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Change Requests Analysis Internal Document

Introduction

This document describe the analysis of a three change requests (CRs) analysis conducted for the Lennard Jones simulation system, as proposed by our clients. The change requests are:

CR1:

Due to a new government law on quality assurance of simulation software, any software release should be tested with a dataset containing 100,000 data samples to verify the accuracy of simulation. The samples and reports should be provided to the government IT office to get the approval for release, the approval time is 15 days.

CR2:

The client wants to increase the number of users for the software, therefore, the client requests to include the following simulation methods:

- Molecular dynamics
- Montecarlo methods
- A module to simulate solids
- A module to simulate liquids
- A module to simulate plasma

CR 3:

Due to compatibility reasons, the client desires that the simulation should be developed using an open-source numerical package. This numerical package is new for you, and the learning curve is at least one week.

In the following sections of this document, we analyze the change request (CR) from several fundamental perspectives that are essential for the overall development of the project.

Description of the Document

In the following sections of this document, we analyze each of these CRs from several fundamental perspectives that are essential for the overall development of the project.

Criteria for Identifying Configuration items

Metrics: criteria and scales

The following tables present some of the metrics used for the analysis of each CR.

Technical analysis

Metric name	Low	Medium	High
Code coverage risk	Below 20%	20%-50%	Above 50%
Technical Debt	Below 10% of available time	10%-20% of available time	Above 20% of available time

Financial analysis

Metric name	Low	Medium	High
Net revenue risk	Below 20%	20%-50%	Above 50%
Return time risk	Before 12 months	12-18 months	After 18 months
Return of investment	Below 10%	10% -20%	20%

PR analysis

Metric name	Low	Medium	High
Referral rate (with respect to current number of clients)	Below 10%	10%-20%	Above 20%
Probability of repeat	Below 30%	30-60%	Above 60%

CR1 Analysis

Statement analysis

After an initial review of the change request (CR), it becomes clear that there is ambiguity regarding the definition of a "dataset containing 100,000 samples." Based on this observation, we have identified two potential scenarios for satisfying the government's new regulation:

- **Scenario A**: The government IT office requires a set of 100,000 data points to assess the accuracy of the system. In this case, the company can generate a simulation with a number of timesteps equal to or greater than the required quantity and save the system measurements for each timestep into a file. This functionality is already present in the proposed software system.
- **Scenario B**: The company is required to provide data from 100,000 independent simulations to comply with the regulation. However, given the high computational and time-intensive nature of these simulations, Scenario B requires further consideration and can be further divided into two sub-scenarios:
  - **B.1**: If the legislation does not specify the characteristics each simulation must possess to be accepted in the dataset, the company could perform simulations with small timesteps and a low upper bound on the number of timesteps to generate the required dataset.

- **B.2**: If there are specific parameters for the simulations in the dataset, the output of this scenario would be similar to that of B.1 if the simulations are not time-intensive. However, if the simulations are lengthy due to their characteristics, this scenario could be risky for the whole project development.

It is important to note that additional clarification from the government IT office is necessary to determine the most appropriate course of action for complying with the new regulation.

To analyze accuracy compliance in the context of the system, you could start by defining what accuracy means in this particular case. Since the system is chaotic, it is important to consider the thermodynamical properties of the system in the accuracy analysis.

One approach to testing for accuracy could be to compare the results obtained from the velocity Verlet integration with a reference solution. We could use various error metrics, such as the mean absolute error, root mean square error, or relative error, to quantify the accuracy of the numerical solution.

Another approach could be to perform simulations at different time and number of particles resolutions and compare the thermodynamical properties of the system, such as temperature, pressure, and energy, with the expected values. The expected values could be obtained from analytical calculations or reference simulations with higher accuracy.

It is important to note that the new regulation might specify the accuracy requirements for the system, or provide guidelines on how to test for accuracy. If this information is available, it should be taken into consideration when designing the accuracy tests.

Finally, it is crucial to ensure that the accuracy tests are performed in a consistent and reproducible manner. This implies maintaining the traceability for the initial conditions, parameters, and numerical methods for all simulations.

Analyzing the quantity of data that must be provided to the government IT office

Affected configuration items by CR1

After checking the criteria for identifying the affected configuration items, we conclude that none of the main modules of the system, namely the GUI, Simulation or Output modules; are affected by the data volume needs of complying with the new regulation. The reason for this is that the regulation requires the provision of a dataset containing 100,000 samples, but the existing functionality of the system already includes the ability to generate and save simulation data. Therefore, it is not necessary to modify any of the main modules to comply with the CR.

Although, the CR's computational intensity must be considered in terms of the system's performance. The system must have sufficient computational resources to generate the required dataset within a reasonable amount of time. Whether that is possible or not depends on the specific details of the regulation. Finally, it is important to evaluate the impact of the CR on the system's documentation. **It is also important to ensure that the documentation accurately reflects the requirements of the CR and how they are being met by the system.**

Technical analysis

After carefully examining the requirements of the CR, we have concluded that it does not necessitate any modifications to the existing code modules of the system. Therefore, **the code coverage risk associated with the new regulation is 0%,** as there is no need to perform any code changes.

In addition, we have found that there is no technical debt associated with complying with the new regulation. Technical debt refers to the cost of maintaining software in the future when shortcuts or suboptimal solutions were made during the initial development. As the new regulation does not require any changes to the existing code, we do not anticipate any additional costs or difficulties in maintaining the system in the future.

To assess the impact of the new regulation on the system, we have evaluated the criteria for identifying the affected configuration items, including functionality, data, performance, dependencies, and documentation. Our analysis indicates that none of the main modules of the system, such as the GUI, Simulation, or Output modules, are affected by the new regulation. Therefore, we can conclude that there is no need to modify any of the existing code modules to comply with the new regulation.

In conclusion, our analysis has determined that the new regulation does not pose a need for modifying any of the existing code modules, and therefore the code coverage risk and technical debt associated with complying with the new regulation are both minimal. We recommend to take the necessary actions to comply with the new regulation, but no code changes are necessary.

Financial analysis

For scenario A, there is no financial risk as the simulations with 100,000 timesteps or more were already programmed for the testing phase of the system. Therefore, no additional cost is required to comply with the new regulation.

However, for scenario B, complying with the new regulation could be financially challenging. The regulation requires the company to provide data from 100,000 independent simulations, which is a considerable amount of data. This scenario branches further into two possibilities: B.1 and B.2.

Scenario B.1: This scenario would require a moderate amount of computational resources, which should be factored into the budget. **However, the financial risk associated with this scenario is relatively low.**

Scenario B.2, on the other hand, **has a moderate to high financial risk**, especially if the simulations characteristics make them lengthy. **To define a threshold between B.1 and B.2, we assume that a simulation's acceptable duration is 25 minutes. If the simulation takes longer than this threshold, it will fall into scenario B.2. According to a quick overview of cloud computing prices, to perform 100,000 simulations with a maximum duration of 25 minutes each, it would require around 1500 USD to complete them in a month.**

Therefore, to comply with scenario B.2, the company would need to allocate additional financial resources to cover the cost of running the simulations. This additional cost should be factored into the budget and considered when assessing the financial risk associated with complying with the new regulation.

For scenario A, no additional expenditure is required for human resources as the testing phase of the system already includes simulations with 100,000 timesteps. **However, for scenario B, due to the need of configuring 100,000 independent simulations, a budget of 500 USD is estimated to be required for human resources to oversee and manage the simulation process.**

While the financial risks associated with the proposed CR have been evaluated, **if such costs are incurred, financial resources could be drawn from the unexpected costs reservoirs. However, it is advisable to perform further analysis when other CRs are financially evaluated, as this may affect the availability of resources in the unexpected costs reservoirs.**

In conclusion, complying with scenario A does not pose any financial risk since the simulations required were already programmed. However, complying with scenario B could be financially challenging, especially for scenario B.2, which requires a considerable amount of computational resources. Allocating additional financial resources to cover the cost of running the simulations should be considered when assessing the financial risk associated with complying with the new regulation.

Human resource analysis

In the current project, we have a development team consisting of three experienced programmers who are also responsible for testing. **Given that the team is already fully loaded for the duration of the project, it is essential to evaluate the impact of the new CRs on human resources.**

Scenario A does not require any extra human time, which is excellent news for the development team. Since they are already fully loaded, the team can focus on other aspects of the project without worrying about allocating additional time or resources. **This means that there will be no extra costs associated with hiring or training new team members, and the project can proceed as planned.**

However**, both instances of scenario B require about 20 hours of extra human labor time. The time is required to configure a set of parameters for each simulation**. To ensure that this work is completed on time, it is essential to have a dedicated resource to manage the task.

To address this issue, we propose hiring an intern to perform the required work. Since the hiring process can be completed in the early stages of the project, the intern's work can be scheduled to take place during the late intermediate stage of the project. This will ensure that the development team is not disrupted and can continue to focus on other critical tasks.

The company will pay the intern about 500 USD for the 20 hours of work, which will be distributed over two months. This payment is reasonable and should not put undue financial pressure on the project. Moreover, it is essential to note that the intern will have a positive impact on the project. Since he will be working on a task that is not part of the development team's core responsibilities.

Infrastructure analysis

The infrastructure analysis for the new regulation compliance project reveals that Scenario A has no infrastructural needs as the existing computing equipment of the company is already capable of performing the required simulations. **Any personal computer within the company can run the simulations, and the processing time is not significant. Therefore, the current infrastructure is sufficient for Scenario A.**

However, for Scenario B, the company's infrastructure cannot meet the requirements. **Performing 100,000 independent simulations on personal computers would take several months, making it impractical for the project's timeline**. **Moreover, purchasing enough computing equipment to handle the workload would cost at least $4000, which is not a viable option for a one-time project. The purchased equipment would be useless after the completion of the project and would require a significant amount of space and specialized power infrastructure.**

The infrastructure analysis committee has decided that renting cloud services is the best option for handling Scenario B. By utilizing cloud computing, we can reduce the time required for performing simulations by half, while keeping the budget around $1500. An overview of cloud computing prices has shown that performing 100,000 simulations with the an estimated average computing time length of 25 minutes would require approximately $1500 for completion in one month. Therefore, renting cloud services is a cost-effective solution for Scenario B.

Timeline impact analysis

The timeline impact analysis is an important aspect to consider for the project's viability. For Scenario A, the timeline impact is expected to be negligible since the dataset could be obtained way before the project's deadline. Furthermore, the company can provide the dataset to the government IT office in such a date that even considering the 15 day time of approval, it won't impact the project's deadline.

Similarly, for Scenario B.1, the timeline impact is expected to be null. The company has enough time to carry out the simulations, given that the infrastructure requirements are met. **However, for Scenario B.2, there is a lot of uncertainty regarding the timeline impact since it depends on the specific needs of the regulation. The first-time estimation suggests a possible delay of about 15 days until approval. Still, this depends on the particular regulations' considerations.**

It is crucial to consult the existing contract for analyzing what such a delay would signify to the project's viability. The delay could impact the project's completion date, leading to additional costs and delaying the project's delivery. Therefore, it is essential to evaluate the specific needs of the regulation in advance and consider possible delays in the timeline impact analysis.

Analyzing the accuracy perspective

Identifying affected configuration items

For delimiting the affected configuration items we will consider two scenarios: one where the system's accuracy is already compliant (scenario C) and another where the system's accuracy is not compliant (scenario D). By examining these scenarios, we can identify potential challenges that organizations may face when implementing the new regulations.

Scenario C: Program capabilities are already Compliant with new regulations. In this scenario, the system is already in compliance with the new regulations regarding accuracy. This means that the system has been tested and verified to meet the accuracy requirements set forth by the new regulations. **The implementation of the velocity verlet integration for numerical integration is already sufficient to meet the accuracy requirements.**

In this scenario, the system can continue to operate as it currently does, with no need for any additional modifications. The system can undergo routine testing to ensure that it continues to meet the accuracy requirements set by the new regulations.

Scenario D: System Accuracy is not compliant with the new regulation. In this scenario, the system does not meet the accuracy requirements set by the new regulation. This means that **the implementation of the velocity verlet integration for numerical integration is not sufficient to meet the accuracy requirements.**

Hence, in this scenario, the affected configuration items are described in the following table:

CI-ID	Name	Criteria
CI01	Simulation module, specifically the numerical integrator.	1, 3, 5

CI02	Documentation regarding accuracy testing and the simulation module.	5

Since Scenario's C outcome is straightforward and doesn't imply changes to the system we will focus on Scenario D.

Technical analysis

The compliance with the new regulation regarding accuracy is of paramount importance for the success of the project. In this regard, it is essential to analyze the technical aspects of the system to ensure that it meets the required standards.

One of the significant technical challenges in scenario D is the code coverage risk, as we will have to implement and test at least one new numerical integrator. The uncertainty about which numerical integrators would improve the system's accuracy to the required level poses a moderate level of risk to the system.

To mitigate the risk, the team should conduct a thorough analysis of the numerical integrators' performance and select the one that can achieve the highest level of accuracy with the least number of errors. This analysis will involve evaluating various numerical integrators based on their stability, convergence, and error estimates. Additionally, it will be necessary to conduct a comprehensive set of tests to ensure that the selected numerical integrator performs as expected.

Another critical aspect to consider is the impact of the new regulation on the simulation module's architecture**. Since the implementation of a new numerical integrator will affect approximately 30% of the code, it is important to analyze the potential impact of the changes on the system's overall performance. This analysis will involve assessing the integration of the new numerical integrator into the simulation module and ensuring that the updated code does not introduce any new errors or bugs into the system.**

Finally, it is important to consider the documentation related to accuracy testing and the simulation module. The team must ensure that the updated documentation accurately reflects the changes made to the simulation module and the new numerical integrator. The documentation should also provide clear and concise instructions on how to conduct accuracy testing and interpret the results.

Complying with the new accuracy regulations is essential for the success of the project. Scenario D poses a moderate level of risk due to the uncertainty about which numerical integrators will improve the system's accuracy to the required level. However, by conducting a thorough analysis of the numerical integrators' performance, carefully updating the simulation module's architecture, and accurately documenting the changes made, the team can mitigate the risk and ensure that the system meets the required accuracy standards.

Human resource and timeline analysis

We need to consider the personnel who will be responsible for implementing and testing the new numerical integrators. **The coding personnel consists of three intermediate coders who will also perform the testing.**

It is important to note that they are fully loaded until the end of the project. Therefore, additional resources will be required to complete the implementation and testing of the new numerical algorithms. So the implementation and testing of these algorithms will require more time than originally planned.

A good estimate for the additional time required to complete this work is approximately 1.5 months. This estimate includes the time required to study the new numerical algorithms, implement them into the simulation module, and test the accuracy of the system using the new algorithms.

Additionally, it is important to assess the impact of this delay on the current contract. We need to determine if the delay will result in any penalties or impact the overall timeline of the project. It may be necessary to renegotiate the contract if the delay is significant enough to impact the delivery of the final product.

It is also important to consider the level of expertise required to implement and test the new numerical algorithms. **We may need to provide additional training or hire personnel with specialized knowledge in this area to ensure the accuracy of the system.**

It is important to acknowledge the risk of uncertainty that comes with the implementation of new numerical algorithms**. Since we are not certain which numerical integrators would best improve the system's accuracy to the required level, there is a medium to high risk of uncertainty in the time and human resources needed. The uncertainty stems from the fact that the implementation of each numerical integrator will require different levels of effort and expertise from the coding personnel. Moreover, as this will be a new area for the personnel, it is difficult to estimate the exact amount of time required to study, implement, and test the new numerical algorithms.** The risk of uncertainty in time and human resources will have to be addressed by closely monitoring the progress of the implementation and testing phase, and by constantly reevaluating the estimated time and resources needed.

Financial analysis

For the financial analysis, it is estimated that paying the coding personnel for an additional 1.5 months to study, implement, and test the new numerical algorithms required for **compliance with the new regulations will cost approximately 6000 USD. This cost can be drawn from the unexpected costs budget for the project. It is important to note that this cost is not insignificant and should be taken into consideration when evaluating the financial impact of the new regulations.** However, it is also important to ensure that the system is compliant with the new regulations, as non-compliance can result in even greater financial consequences. Overall, while the cost of implementing the new numerical algorithms may be a burden on the project budget, **it is necessary to ensure compliance and avoid potential legal and financial consequences.**

CR2 Analysis

Configuration items affected by CR2

Upon considering the requested changes in CR2, it becomes necessary to analyze why it is essential to consider the three modules of the system as affected configuration items. The client has requested that the software include new simulation methods such as molecular dynamics, Montecarlo methods, and modules to simulate solids, liquids, and plasma. This will require significant modifications to the software, impacting not only the simulation module but also the GUI and output modules. The identified affected CIs are:

CI-ID	Name	Criteria
CI01	Simulation module	1,2, 3,4, 5
CI02	Documentation	5
CI03	GUI module	1,2,4,5
CI04	Output module	1,2,4,5

The GUI module will need to be modified to accommodate the new simulation parameters requested by the client. Since there are no visualization tools in the proposed system, the GUI will be responsible for displaying the simulation parameters and progress**. The GUI will need to support the different parameters and configurations for the different simulation types, which will require changes to the existing GUI module.**

Montecarlo and molecular dynamics simulations are implemented with different algorithms, and this will necessitate changes to the simulation module. The current implementation of the simulation module is based on the velocity verlet integration method, which is not suitable for Montecarlo. Therefore, the simulation module will need to be updated to include these new simulation methods.

The output module is another affected configuration item. It will need to handle new types of outputs for different simulation types. For example, the module may need to output the properties of solids differently from those of liquids or plasma. Thus, the output module will require modification to ensure it can handle the new simulation types and produce the required output formats.

The requested changes in CR2 will require modifications to all three modules of the system. The GUI module will need to be modified to accommodate new simulation parameters, the simulation module will need to be updated to include new simulation methods, and the output module will need to be modified to produce different output formats for different simulation types. It is therefore necessary to consider all three modules as affected configuration items to ensure that the system can handle the requested changes effectively.

Technical analysis

The client has requested the implementation of several simulation methods in the system, including molecular dynamics, Monte Carlo methods, and modules to simulate solids, liquids, and plasma. **However, there are several uncertainties and technical challenges associated with the implementation of this CR.**

The client has not provided clear requirements for the Montecarlo simulations. There are various types of Montecarlo simulations available, such as those for hard disks and hard spheres in two and three dimensions, respectively. The vast number of possibilities for Montecarlo simulations makes it impossible to cover all possible scenarios, and it is essential to consider the client's specific needs. **Therefore, the implementation of Montecarlo simulations requires careful consideration and collaboration with the client to ensure that the simulations align with their requirements.**

The client has not provided clear requirements for the simulations of solids and liquids. The proposed system is not capable of calculating variables such as stress or strain tensors for solids or Reynolds numbers for fluids, as this type of software is typically used in a different context**. However, the system can simulate liquids, solids, and gases in the context of molecular dynamics with Lennard Jones potentials. Still, the information obtained from solids simulations may not be relevant due to the nature of these simulations.**

The client has not specified the properties of plasma they wish to simulate. **Simulating plasma poses a particular challenge as it may require special integration methods because magnetic forces depend on the first temporal derivative of the particles' position. Furthermore, plasma simulations are a frontier topic in the field, which increases the technical uncertainty associated with implementing this CR. The technical team has suggested that this CR may introduce complicated situations that require additional resources, including time and cost.**

Moreover, implementing all the requested simulations could increase the size and complexity of the system significantly. Although it is difficult to quantify the extent of growth and complexity, even the simplest implementation could increase the amount of code by 300%. It is essential to note that complexity increases disproportionately to the project's scale, which implies a high-risk associated with the project's incremental growth.

To implement this CR, it is necessary to consider the risks associated with the technical challenges and uncertainties mentioned above. Collaborating with the client to define their specific requirements for each simulation type and carefully selecting the simulation methods and algorithms can help mitigate these risks. **Additionally, conducting thorough testing and validation processes to ensure the accuracy and reliability of the simulations**

is crucial. It is also important to keep in mind that implementing this CR may require additional resources, including time, cost, and technical expertise.

Human resources and timeline analysis

Taking into account the technical analysis previously performed, it is clear that the implementation of this CR represents a significant risk for the project. This risk is not only related to technical uncertainties, but also to human resources and timeline constraints**. The technical uncertainties lead to difficulties in estimating the amount of additional resources required, which directly impacts the timeline of the project.**

It is clear that, in order to implement this CR, additional human resources will be required. However, the uncertainty regarding the size and complexity of the project makes it impossible to accurately estimate the number of resources required. Therefore, it is necessary to approach this situation with caution, and allocate a significant amount of time and resources to ensure that the project can be completed successfully.

It is essential to ensure that the project team has the necessary skills and experience to handle the challenges presented by this CR. The current development team doesn't have the experience in molecular dynamics, Monte Carlo methods, and the simulation of solids, liquids, and plasmas required by even the simplest implementation of the CR. Additionally, given the uncertainties associated with this CR, it is important to have a contingency plan in place in case the implementation of this CR proves more difficult than anticipated.

The implementation of this CR represents a significant risk for the project in terms of human resources and timeline constraints. Therefore, it is important to approach this situation with caution, and allocate a significant amount of time and resources to ensure that the project can be completed successfully. Additionally, it is crucial to have a contingency plan in place.

Financial analysis

Based on the technical analysis of the CR, there is a significant amount of uncertainty regarding the project's growth and complexity, making it difficult to accurately estimate the financial implications of implementing the CR**. As a result, the budget for the project must be flexible and able to adjust to any unforeseen circumstances or changes in the scope of the project.**

Given the prospective code growth provided by the technical analysis, it is expected that the budget will grow in a non-linear way with respect to it. This means that the cost of implementing the CR may be higher than originally estimated, and the financial plan should take this into account. This situation poses a high risk for the project.

To mitigate the risk associated with the financial uncertainty of the project, it is recommended that the budget be redesigned with flexibility in mind. This includes building in contingencies for unexpected costs, maintaining a reserve fund, and ensuring that there is adequate financial oversight and management throughout the project's lifecycle.

Additionally, it is essential to maintain transparency and communication with stakeholders regarding the financial status of the project. Regular reporting on expenditures, budget adjustments, and potential financial risks should be provided to ensure that all parties are informed and able to make informed decisions.

CR3 Analysis

Configuration items affected by CR3

The change request requires the use of an open-source numerical package for the simulation module, which means that the original numerical package proposed for the system will no longer be used. **This change affects two configuration items (CIs) of the system: the simulation module and the output module as described in the following table.**

CI-ID	Name	Criteria
CI01	Simulation module	1,2, 3,4, 5
CI04	Output module	1,2,4,5

The simulation module is the core of the system, where all the numerical computations are performed. The change from the original numerical package to the open-source numerical package introduces the need for learning a new software tool.

The output module is affected by CR3 because it needs to adapt to the new format of the open-source numerical package. If the format proposed for the system is incompatible with the open-source numerical package, it will be necessary to implement changes in the output module to ensure compatibility with the new package. In this scenario, the output module must be re-designed to fit the new format.

Technical analysis

After analyzing the proposed change request, we can conclude that using the open-source numerical package as requested by the client could be advantageous for the project**. The new package may require some time to learn, but it could significantly reduce the implementation and testing time, allowing the developers to focus on other critical aspects of the system. Additionally, the fact that it is open-source means that there will be no additional licensing costs, and different versions of the package may be available, providing flexibility in case compatibility issues arise.**

However, using a new numerical package raises the need to study how well it adapts to the current system design. While this may suggest a low risk, there is still a need to ensure that the new package is compatible with the system's structure and that it does not affect the overall performance negatively. This compatibility analysis must be performed thoroughly to prevent unexpected problems and delays in the development process. **This situation is considered as a low risk for the project.**

Therefore, we recommend performing thorough compatibility testing between the new numerical package and the current system design before implementing this change request. The testing process must ensure that the new package works correctly with the current system, including the output and simulation modules. Finally, it should be noted that given the potential changes in the codebase, the prospective increase in complexity would impact the development cost, and the budget should be adjusted accordingly.

Human Resource and Timeline Analysis

The adoption of the new numerical package may bring certain advantages, such as reducing implementation and testing time significantly. This will allow developers to focus on other critical aspects of the system, potentially leading to a lower risk for the project.

However, the learning curve associated with the new numerical package should be taken into consideration**. Although it will take at least a week for developers to learn how to use it effectively, it is important to note that the deadline for the project will not be affected since the time required for learning the new package will be compensated for by the reduced development time of the numerical algorithms.**

The development and testing team is available for the project, but additional training may be necessary to ensure that they are well-versed in using the new package. This training will require additional resources. The human resource and time risk for the project from this perspective is hence low.

Financial Analysis

The adoption of the new numerical package may have financial implications for the project. While the package is open-source, and therefore, there are no licensing costs**, it is important to take into account the learning curve associated with the package and the financial resources to train the development team if needed.**

Overall, the adoption of the new numerical package may result in cost savings in the long run, but it will require additional resources upfront. However, if the package is well-suited to the system design, the savings in development and testing time may outweigh the costs of the additional training required.