CAD-SYSTEM COMPARISON
CATIA V5 AND ZW3D 2011

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**Summary**

ZW3D 2011 is a very young CAD-system that Pär Nobring at r.a.p.s asked us to put against one of the world leading CAD-systems today, Catia V5. Since we are going through an education that centers round engineering and technical facts, this comparison had to be in tune with that.

After discussion with both Pär Nobring, and our mentor Johan Wretborn, we came to an understanding regarding what should be done. We performed a technical comparison of the following main features:

- KBE tools (Knowledge Based Engineering)
- Curvature and Continuity Analysis
- File Format Translation Verification
- NC Machining

We are very happy with all our result, if you don't count the failure with the NC machining section. However none of the tests we did turned out unnecessary. It lead to a greater understanding than we already had, and gave us very useful experience.
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Introduction

Since r.a.p.s, a company in Landskrona, Sweden, is aiming to be the first reseller in Sweden of ZW-SOF'T's latest application, ZW3D 2011, some knowledge about the software and it's capabilities may come in handy. Therefore we came in contact with the CEO, Pär Nobring, asking us to perform a comparison between ZW3D 2011 and Catia V5.

The goal is not to perform a comparison for marketing reasons, although the results we get may be used for such a purpose. We are aiming to come up with results that actually have a significant meaning in certain types of modeling.

In order to test the performance and mathematics behind the program, we are going to see how well the program can translate it's native file format to the STEP standard format, use the existing but limited KBE-tools that can be found in ZW3D 2011, try to test how well the software manages surface modeling of the more advanced kind, and perform a NC-machining setup and then see if the result from this significantly deviates from the results computed in Catia V5.
Background

We received this assignment from Pär Nobring at r.a.p.s, a Swedish company specializing in technical consulting, competence improvement programs for other companies and in-service training.

The possibility for this project was created when r.a.p.s decided to become the first Swedish reseller of ZW-SOFT's latest CAD-software ZW3D 2011. In order to give r.a.p.s more knowledge about the software and it's capabilities, they asked us to do a comparison against an already established and powerful CAD-software, in this case Dassault Systemes Catia V5.

ZW3D-2011 isn't completely new to this market. The software is a collaboration of ZW-SOFT and VX Corp., which ZW-SOFT bought in 2010. They then developed ZW3D 2010, and has now developed the new version ZW3D 2011, however it's still in BETA-stage.

ZW-SOFT first draw attention to themselves when they introduced a software solution much simular to AutoCAD, this was called ZWCAD, as a less expensive 2D drafting package. Now though there fighting their way in to the 3D market and competing with other NURBS-based applications as Autodesk Inventor, Autodesk Alias and Dassault Systemes Catia V5.
Presentation

We’ll begin with a short presentation of both CAD-systems. The two systems we working with are Catia V5 and ZW3D 2011, Catia V5 is the most well known and established of these two.

Catia V5

Catia (Computer Aided Three-dimensional Interactive Application), initially known as CATI (Conception Assistée Tridimensionnelle Interactive — French for Interactive Aided Three-dimensional Design) is a CAD-system that have been around for quite a long time now. It was created 1977 at a french manufacturer of aerospace technology, Avions Marcel Dassault.

Since then there has been several versions of this software, currently at Catia V6, and it's one of the most used CAD-solutions in the world. The largest industries which use Catia is of course the automotive industry, but also aerospace industry. Here in Sweden you can find Catia at Volvo's development department, SAAB Aero industries and many more.

Catia is a very powerful CAD-system which handles not only modeling but also analysis, simulation and different KBE tools. This makes it to an all-in-one solution for many companies around the world, instead of having several different softwares for these tasks.

ZW3D 2011

This is something of a newcomer in this world. They are presently only at the second version of the software. The system is developed by ZW-SOFT, a Chinese software development company. They first became known in the CAD-world when they introduced ZWCAD, which is a 2D drafting tool very similar to Autodesk AutoCAD.

In 2010 ZWSofb bought VX Corp, and therefor got access to VX CAD\CAM solution. And it's this software that ZW3D is based on today.

ZW3D is a less expensive alternative to many other CAD-solutions on the market today. This can make it very attractive software for smaller companies that don’t need all the advanced tools that you get in e.g Catia or Pro Engineer.

Some of the features you get in ZW3D 2011 is solid and surface modeling, and a NCCAM module. You don't get any tools for structural analysis or simulation. But ZW3D has prepared the system for the ability to use other softwares as a plug-in for these tasks.
Method

In this section we will walk you through the different steps and methods we'll be using in order to come up with the results we need. It was understood that we had to use methods that could be created in both softwares, but coming up with these were harder than we first thought.

**KBE Tools (Knowledge Based Engineering)**

Since the only KBE tool available in ZW3D 2011 is an optimization tool called “Design Optimizer”, this is the one we're going to put to the test. And this will be against the “Product Engineering Optimizer” in Catia V5.

**General**

The basic purpose of an optimization tool is simple. To generate a result based on values or parameters that you input manually. As an example of this we can take the following:

You're going to design a bottle of some sort, and you know that the volume of this bottle must be X mm$^3$. Other measurements shall be customized after this requirement. You then input your given volume as the “Target Value” of the optimization, and the measurements that control the shape and volume of the bottle as “Free Parameters”

Now when you run this optimization the “Free Parameters” will be modified to give you your given volume. You can also set up rules and constraints for the “Free Parameters” if you have other requirements regarding the shape an so on.

**Problem**

The problem we're facing with this task is to create a scenario where the two CAD-systems generates different results, really to see which software fails first. This is really a test for the mathematics that the tools are based on, and which software has the most efficient way of solving the equations.

We tried a couple of ways to accomplish that, and the way we're going to present in this paper is the method that we think worked best, and showed the most apparent result.
**Method**

To create a controlled “Multi-section Solid”, that are identical in both systems, do individual optimizations and then see if one software can replicate the results that the other software generates using the same input data. If we discover a significant difference between the results, or that one system can't replicate the results, we can draw the conclusions from that, depending on what the results might be.

See “KBE Tools (Knowledge Based Engineering)” in the Result section (page 12).
File Format Translation Verification

When working in the CAD related industry you will encounter situations where you must convert your CAD-files to a different format so they can be read by another software. The most common file format for this operation is STEP (.stp), which is used worldwide with good results.

Depending on which CAD-software that performs this operation you will get a slightly different end result. In most cases this deviation is insignificant. What we are going to find out is if that is the case with ZW3D 2011.

Problem

The first problem is to create a fairly complex surface that can the absolutely identical in both CAD-systems. In our case a double curved surface would be ideal.

We can never really say that one system has the correct result, since every CAD-software does this translation a little bit different. All we can present is that there is a deviation between two results. However if we use Catia V5 as a reference, and then compare the result from ZW3D against Catia's result. This way we can get an idea of how much ZW3D's result deviates from the result generated in Catia V5.

The alternative would be to use a third CAD-system to compare these results. But if we do that, then the margin of error from that software also plays a role in the comparison. So no matter how many CAD-systems we use to perform this task, there will never be a way to say for certain what's right. The only advantage it would bring is the opportunity to perform a more comprehensive statistics, but the fact remains, you have no way of knowing for sure which result is correct.

As a compromise we can use a translator software e.g Transmagic, to convert the files. If we can see some sort of pattern among the results we get, we can draw our conclusions from that.

Method

It took some thought before we came up with a way to create the surface we needed for our comparison. We knew thanks to our testing that we couldn't use splines, because these are drawn different in Catia and ZW3D. Then we thought about using a swept radius along another radius, but this doesn't give us a true double curved surface. After a meeting with our mentor, Johan Wretborn, we came up with a further development on our own idea. This was
to use a third circle which is extruded through our swept radius, if this intersected circle is trimmed out, you get a true double curved surface which is completely controlled with fixed dimensions. (See attachment B)

When it comes to the translation itself we are going to use both systems for the translation to STEP-files. We are also going to use Transmagic R8 to convert CATPart to STEP, unfortunately Transmagic can't read or convert Z3-files (the file format of ZW3D) since this is a new and fairly unused file format.

The reason for this is to see if that STEP-file is closer to the result from Catia V5 or ZW3D 2011. Depending on which case it turns out to be, we'll be able to draw an uncertain conclusion of which file or files that has the better quality. If the Transmagic STEP-file is closer to the ZW3D STEP-file, that could mean that Catia doesn't convert to STEP as well as ZW3D or Transmagic. However if the result from Transmagic lies closer to Catia's own STEP, this could mean that ZW3D doesn't convert to STEP as well as it should do.

See “File Format Translation Verification” in the Result section (page 12).
Curvature and Continuity Analysis

If the purpose with the work you are doing is to create surfaces or edges with certain requirements regarding the different continuity levels, an important tool to have in your CAD-system is a continuity or curvature checker.

These tools are available both in ZW3D 2011 and in Catia V5. However the tools in ZW3D are very limited and don’t display the results in the same way, you can use it to check the continuity of an edge or surface.

ZW3D Tools

The tools that are available in ZW3D are “Display Curvature Plot of Curve” (Porcupine) and “Show Surface Curvature”. The drawbacks with the porcupine tool in ZW3D are that you can't get any data results from this tool in this version of the software, we've been told that this feature may be added in future versions.

When it comes to the surface curvature tool it basically works in the same way as Catia's “Surfacic Curvature Analysis”, however the settings in ZW3D are very limited. The only thing you can get is basically the max. and min. curvature of the surface or face, and the curvature in a specific point.

The same goes for the “Display Continuity Error”. This is ZW3D's equivalent to Catia's “Connect Checker Analysis”. In ZW3D this feature has quite poor functionality for our purpose. It can detect continuity errors just like Catia, but only up to G1 continuity, ie tangent continuity. This is a very simple task for both systems to compute.

A mutual “problem” for both these tools are that the results isn't saved, neither in the specification tree nor graphic on the screen. This makes it a bit inconvenient to use if you are working with multiple faces.

Problem

We must create and use a surface that we know has the identical structure in both systems. A way to accomplish these results is to use the same technique which we used to create the surface for the translation verification.

The next obstacle will be to verify the result we get from both CAD-systems, if these results
deviate from each other. If we get the same results from both, we should be able to assume that the result is accurate.

If the results would have a significant deviation we will need a third CAD-system to do the exact same thing, in our case PTC Pro Engineer, and if this result corresponds with either of the two results we got from ZW3D or Catia, we can assume that the answer computed by two systems should be the correct one.

**Method**

We have decided to go with the same face that we created for the “File Format Translation Verification”. The decision was made for the same reasons as before. We needed a double curved surface that could be created in the exact same way in both systems, and built on controlled constraints, and not splines and other undefined curves.

The tools which will be used are: “Display Curvature Plot of Curve” and “Show Surface Curvature” in ZW3D 2011. And in Catia V5 we will use: “Porcupine Curvature Analysis” and “Surfacic Curvature Analysis”.

We will test the “Display Continuity Error” tool in ZW3D and the “Connect Checker Analysis” in Catia V5. However we think that the results for tangent continuity will be the same since this is a very simple computation.

See “Curvature and Continuity Analysis” in the Result section (page 13).
**NC Machining**

Since ZW3D 2011 has a fairly sophisticated NC/CAM module, we think a test of the module and its features would be a constructive test to perform. A couple of things that we are aiming to find out are how accurate results the NC-simulation can generate, and how complex geometries the software can handle.

To conduct this test, the best scenario would be to have a CATProcess from Catia. This means that we have a result that we can strive for.

What we would like to achieve is to generate to solid models from the NC simulation in both Catia and ZW3D, and then perform a comparison with these two models. If the model from ZW3D has a significant deviation, we can determine that the result from ZW3D isn't as accurate as the result from Catia.

**Problem**

The biggest challenge we're facing with this test is to create the CAM-plan in ZW3D. This software is new to us, and creating a CAM-plan can be rather difficult. We have some experience of this in Catia V5, so we should manage it in Catia.

If we can get an existing product made in Catia V5 would be the best scenario for us, and if this product already has a finished CAM-plan, that would be optimal. In that case we have a result that we can replicate in ZW3D.

Last but not least we must find the tools, in possible, to save the models generated by the NC simulation. If this cannot be done, we will have no way of comparing the results from the different CAD-systems.

**Method**

Through contact with Pär Nobring at r.a.p.s we have gotten a model from another company called SWEP, specializing in heat exchangers. This product contains all the CATParts, NC-setup, and CATProcess, complete with a CAM-plan. This was the best input for us to conduct these tests regarding NC machining. The information from SWEP is confidential, however we're allowed to show some images from our work process.
To find out whether the tools to save the simulated model is available in Catia or not we are going to use our contacts with knowledge of the software. We are also going to sign up for the online discussion forum at COE.org. A forum focused on the PLM solutions from Dassault Systemes, including Catia V5.

To find out if the tools are available in ZW3D we are going to contact their support department and see if we can get an answer on this. And to learn the CAM-module in ZW3D we are going through a number of tutorials created by ZWSoft themselves.

See “NC Machining” in Result section (page 14).
Result

Here we will present all the data and results we got from our testing. Divided into different sections and with explanatory images showing the different tests and how we performed them.

Some addition to our previous methods have been made, we will also present these additions under each sub section in this segment.

**KBE Tools (Knowledge Based Engineering)**

See “Attachment A” for work progress under the KBE section.

Conclusion

It appears that the mathematics supporting ZW3D 2011 isn't as exact or powerful as the mathematics supporting Catia V5. In all of our tests of the optimization tool we got deviations of various sizes, the test we presented here was the most apparent. However the deviations are fairly small they can almost be counted as insignificant, but if it comes a time when the demands on a certain product is higher than usual, this can prove to be an important drawback.

The alternation of our ranges has no reasonable explanation as we see it. It changes, but still it generates a value that lies within the original limits. If this has to do with that the program must test its way to the result and can't manage tight ranges, or something else, we can't know.

**File Format Translation Verification**

See “Attachment B” for work progress under the translation section.

Conclusion

In two of our three tests we got pretty much the exact same result. The deviation between the STEP-files created with Catia and Transmagic is very small. However the deviations between these to files and the STEP-file created in ZW3D there's a great deviation.

In having said this, we can't really say which result is the correct one. No matter which methods or software you use, you will never be able to know where the source of the error lies. Depending on the software you use for this geometric comparison you will probably get different results on the deviation. But what we can be sure of is that the deviation is there.
Since we got pretty much the same results from two of our comparisons we’d like to think that the STEP-files created in Catia and Transmagic are better than the STEP-file created in ZW3D. Though this result may not only depend on the translation, but also on the modeling of the part itself. Because we used specific radii and constraints to create our face it should be exactly the same. To get an even better result the ideal way would had to mean the use of a third CAD-system where we also created the face, and then compared this one as well. Unfortunately we didn't have access to a third software for this test.

**Curvature and Continuity Analysis**

See “Attachment C” for work progress under the translation section.

**Conclusion**

To begin with we were right about the “Display Continuity Error” tool in ZW3D and the “Connect Checker Analysis” tool in Catia. We got identical results in our tests on the G1 or tangent continuity edges. In Catia you can get results all the way up to G3 continuity, but this is not the case with ZW3D, it’s limited to G1 continuity.

Therefor we won't present any of these results as we don't find it necessary.

When it comes to the results from the curvature analysis tests we performed we were a little bit surprised. We thought that we would get at least a small deviation between the results from Catia and ZW3D, but we were wrong.

We got as close to identical results as possible. Since we got the same results from both CAD-systems we are going to presume these results are accurate.

We are going to draw another conclusion from this testing. From our curvature analysis we got the same results from both systems. However when we compared the STEP-files there were a much greater deviation. This must mean that the translation to STEP in ZW3D isn't as accurate as in Catia V5. If the translation was equally accurate we would have got a much smaller deviation between the STEP-files.
**NC Machining**

The first thing we decided to do was to learn the NC\CAM module in ZW3D 2011. We soon discovered that the software had a feature that automatically calculates the CAM-plan for e.g 3-milling. It detects the features in the geometry and optimizes the tool changes and the tool paths. After experimenting with this tool we soon discovered that our own machining tactic was a bit unpractical and had room for a lot of improvement. This depends both on our lack of experience in NC machining, and lack of experience in ZW3D. Therefore we chose to use the automatic function.

The computation of the tool paths was a very time consuming process and very demanding of the computer we ran it on. When we finally got the finished CAM-plan it was so tough to work with that the computer almost crashed.

When we tried to simulate the machining the computer did crash, because of lack of memory or some kind of internal error. We then tried it on a way more powerful computer, but with the same result. If this is because the operation is so resource draining or some kind of internal error in ZW3D, after all it's still in BETA stage.

See "Attachment D" for work progress under the NC Machining section.

**Conclusion**

It was very disappointing that we didn't manage to get a result from this test. It would have been really interesting to see if ZW3D's simulated model would be as accurate as the original model generated in Catia V5.

Despite the fact that we failed the first part of this test, it wasn't a complete failure. We got a pretty good understanding of the NC module in ZW3D, and it's surprisingly functional, Some of the features including the automatic 3-axis milling tactic, was very user friendly.
Conclusion

ZW3D 2011 is a very promising CAD-system. In some of our tests we may have made it look like the features are inaccurate and that the software has poor functionality. However the deviations that we have presented are very small, in most cases even insignificant. It only matters when you have very high demands on the product you’re designing.

Another thing you must have in mind when judging this software is that it's still in BETA-stage. This means that any bugs or other faults you might find when you're working in the program may very well be gone when the full version is released.

It's surprising to see how small the differences are between two completely different CAD-systems. Once you learned the names of the equivalent tools in the unfamiliar software, it's very easy to get started and learn the more advanced features.

Another very good thing that has come with all this work we have done, is all the new tools we've discovered and began use of in Catia V5. Tools that can be very useful in future use, and a great advantage when we start working in the future.

It's a very tough task to stand up to a CAD-system as well established as Catia V5, however we think ZW3D did a very good job after all. You can't expect a CAD-system as unknown and new as ZW3D to be better than a system that has been in development for over 30 years.

But with the same pace the have kept so far, we reckon that ZW3D very well might be one of the big ones in a matter of years.
Attachments
Attachment A – KBE tools

In the following attachment we will present images taken from one of our tests, and text to describe these images and the steps we made. The solid we used to perform the optimizations is a multi-section solid with the following geometry:

Base_Radius / R1 = 50mm
Middle_Radius / R2 = 25mm
Top_Radius / R4 = 50mm

The shape is also controlled with spine, so it's swept identically in both systems.

One of our tests consisted of an optimization performed in Catia V5 which we then tried to replicate in ZW3D 2011. The optimization window in Catia has the following inputs:

We set the “Optimized parameter” to the volume of our shape.

Target value = 0.45 m³

After we ran the optimization we got the following results:

Base_Radius / R1 = 1504.854mm
Middle_Radius / R2 = 420.902mm
Top_Radius / R4 = 1504.854mm

On the next page we will present what happened in ZW3D 2011 when we performed the same operation.
With exactly the same inputs in ZW3D 2011.

This is before we ran the optimization, we have set the ranges so ZW3D would get roughly the same values as Catia V5.

Base_Radius / R1 = 1504 – 1505mm
Middle_Radius / R2 = 420 – 421mm
Top_Radius / R4 = 1504 – 1505mm

We know that there is a solution within these ranges, and the program should be able to calculate correct values for the different radii.

When we ran the optimization we got the following results:

The first thing that happened was that ZW3D automatically changed our allowed ranges, however it kept within range with to of the values.

The third value, R4, got its range changed and a value outside of the allowed range.

Another strange thing in ZW3D's optimization was that it ignored the constraint we set up to keep R1 and R4 to the same value.
Attachment B – File Format Translation Verification

To the right is an image of the face that we used both for this section and for the “Curvature and Continuity Analysis” section.

The image below shows how the face was created. As we mentioned earlier it had to be created using only controlled radii, for the modeling in both CAD-systems to be possible.

In order to perform the comparison we needed data from both Catia V5 and ZW3D 2011. We also used Transmagic to get another result, and if we can see a resemblance between two of the result, we have a better foundation for a conclusion than if we had only used Catia and ZW3D.

We compared every STEP against the original CATPart, since Catia nor Transmagic can read and translate the Z3-file, and compare the STEP-files against another STEP-file would not give accurate results.

On the next page we will display the results.
To the left is the result from the comparison between the Catia original file and the STEP-file created in Catia. It's hard to capture the result in a good image, but if you look closely you can see the red dots that indicate the deviation. The deviation between these two files is not so great, but fairly small.

The same story on the picture to the right here. This is the result of the comparison between the Catia original file and the STEP-file created in Transmagic R8.

Pretty much the same result here. A very small deviation between the two faces.

In the image to the left here the deviation is pretty significant. This is the comparison between the Catia original file and the STEP-file created in ZW3D.

All the comparisons has been created using the “DMU Space Analysis” in Catia V5 with a "computation accuracy" of 0.15mm.
Attachment C – Curvature and Continuity Analysis

The first two images show the result from the “Surfacic Curvature Analysis” in Catia V5. The image to the right shows the maximum curvature of the face.

This value corresponds with the radius of our profile, which is \( r = 250\text{mm} \).

The maximum curvature of our face is 0.004.

This image to the left shows the minimum curvature of the face. This gives a radius of \(~751.8\text{mm}\) in the specific point.

The minimum curvature of our face is 0.00133.

The last image here to the right shows the result from the “Porcupine Curvature Analysis”. The visibility of the values in the yellow boxes is poor in this image, but the feature is available. This can be useful in cases where the curvature value is important.

On the next page we will present the results from the same operation in ZW3D 2011.
The top image shows the maximum curvature of the face, and as you can see the result is the same as in Catia. This shows that ZW3D is capable of this type of curvature analysis. However this isn't the toughest face to perform analysis on, but then again it's difficult to create the exact same double curved surface in two different CAD-systems.

The same goes for the minimum curvature of the face. We have taken the point of the min. curvature and as you can see all the values corresponds with the values in Catia V5. Just as previous testing we cannot be sure that this result is accurate, but since we have gotten the exact same result in both CAD-systems, it should be a correct result.

The image to the right shows ZW3D's equivalent to the “Porcupine Curvature Analysis” tool in Catia, “Display Curvature Plot of Curve”.

The only drawback with this feature is that you cannot get the values of the plot, therefor no way of knowing the max. and min. curvature of the plot.
When looking at this image taken from the CAM-plan in ZW3D you can almost understand the program crashed. When we tried it again we did it step by step, instead of running all operations sequentially. This worked and we didn't get any errors or crashes. However we didn't get any finished model as an end result either.

Because this was required for the comparison to Catia, we realized that a comparison wouldn't be possible.

The whole CAM-plan from ZW3D resulted in an NC-code with a bit over one and a half million lines.

See next page for Catia results...
Since we started to make the CAM-plan in ZW3D and discovered that it didn't work properly, we never bothered to perform the complete NC computation in Catia.

We tested the computations already made for us, and these worked fine in a way very similar to the result we got in ZW3D.
Attachment E - References

http://www.deskeng.com/virtual_desktop/?p=2453, 20110510

http://en.wikipedia.org/wiki/CATIA, 20110511

COE Discussion
Attachment F – Thanks

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