Available engineering software for simulation in various fields

Islam Magomedov\textsuperscript{1}, Timur Aygumov \textsuperscript{2}, and Natalya Pikuleva \textsuperscript{3}

\textsuperscript{1} Kadyrov Chechen State University, Grozny, Russia
\textsuperscript{2} Dagestan State Technical University, Dagestan, Russia
\textsuperscript{3} Kazan National Research Technical University named after A. N. Tupolev-KAI, Kazan, Russia

**Abstract.** Modern analytical tools for structure analysis can be found in different forms and states. The market is full of different tools for engineering purposes. Some of them are free and some provide partial access to the software without fully purchasing them. For the common man, it is hard to select the one that will suit them perfectly without any experience or deep knowledge of these tools. The work will present the four tools that are commonly used in the scientific world for analysis of different areas in the engineering world. The work will present in brief the overall background of the software. Also, the fields that they are most commonly used and gained a reputation. Some comparisons of the tools will be presented in the paper.

1 Introduction

Modern tools allow engineers to test virtual models before testing the real prototype. Back in the past to test or at least to perform a simple mathematical calculation one could spend many hours. The result would not always be the desired outcome. It would take many scientists from different fields and a large workforce to work together to solve some analytical issues. However, it is completely different in the present as technological progress has given humankind many tools that are easy to handle to overcome not just engineering but daily problems. These tools provide time savings, and quality results (with the correct knowledge on how to use boundary conditions).

As time passes these tools become easier to use. With artificial inelegance advancement, some tools could perform extra analysis, where the provided structure is further improved by the given conditions. Technological progress in many different fields allowed scientists to utilize these tools throughout the whole process of unit production. These tools are capable of performing almost every possible task from building to the final product and even the future lifespan of the unit. Nonetheless, the real representation is required to validate the results as the possibility of error occurrence. Errors are a vital part of the whole process as they illustrate the weak spots in the structure. Therefore, these tools are used with some other methods to create a unit that will be up to standards.

Nowadays, the market is filled with engineering tools that can perform enormous tasks within itself without extra plug-ins. Some tools are specifically monodirectional and those

\* Corresponding author: ismwork@mail.ru
that can perform numerical tasks. They also are different in many other aspects such as complexity, fields, design, price, and so on. Therefore, choosing the correct tool for an analysis is a major part. The article will look at software (tools) that are used to analyze the structure. The following tools will be covered: SolidWorks, Ansys, Fusion360, and Abaqus [1, 2, 3].

2 Engineering software

2.1 SolidWorks

SolidWorks has been around since 1995 and has shown its usefulness when dealing with modelling and partial analysis. SolidWorks is a powerful tool when dealing with different engineering and design fields. Its key appealing factors are related to its user-friendly interface, which most of the other tools adopted directly or partially, meaning that tools that occurred after were using this tool as the standards to look up. SolidWorks combines in itself not just the modelling of separate parts, but also assembly, drawing, and most importantly its simulation part. In general use, when constructing a single part one can use its robust functionality with a user-friendly interface to create the most complex items. The built-in assembly allows users without a second application to continue the work and assemble the created parts. Assembly in SolidWorks consists of complex constraints that allow different adjustments in the overall structure. As with any other tool, it does have a drawing section, which is not lacking any advantages. The last and the most powerful tool that can be used in this tool is simulation. The capabilities of this part are vast and cover diverse fields making it suitable for different analyses. It can perform stress analysis, fluid dynamics, thermal studies, frequency analysis, and many more [4, 5].

2.2 Ansys

While SolidWorks is aimed at checking all three main points (parts), which are modelling, assembly, and simulation, Ansys uses a bit different approach. Its main accent in the analytical part makes it more appealing for those who want more control over simulation rather than the whole process from building to analysis. This tool is created for engineering simulation by Ansys, Inc. Similar to solid works it copes with different fields and can perform more complex tasks. This tool can perform the following: structural, acoustics, vibration and thermal analysis, fluid and explicit dynamics, electromagnetics, and others. It is clear that Ansys is focusing more on the analytical part and its variety is vast compared to the previously mentioned tool. Therefore, scientists prefer the building and assembly part done in a separate software, while analysis is performed using a tool that mostly suits the case [6].

2.3 Fusion360

This tool is similar to the first one but widens its abilities by introducing novel approaches. Fusion 360 is Autodesk's tool, which is a cloud-based 3D computer-aided design. As it was said this tool includes all the necessary parts for the engineers. Within its environment, one can find all the needed parts like modelling, assembly, simulation, and other necessary add-ins. Its general dissimilarity to other products is that it includes in itself CAD, CAE, and CAM. It is also a cloud-based platform allowing the users at a fast pace to perform computational parts. Similar to the second tool its capabilities in simulation are vast. It does include all the aforementioned abilities of the second one and can perform many more. It
seems that this tool is more progressive in terms of utilizing new technologies to push the limits of its own [7, 8, 9]]

2.4 Abaqus

This tool is similar to the second one in terms of its capability. It is aimed at analyzing the built structure. It is not well suited to build and assembly. The core purpose is to put all the effort into the analytical part, which makes it a perfect tool to do the simulation. It is a powerful tool used by researchers to analyze complex mechanical and structural behavior. This tool includes more complex analytical abilities. For example, it can be used to perform the following: soil-structure interaction, nuclear and chemical process engineering, bioengineering, and so on. One can see the different paths it takes when it deals with complex and rare analysis (in analytical tools) [10].

![Generated image of simulation results](image.png)

Fig. 1. Generated image of simulation results

3 Application of engineering tools

As one can imagine, the use of engineering tools in industry is vast. Various fields are greatly advancing their abilities through the use of such software. The variation in utilization varies from parts to the ready product. As it was stated before, these software packages can perform not just modelling of three-dimensional parts, but they can do complex analysis on durability,
weak spots and many more. Therefore, the following paragraph will be devoted to the application of engineering tools in different industries. The following industries will be covered: automotive and aerospace, medicine and construction and civil engineering.

### 3.1 Automotive and aerospace industry

The automotive and aerospace industries are the main drivers of this software improvement and existence. These industries are greatly utilizing this software in the whole process. These tools allow engineers to design and build components and assemble them for analysis even before the product is being produced in the real world. These tools allow scientists to perform the following simulations: crashworthiness, aerodynamics, and thermal management and so on. They also introduce possibilities for the engineers to work out the lifespan of the product, the possible appearance of weak spots and defects. The accordance of generative design allows the further improvement of the structure in different ways. The material usage can be minimized through generative design. Different possible design variations can be suggested. The overall performance and whole structure can be analysed in compliance with regulatory standards and safety requirements. It is obvious that the created field is now fully dependent on these engineering tools and their improvement.

### 3.2 Medical industry

It is hard to imagine the use of these tools in the medicine industry. However, they found their niche in this area. The first and most obvious field of application is modelling and design, as was mentioned in the previous paragraph, of apparatus and equipment for medical use. The modelling of medical apparatus and equipment can be done by using tools that can ensure the quality of a product and its durability. Also, it can be utilized for the following: designing medical devices, implants, and prosthetics.

### 3.3 Construction and civil Engineering

This area is the one that uses tools similar to the automotive and aerospace industries. Again, the first use is design and modelling, but in this field the analysis part plays a major role as structure integrity and its safety are directly related to the health of humans. Tools also play a significant role in visualizing. It is similarly important for the construction to have an appealing appearance and at the same time compliance with the regulations. The tools described in this article are capable of handling different tasks, from simple to complex and hence, they suit the construction area.

### 4 Generative comparison

By observing these tools, it is clear that they all go by their own paths yet there are collisions of lines where the similarity is shared. It is clear that the main point of SolidWorks is to be good at building models and structures rather than analyzing them. It has a user-friendly interface that attracts immediately users from a wide range of experiences. It is built to be used with ease and it can be seen throughout the whole process of building a part then assembling it with other built parts and finally analyzing it through various steps. That is why it lacks the capabilities to perform complex or wide-range analysis. However, it does not mean that it is not capable of robust simulation. Ansys and Abaqus have a different path if compared to SolidWorks. It is clear that the two tools are focusing on analysis and not on building the structure or body itself. As it was discussed before these tools are built for
analysis. They can do other parts as some of the similar tools, but still accents on the analytical part. These two tools have greater control over simulation. In their list, they have divers’ fields that can be handy for the researches. With these advancements and greater advantages in terms of analysis, there is a drawback too. The main disadvantage of these tools is a mono-orientational issue. These tools lack abilities to construct a part and then assemble them. Meaning they need an additional tool for modelling and assembly. Some boundary conditions or constraints must be added before analysis. Therefore, one needs to understand the clear path of necessary steps required to properly select a best-suited tool. The one tool that tries to be optimal in almost any stage is Fusion360. This software tries to balance the stages in itself from building CAD to its final product state, where it ends up in the consumer’s hand. Its novel approaches with a combination of new technology push its limits to a new upper step compared with other tools. It has a user-friendly interface and yet combines many functions that can be easily navigated and used. It has both assembly part and simulation part built in a way that a common user will understand. However, this one is too for drawbacks. The first thing lies in its functionality. To many could mean less application. As not all of the tools and functions are available in the main window. The second one is related to dependency on the new technology. For example, cloud analysis depends on proper connection and the absence would mean a delay in the analysis. The one thing is clear the market is full of software that allows consumers to choose the best variation for any purpose. It depends on the consumer or on the researcher to select an appropriate tool that will include all the necessary steps [11, 12].

5 Conclusion

To conclude, the paper covered some popular tools for the simulation of a given structure. The work is done due to the availability of many tools in the market for the analysis. It is hard to choose from different tools that are good at one part and similarly bad or mediocre at other parts. For the comparison, the most commonly used tools were selected in this work. These tools are as follows: SolidWorks, Ansys, Abaqus, and Fusion360. This work beefily outlined each tool and the main focuses that they have. The comparison was also done to present a clear vision for those who want to utilize them in analysis. It was clear that they all are different and at the same time have some common parts. It was established that SolidWorks is more for construction rather than analysis-focused. Abaqus and Ansys are built for the analysis of complex structures and with capabilities to perform various analyses in different fields. The last one, which is Fusion360 ticks all the boxes, although has some drawbacks too.

References

5. V. A. Gerasimov, M. G. Nuriev and D. A. Gashigullin, 2022 International Russian Automation Conference (RusAutoCon), pp. 75-79, (2022)


9. I. Magomedov, E. Belashova, M-D. Bersanov, Review article: enhancing the power of artificial intelligence in mechanical design, E3S Web of Conferences. VOL. 402, 03042 (2023)

