation phase, Mobility Corporation cements their identity as a spreadsheet-centric organization. They use the spreadsheets containing the variety of requirements information as the input to this set of activities.

Mobility Corporation employs a team of experts to run simulations. However, they use a highly specialized set of software applications and manage all of the simulation models, loadsets, and results in a dedicated Simulation Data Management (SDM) system. The engineers from the multi-disciplinary team provide their models and documentation to this team. The experts then tweak and change those models, making abstractions and simplifications, so their simulations run quickly yet still functionally represent the performance of those designs. This effort of tweaking the designs requires a significant investment of time. Of course, some of the designs pass this step; some do not. For those that fail, the engineers make changes to the design and return to the experts, who must then repeat the abstraction and simplification process. Because of the effort to tweak these design models, multiple rounds of analyses take a significant amount of time, delaying the project significantly.

At physical test, the test engineers in Mobility Corporation rely on spreadsheets to document what kind of test will be used to validate the satisfaction of which requirements. They use spreadsheets to document when and how each test was completed. They use them to document the configuration of the product being tested and the result of the test. Many of the flaws of using spreadsheets in earlier design phases manifest here as well. Entry errors result in an inaccurate picture of the requirement being tested, the configuration of the product being tested, or even the test result. Failure of a test starts a familiar cycle: design engineers make a change and bring it back for another physical test. As was the case with simulation, multiple rounds of testing incur significant delays and building costs for the program.

VEHICLE DYNAMICS: USING THE **3D**EXPERIENCE PLATFORM

At Vehicle Dynamics, the **3D**EXPERIENCE platform continues to act as the digital backbone for the entire process. The requirements defined early in design and refined throughout the process become the basis of verification and validation. There is no confusion about the state of a requirement. There is a single definition that is always up-to-date.

Vehicle Dynamics has a team of experts who run analyses, as well. However, instead of using a separate set of applications to conduct the simulations and manage the results, these analysts use the **3D**EXPERIENCE platform. They create a different yet associated representation of the models developed by the engineers in the detailed design and implementation phase. Here, they can apply their simplifications and abstractions. The **3D**EXPERIENCE platform manages these simulations, as well. But most powerfully, when an engineer changes the original model, the expert's model updates associatively with the abstractions and simplifications still in place. This eliminates the non-value-added work of recreating the simulation model after design changes.

For the test engineer at Vehicle Dynamics, the story is likewise vastly different. They access the requirements allocated to the items they are planning to test as a first step. Then they can develop their testing plans, simply referencing the product configuration to be tested and allocated requirements in the **3D**EXPERIENCE platform. Once the test is complete, the test engineer simply has to log the results in the **3D**EXPERIENCE platform as well. This all contributes to the single unambiguous body of information about the product in the **3D**EXPERIENCE platform.

DESIGN SIMULATION WILL ENABLE YOU TO:

Give people what they expect

Persuasive simulation applied early and often in the design cycle can make a significant difference in creating optimized designs.

Accelerate time to market

Eliminate lost productivity and costly errors with a cobbled-together approach!

Increase market share

Use a holistic set of capabilities to cover simulation from end-to-end in the entire design cycle.

SUMMARY AND RECOMMENDATIONS

There's little doubt: the mobility industry is undergoing dramatic change as more manufacturers shift to autonomous, electric platforms. This presents significant new challenges for engineering. Pervasive simulation, applied early and often in the design cycle, can make a significant difference.

Unfortunately, some companies use a cobbled-together approach to pervasive simulation that undermines the benefits that such an effort might yield. At Mobility Corporation, this is a significant source of lost productivity and painful errors.

In contrast, a simulation process powered by Dassault Systèmes' **3D**EXPERIENCE Platform is markedly more successful. It delivers a holistic set of capabilities to cover simulation from end-to-end in the design cycle.

Too often, it is hard to gauge how much of a difference a solution like the **3D**EXPERIENCE Platform can make for a company like yours. However, Adaptive Corporation can provide some clarity. To help you get started, we offer you three of paths to consider depending on where you are with your engineering and optimization efforts.

1. EXPLORE THE 3DEXPERIENCE PLATFORM

Sign up to watch our video series that shows you how quickly you can be up and running on the **3D**EXPERIENCE on the Cloud platform. We will be releasing videos periodically that demonstrates new functionality on the 3DEXPERIENCE solution.
Info.adaptivecorp.com/3dexperiencevideoseries

2. REQUEST A MEETING WITH A 3DEXPERIENCE CONSULTANT

Perhaps you know that you need a platform and want to have that follow on conversation. One of our consultants will be happy to set up a time to talk with you about your PLM needs to support your innovation and development process. Request a meeting **here.**

3. GET STARTED WITH 3DEXPERIENCE AND SIMULATION PILOT

Get a jumpstart on using the **3D**EXPERIENCE platform and the Simulation tools with a mini-pilot project. This special offer gets you the **3D**EXPERIENCE platform with a 3-month subscription PLUS a 10-hour block of technical support all at a discounted rate of $1200. Our team will help you get your pilot up and running, and help you establish baseline models for simulation and optimization. Get one step closer to developing a stronger, more cost effective part or product. Sign Up for the Pilot **here.**

Adaptive Corporation

THE DIGITAL TO PHYSICAL PRODUCT LIFECYCLE COMPANY

ABOUT ADAPTIVE CORPORATION

Introducing Digital to Physical Product Lifecycle Management

Adaptive Corporation is dedicated to connecting virtual design to the physical world by creating solutions that help their clients innovate, validate and refine the design of new products being introduced in the market. With Adaptive's technical expertise, your design engineering team can be assured you will build products right the first time, with the most efficient and profitable path possible. Covering the full span of Product Lifecycle Management solutions, Adaptive addresses Virtual Product Design, Product Data Intelligence, Enterprise Collaboration, Digital Manufacturing, Simulation and Metrology/Quality Control.

Connect with us

sales@adaptivecorp.net

support@adaptivecorp.net

training@adaptivecorp.net

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