Vertex Instrumentation at Power Generation

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Bachelor's Thesis

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BACHELOR'S THESIS

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Abstract

This Bachelor's thesis has been done for VEO Oy. The goal of the thesis is to create an instrumentation base project for the Expert Service department. The base project will be used in thermal power projects. The project is done in the planning tool Vertex.

Conducting this thesis, future instrumentation projects will be easier and faster for the planners. The goal is to be able to use this base project when planning future thermal power plant projects. A long-term goal of this thesis is to introduce Vertex more into the Expert Service department.

The theoretical part will deal with Vertex, the instrumentation, a comparison between Vertex and AutoCAD, and with the advantages of having a good planning system. This thesis will also include a small study on Vertex's future at VEO's Power Generation.

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Language: English   Key words: Vertex, power generation, instrumentation
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EXAMENSARBETE

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Titel: Vertex instrumentation vid Power Generation

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Abstrakt

Detta examensarbete har gjorts åt VEO Oy. Målet med examensarbetet var att skapa ett basprojekt för instrumentation åt Expert Service-avdelningen. Basprojektet kommer att användas inom värmekraftsprojekt. Projektet görs i planeringsverktyget Vertex.

Målsättningen med detta examensarbete är att göra framtida instrumentationsprojekt lättare och snabbare att utföra. Målet var att man skall kunna använda sig av detta basprojekt när man i framtiden planerar värmekraftverksprojekt. Ett långsiktigt mål med detta examensarbete är att introducera Vertex mera inom Expert Service-avdelningen.

Teoridelen kommer att behandla Vertex, instrumentation, jämförelse mellan Vertex och AutoCAD, samt fördelar med att ha ett bra planeringssystem. Examensarbetet kommer också att innehålla en liten undersökning om Vertexs framtid vid VEO:s Power Generation.

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Språk: engelska   Nyckelord: Vertex, power generation, instrumentation

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OPINNÄYTETYÖ

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Nimike: Vertex-instrumentointi Power Generation -osastolla

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Tiivistelmä

Tämä opinnäytetyö on tehty VEO Oy:lle. Opinnäytetyön tavoitteena oli luoda asiantuntijapalvelulle instrumentaatiopohjaprojekti. Pohjaprojektia käytettäisiin lämpövoimaprojekteissa. Projekti tehtiin suunnittelutyökalulla Vertex.

Tämän opinnäytetyön avulla tulevaisuuden instrumentointiprojektit ovat suunnittelijoille helpompia ja nopeampia. Tavoitteena on pystyä käyttämään tätä pohjaprojektia tuleviin lämpövoimalaitosprojekteihin. Opinnäytetyön pitkän tähtäimen tavoitteena on lisätä Vertexin käyttöä asiantuntijapalvelun osastolla.

Teoreettisessa osassa käsitellään Vertexiä, instrumentointia, Vertexin ja AutoCAD:n vertailua sekä suunnittelujärjestelmän etuja. Opinnäytetyössä on myös pieni tutkimus Vertexin tulevaisuudesta VEO:n Power Generationilla.

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1   Introduction

This Bachelor's thesis is undertaken for VEO Oy. The main objective of this thesis is to create an instrumentation base project for the Expert Service department in the planning tool Vertex. At VEO in Vaasa, most planners use Vertex general mode, which differs from the instrumentation mode. This thesis will have the instrumentation mode as a cornerstone. The theoretical part of the thesis will mostly be about Vertex and why it is an efficient planning program. This thesis will also take a closer look at the planning structure at Expert Service.

The last part of the thesis will be a small-scale research to look into Vertex future at VEO's Power Generation organization, and to see if instrumentation mode can be introduced more into this unit's different departments.

1.1   Purpose

The main purpose of this thesis it to create an instrumentation base project. This project will give more knowledge about the instrumentation mode in Vertex. The project is created to help the planning process go faster and easier for future planners and for myself. This project acts as a starting point for future development.

The long-term goal is to introduce Vertex in more details at the Expert Service department, especially the instrumentation mode. This department deals mostly with thermal power projects, which contain a lot of instrumentation. This means that the instrumentation mode would be a great asset. Today, most projects are being planned with AutoCAD.

Another purpose is to research Vertex and the instrumentation mode situations at the Power Generation organization. In this organization belong the departments Diesel, Hydro, and Expert Service. All of these departments use different planning programs. These programs are AutoCAD, Eplan and Vertex. This thesis research will be about Vertex's future at these departments and to see if the planning structure could be made easier.

1.2   VEO Oy

The 6th of December 1989, Vaasa Engineering Oy was created. Today it is known as VEO Oy. The founders of VEO were afraid that the energy industry would be moved abroad after the merge of Asea, Brown Boveri and Strömberg, today known as ABB. Therefore, to keep the business and to continue to develop in Finland, VEO was founded. Today VEO's headquarters and switchgear factory are in Runsor, Vaasa. VEO also got smaller offices in Seinäjoki, Rovaniemi and Paimio. There are also offices in Sweden and Norway. In 2017, VEO had 450 employees and revenue of about 88 million euro (VEO Oy, 2018).

The largest departments in VEO are Hydropower, Diesel & Gas power, Industry, Expert Service and Substation. These departments are divided into three organizations, Power Generation, Power Distribution, and Power Utilization (VEO Oy, 2018).

VEO offers a wide product range of quality products. VEO's core products are panels, switchgears and substations, which are used by power plants and process industries worldwide (VEO Oy, 2018).

1.2.1   Power Generation

Power Generation organization is one of the three organizations at VEO Oy. In this organization belong the departments of Diesel, Hydro and Expert Service (VEO Oy, 2018).

Diesel & Gas power includes plant commissioning services, managing spare parts for power plants and marine projects. This department focuses on modernizations of power plant equipment, electrification, maintains and updates of control systems. Most projects are abroad (VEO Oy, 2018).

Hydropower delivers turbines and generators for small to large hydropower plants. This mainly consists of electrification and automation system upgrades. This department also handles project management. This can range from supervising a project to consulting services (VEO Oy, 2018).

Expert Service is the department at focus in this thesis. This department deals with many thermal power projects. Expert Service delivers process electrification, instrumentation, automation and commissioning. This means designing, programming and testing. This department includes 24/7 support (VEO Oy, 2018).

2 Instrumentation

Instrumentation is defined as when there are several measuring, control and electrical instruments connected. Industries use instrumentation to make their systems more efficient, reliable and cheaper. These instruments are devices that are used for measuring physical quantities.

The quantities can be the following:

- Flow

- Pressure

- Temperature.

Most common devices are *sensors*. There are several kinds of sensors. Pressure sensor, flow sensor, level sensor, speed sensor, optoelectronic sensor and temperature sensor. These are used in real-time instrumentations. For example, a temperature sensor's job is to detect changes in temperature in a system or in a device. Then when finding a change, it gives a signal to the controller (Agarwal, 2015).

Another device is the *controller*. In today's industries, industrial control systems depend on computer control systems. Most used systems in instrumentation are PLC (Programmable Logic Controller), DCS (Distributed Control System) and SCADA (Supervisory Control and Data Acquisition) (Agarwal, 2015).

Actuators are also devices commonly used. These are used to control systems depending on the signal it is given. These are controlled by the control system. Actuators convert electrical signals into actions, and are used for controlling output devices like contactors, valves and motors (Agarwal, 2015).

A person who works with instrumentation can, for example, be responsible for development, design, installation and maintenance of instruments, which are used for control systems or machines.

At VEO Oy, the Industry and Expert Service department conduct most instrumentation projects. Therefore, the instrumentation mode in Vertex can be a great help for engineers who work with these kinds of tasks.

3   Vertex

Vertex Systems is a world-renowned and respected provider of design and data management software solutions for industries. Founded in 1977, Vertex has 18,000 users in 37 countries. Vertex have their headquarters in Tampere, Finland. Their customers include metal industry machinery, equipment manufacturers, industrial house builders, furniture manufacturers, plant suppliers, process industry and design offices (Vertex Systems Oy, 2019).

Vertex helps industries to develop and improve design and productivity. The software has being improved substantially to bring new design and information options (Vertex Systems Oy, 2019).

Vertex Systems offer following examples of products:

- Vertex G4, mechanical planning
- Vertex BD, building planning
- Vertex ED, electrical and automation planning
- Vertex G4Plant, department of planning
- Vertex InD, kitchen planning
- Vertex Flow, product information management.

Vertex ED, electrical and automation planning, is the program used at VEO Oy. Vertex is used for making different types of electrical planning schematics. These types can be control panel diagrams, instrumentation drawings, layouts etc.

Vertex ED provides tools for creating intelligent drawings with information, producing lists and handling databases. The program includes circuit diagram applications with symbol libraries and templates. Vertex manages documents in a project, as well as drawings, revisions and production to PDF book. Vertex includes tools for custom document deliveries. Vertex is designed to work in a large design workgroup and to handle thousands of drawings and related documents. (Vertex Systems Oy, 2019).

At the Diesel and Gas power department, Vertex has been used since 2007, making control panel planning. Before Vertex, a program called Microstation was used and is still used at some level. The advantages of having Vertex as a planning program is that all information is in the same place. Vertex has its own database that handles all cables, components, and

device lists directly. This means that all pages have the same frame and look. This makes it look very professional (Palmberg, 2014, p.16).

Depending on what department is doing the project, the design modes in Vertex can differ. Vertex has three design modes. These are *general mode*, *electrical mode* and *instrumentation mode*.
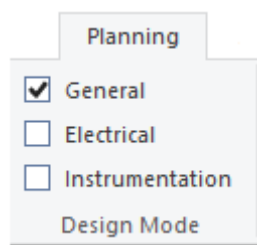

Figure 1. Design modes.

At Diesel & Gas power department, everybody uses *general mode*. This mode is the most common one and is mostly used for drawing control panels. These projects can be hundreds of pages long and are mostly for power plants.

At the Industry department, *instrumentation mode* is more commonly used. These projects are also hundreds of pages long, if not even longer. At this department, most projects are for thermal power plants. In thermal projects, there can be several instruments that are taking care of measuring and controlling. Vertex instrumentation mode is potentially very advantageous for handling different instruments. Instrumentation mode provides tools for handling information like physical quantities in a thermal power plant.

The electrical mode is used when handling motor drives only. This thesis will not involve this mode.

3.1 Instrumentation in Vertex

Vertex ED instrumentation offer tools to make an instrumentation project, to create base drawings, to generate diagrams and electrical drives automatically. Instrumentation mode also gives the opportunity to test circuits and increase I/O-spaces and cables. When generating cables, I/O, air supplies and power supplies, the drawings are updated to the newest version. The finished drawings can then be revisited with the revision button. By reserving resources to wanted design areas, you can control usage of I/O cards and other resources (Vertex Systems Oy, 2019).

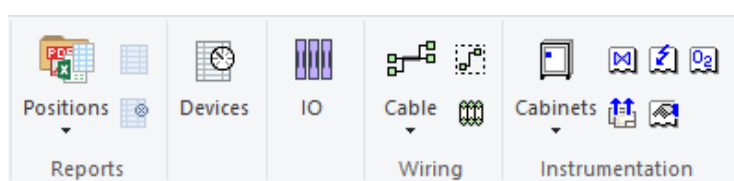When making an instrumentation project, Vertex has specific symbols for it.

Figure 2. Instrumentation symbols in Vertex.

3.1.1 Cabinets/Positions

With the *cabinets and positions option*, you can decide what documents you want to generate. These documents are divided into which cabinets the drawings are positioned in. This is where, for example, list of drawing, wiring tables, list of apparatus and cable lists are generated. After having generated these, you can generate everything into pdf. This means that all documents under the same cabinet will be collected into one pdf document. In the *cabinet* option, you also need to add the project's cabinet resources. These resources can be voltage levels, field cabinets and air supplies (Vertex Systems Oy, 2019).

There are hundreds of different types of documents that can be generated with Vertex, but only the most used documents are mentioned in this thesis. After the pdf document is generated, it is ready to be sent to the factory or to the customers.

3.1.2 Devices

With the *device option*, you have all the devices used in the project in one list. These devices can be terminals, fuses, plates etc. These have to be put in manually. The good thing is that Vertex has its database with mostly all devices in it already. All you have to do is search for

the device in the database and add it to the project (Vertex Systems Oy, 2019). Quantity of the devices also needs to be added in the device list. This list can later be generated into a list of apparatus, where all the devices are listed.

3.1.3 Power Supplies and Drives

With the *power supplies and drives option*, you need to add all the power supplies that will be used in the project. The cabinets in the project need to be added with their voltage levels, and from where they get their supply. With this option, you also need to add the individual cabinet's fuses. This means you need to add fuse types, names, terminals, voltage and current. These will later be included in the list of apparatus, or if one wishes, in a separate document called fuse list (Vertex Systems Oy, 2019).

3.1.4 Air Supplies

With the *air supplies option*, air supply units can be added. You need to have a device name, type and supply for this list to function correctly. The cabinet in use needs to be added into the list with unit name and supply unit. This list will not be very long in most projects. These will also be added in the device list, and later generated to list of apparatus (Vertex Systems Oy, 2019).

3.1.5 Tools and Databases

The *tools and databases option* is mostly about settings. You get information about instrumentation loop tools, functions, electrical tools, settings and summation. Most of these tools can be found under the other instrumentation options in Vertex. The most important consideration with this option, is the setting, which needs to be set right before making a base drawing. This setting is called *use special text input for base drawing* (Vertex Systems Oy, 2019).

3.1.6 Base Drawings

When you draw a diagram in instrumentation mode, you draw a base drawing. The base drawing, when done, is generated into the actual drawing that shows all resources. When making a base drawing, there is something called resources. You add all the resources, such as power supply, cables, terminals and PLC. These are connected to the device list. With this option, you can see all the base drawings in the project and their individual resources. You

can also add, delete or copy resources. Handling resources can also be done in the individual drawings. This option is more of an overview of the base drawings. The functions of base drawings and their performance will be mentioned more specific later in this thesis (Vertex Systems Oy, 2019).

3.1.7 I/O

The *I/O option* handles I/O-Cards and I/O-channels. First, you need to add information about the cards. The information you need to add is cabinets, the position of the cards, card tags, process stations and card types. The card and its type also need to be added to the device list. The cards are also connected to the drawing. These will be generated into a list of PLC.

I/O-channel information also needs to be added. You need to add information about card tag, channel and card type. Card terminals also need to be added, so that the cable list can work correctly (Vertex Systems Oy, 2019).

3.1.8 Loops

The *loop option* is where you create the actual drawing. You make a loop and give it a name. Information that needs to be added is a cabinet, drawing name and selection tag. After this is done, you add the base drawing. After this, you can generate the loop to make the actual drawing. You cannot change anything on the actual drawing, so if you want to change something you need to "release" the generated drawing, make changes, and then generate the drawing again. You also add information about PLC amount and device names under this option, if needed (Vertex Systems Oy, 2019).

3.1.9 Cable

The *cable option* is where all the cables in the project will be shown. After generating a loop, the cable information should automatically be in this list. In the instrumentation mode, you give all cable information in the resource option, so nothing needs to be done in the cable option. In this list the cables names, types, start and end positions will be shown. This list can later be generated into a cable list or list of instrumentation cables (Vertex Systems Oy, 2019).

4 Differences between Vertex and AutoCAD

Both Vertex and AutoCAD are popular at VEO Oy, and both of them have advantages and disadvantages. When starting a project, the customer usually sends an output document of what they want. This may include devices, cables and drawing names. Whatever planning program will be used can make the project easier or harder.

When planning in AutoCAD, there will be several separate documents involved. The layout and schematics are drawn in AutoCAD, while the cable list and device list most likely will be made in Excel. Then you can also have list of drawings in Microsoft Word. It can be difficult in the later part of the project to keep track of all these different documents, and it is important that the customer receives all the needed documents.

In Vertex, all of these documents are made automatically. After drawing layouts, schematics and entering all info about devices and cables in the project, Vertex will generate all lists that are needed. This will include a list of drawings, list of apparatus, list of cables, list of PLC apparatus and wiring tables. By using Vertex as a planning program, all the documents in the project will be in one place.

Customer output · Customer output

Vertex
- Layouts
- Schematics
- Device list
- Cable list

AutoCAD
- Layouts
- Schematics

Excel
- Device list
- Cable list

Ready PDF Documents · Ready PDF Documents
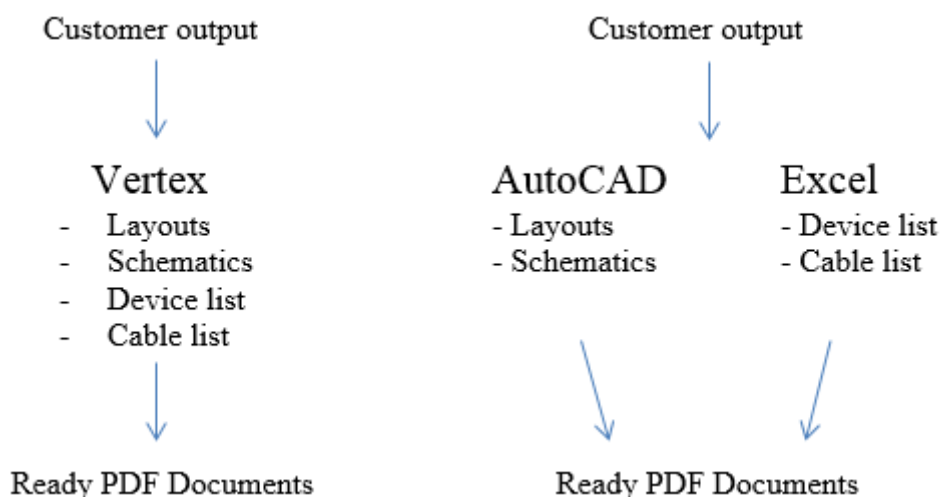
Figure 3. Planning differences.

The figure above illustrates the different planning systems. It is logical that using one program, instead of two, is a lot easier, but both these programs can be useful under different circumstances.

4.1 Advantages

As said on the previous page, Vertex's biggest advantage is that everything can be done in the same place. Vertex has got its own database and "brain" behind it. All lists are generated and collected in one folder, so that it is easy to find when needed. Documents to be generated and turned into pdfs can be selected specifically.

Vertex has its own component and cable databases to select from, and if any of what is needed is missing, it can easily be added to the program. When making wiring connections, Vertex also got a good help system and is fast to notice if something has gone wrong.

All documents that are generated also have the same structure. This makes everything look professionally. If there need to be changes to a specific document, the only thing needed to do is to make the change and then generate the document again. After using Vertex for a while and getting to know all the functions in it, it is an intuitive programme.

AutoCAD is efficient because it is taught in school. This means you have many years to practice and use it before going out into work life. AutoCAD is also very easy to use. It is easy to draw schematics and layouts in. If something needs to be changed in a drawing, it can be done without making too much of a mess. AutoCAD is also good because everyone in the electrical planning business knows it. This means it is easy to share the drawings with others if needed.

Advantages:

Vertex	AutoCAD
- Collective Database	- Easy to learn
- All documents in one place	- Learnt already in school
- Help systems	- Can make changes easy
- "Brain" behind it.	- Everyone knows it.

4.2   Disadvantages

Vertex is hard to learn and to use as a beginner. Vertex is not commonly used in school, so you only get familiar with it in work life. One problem is also the different modes Vertex offers. If somebody uses the general mode, they commonly do not use the instrumentation mode, and vice versa. This means getting help as a beginner can be tricky.

Because Vertex has its own database, it takes a long time to understand all the functions that exist. If some component or cable needs to be changed in a drawing, it cannot be changed as easily as in AutoCAD. By making a change it will probably impact on something else within Vertex, because everything is connected. This means making any changes needs caution. Another disadvantage is that it is not used by many people. This makes sharing drawings or sharing resources within the company difficult.

AutoCAD's biggest disadvantage is that more programs need to be involved in the planning. For example, some documents, such as the list of drawing, wiring tables and cable lists will have to be made manually and probably in Excel. Because it has no "brain", this will take more time and more resources.

AutoCAD has no database with components, so that means someone must draw all components that are needed. If something goes wrong with wiring connection, nothing will tell you about it. AutoCAD has got more disadvantages than Vertex, but its easier to use and that is a good advantage.

Disadvantages:

Vertex	AutoCAD
- Difficult to learn	- No "brain"
- Not easy to make changes	- More programs need to be involved
- Not used by many	- Documents need to be made manually
- Sharing resources is difficult.	- Time-consuming.

5   Benefits with an organized system

Having a well-structured planning system is important. If dealing with a project that has hundreds of pages in it, there has to be some kind of organizing system. This helps when dealing with final documentation for the customer, and for internal planning. It is important to have folders with a good structure so that finding documents is easier and less time-consuming. Vertex has a good organized system. All documents in one place.

The benefits of having an organized system are the same in any planning business. In planning, the goal is to make everything with speed and flawlessness. In practice, this is hard to achieve, but it is always something to strive toward.

5.1   List of drawings

List of drawings is usually in the beginning of the project. This document lists all the drawings in the project. It is important that this document have the needed information so that the customer can understand and find the drawings easy. In most projects where Vertex is not used, this document is made in Excel or Word. In Vertex, this document is generated automatically. This document can be seen as a table of contents for the project documentation.

This document gives information about:

- Drawing numbers
- Drawing names
- Pages
- Revision.

5.2   Layout and instruments

Layout and instruments documents contain what has been drawn and planned. This can, for example, be a panel layout or instrument schematics. It is important that these documents are correct and clear. These go to the installer and customer, who uses them to install the hardware. The installer may be an outside contractor, which means that the document needs to be correct for him to follow. These are drawn in AutoCAD or Vertex, and made into pdf.

To make these documents correct and organized, they need the following information:

- Positions

- Measurements

- Cable types

- Cable marks

- Correct connections showing

- Devices.

5.3   Apparatus list

Apparatus list contains the devices used in the project or in the project documents. When planning a control panel, this list will contain devices like contacts, plates, circuit breakers, fuses and terminals. This list may also be used as a purchase list. This list in made in either Excel or Word. In Vertex, this list is generated automatically into pdf.

Apparatus lists have the following information:

- Position

- Name of the apparatus

- Type of apparatus

- Manufacturer

- Quantity.

5.4   Cable list

Cable list contains all the cables used in the project. The list can also be a purchase list to know what sorts of cables to buy for the project. In this list, it is important that the correct cables and wires are mentioned. Same as the schematics, this list goes to the installer. The installer needs to know the correct cables and wires to be able to make the electrical connections correctly.

The most important information on this list is from what position the cables go, and to where they go. Having this information correctly means the installer can make a smooth instalment. It is also important to have what terminals the cables go to and what wires are used. When planning with AutoCAD, this list is made manually in Excel.

When planning in Vertex, this list is generated automatically. For this list to work, every little detail must be correct. The list uses all the devices and their positions to gather information on how the cables are connected.

This list contains the following information:

- Cable numbers
- Type of cable
- Cables outgoing
- Cables ingoing
- Drawing number where the cable is used.

5.5 Wiring table

Wiring table is automatically generated into pdf when planning in Vertex. The table shows cables, wires and what terminals they go in and out off. It is important that the cable and device lists are correct so that this list can be generated without problems.

This list contains following information:

- Cable type
- Wires
- Ingoing terminals positions
- Outgoing terminals positions.

Vertex also generates a document called internal wiring. This document involves internal wiring from apparatus to apparatus in a panel or casing box.

5.6 Wire marks

A *wire mark* also needs to be pointed out when planning it. In the drawing, marks are shown with a small square with either a wire number or colour mark. This depends on what cable that is in use. MMJ cable, for example, is marked with the colour abbreviation Ru, Si and KeVi. There can also be wires that come with the instrumentation device. These are usually planned with number marks 1, 2, 3 etc.

6 Instrumentation base project

The purpose of this thesis is to make an instrumentation base project for the Expert Service department. By looking at old and current projects, you will see what kind of drawings they need. Ideas will also be taken from the Industry department, where they have handled many thermal projects. The project will consist of several different instrumentation base drawings from panels to different instrumentation diagrams. The purpose is to have everything collected in one place, so that it is easy to go and grab similar drawings when a new project is beginning.

First thing will be to create a new project.

Figure 4. New project setup.

First thing required is a project id. Depending on the department, the names differ. At Expert Service, a project has the id KG, Diesel has KD and Industry has KI. Because this project is internal, we can use the internal abbreviations. Expert Service internal id is AG. The numbers after can be random. This projects name will be AG.00002. We also need to add a project name. A good name for this project is Instrumentation Base Project. The names can be changed later. There is also an option to base the project on other projects. This means that the project will copy all the chosen projects resources and copy them to the new one.

After this, press ok. Now the project will be created. It will ask if you want to set the project up as an instrumentation project, which we want, so we press yes. Now it will take a few

seconds for the project to set itself up. If it was chosen to base the project on another project, it may take minutes.

The project will have several different instrumentation diagrams as stated earlier. It will also have panels. Because this thesis' main subject is instrumentation, the focus will be on how to make an instrumentation drawing. The drawing in focus will be a flow measurement drawing. This kind of drawing can be used in thermal power plants planning.

The first step is to create a new drawing. *File - new -* enter a *drawing name* and then hit *ok.*
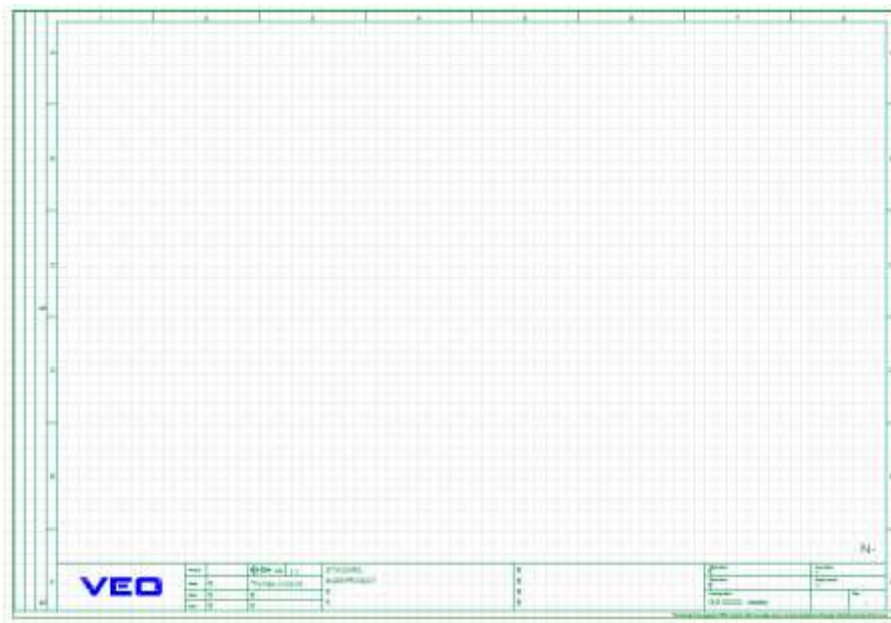
Figure 5. New drawing.

When this is done, right click on the drawing. Vertex offers the following options.
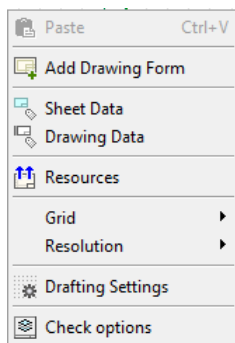
Figure 6. Drawing options.

With the drawing form option, you can change the drawing frame. The newest version of VEO frame should be picked. Next thing that needs to be done is going into drawing data.

When making an instrumentation drawing, it is important to make the following changes. At the *DWG group* box it needs to be written *BASEDWG_I*, and at the *+ Position* box, the same thing. This means that the drawing is now set up as a base drawing. If it is not written this in these boxes, it will not be possible to add resources to the drawing. It is also possible to make BASEDWG_E, which is for the electrical mode, but this will not be shown in this thesis.

Figure 7. Drawing data.

In this drawing, there will be the following resources.

- One transmitter
- One pressure sensor
- One flow sensor
- One temperature sensor
- Power supply to the transmitter
- Analog input
- Cables.

To this project, there has been added an already drawn panel. This panel has I/O and fuse spaces that can be used.
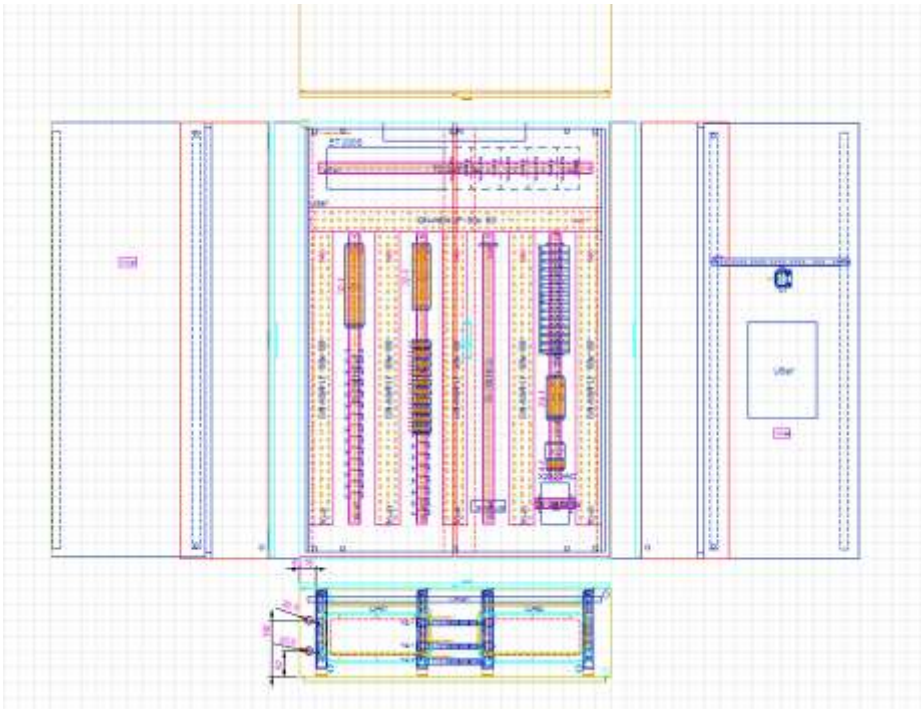
Figure 8. Fuse and I/O cabinet.

All the components in the panel are included in the device list. To this list, you also need to add the devices in the instrumentation drawing. When adding the instruments in the list, you only need to add the device names and what kind of instrument it is.

The panel's components go under the name of the panel, in this case, Cabinet1. The instrumentation devices go under FIELD, which is where they are positioned. When adding a component, there is, an option called *Add Comp*. This option shows the component database in Vertex, where there are hundreds of devices ready to be used.

Figure 9. Device list.

When right clicking on the drawing, there is an option called resources. This is where all the resources in the drawing need to be added. First, you add an analogue input. We then

need to choose a card. Make sure that the card exists in the device list and in the panel. When going to the IO option, you need to update the list, and then the cards available should be there automatically, as long as they are in the instrumentation database.
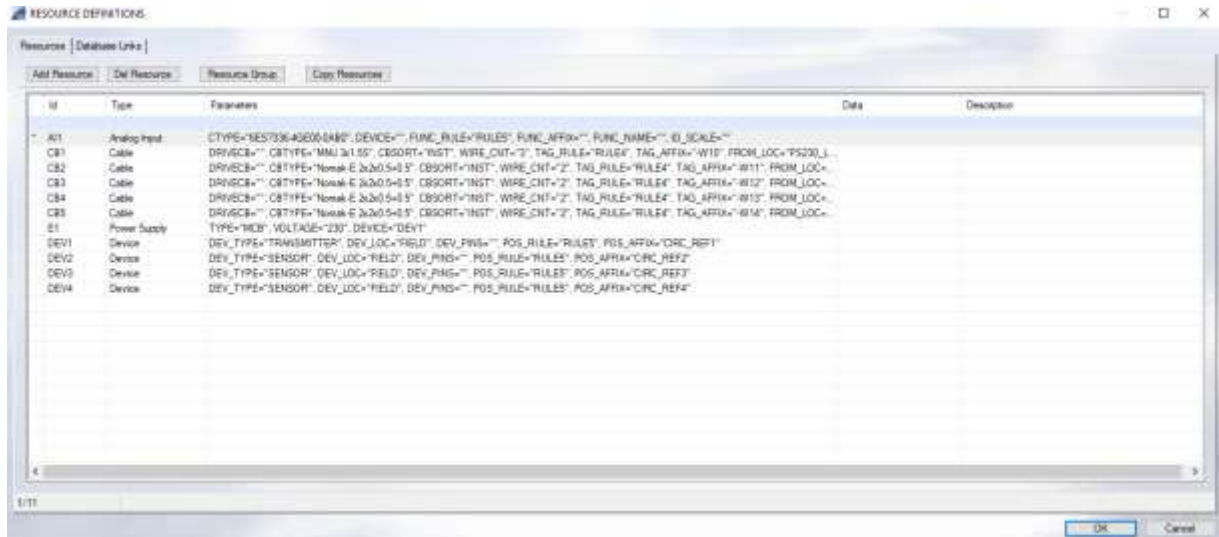
Figure 10. Resources.

Next thing is to add cables. To this drawing, we add five cables. Three cables between devices, one cable for the power supply, and one cable for the analog input. We also add cable types, cable tags and cables from and to positions. This drawing has five instrumentation cables, which are all Nomak-E, and one MMJ cable from the power supply to the transmitter device. After we added all the drawing's resources, we can start to draw. Alternatively, you can draw first and then add the resources. These can be changed, added or deleted whenever you want. There is no order in which you need to do these steps.
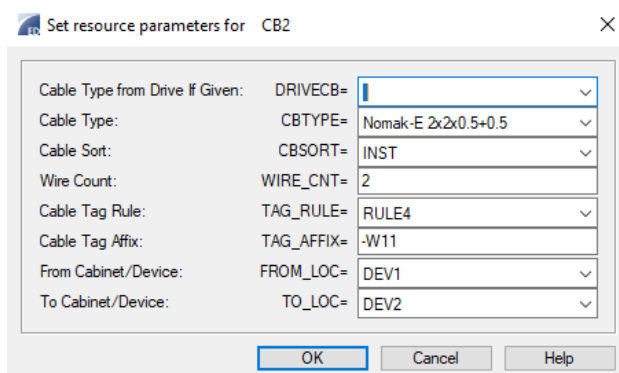
Figure 11. Cable parameters.
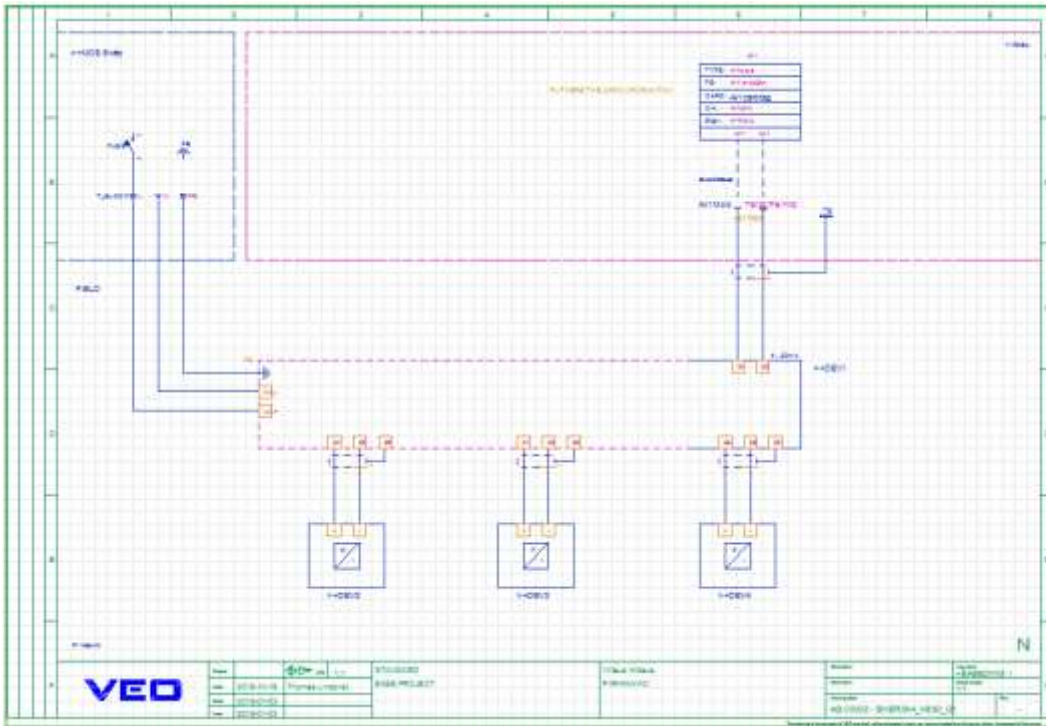
Figure 12. Drawing.

The above figure is the base drawing we have drawn. As you can see in the figure, the three sensors are at the bottom, the transmitter in the middle, the analogue input in the right corner and the power supply in the left corner.

All the components have "coding". For example, let us look at device four, which is a flow sensor. When double clicking on the device name, this case >+DEV4, we get following option.
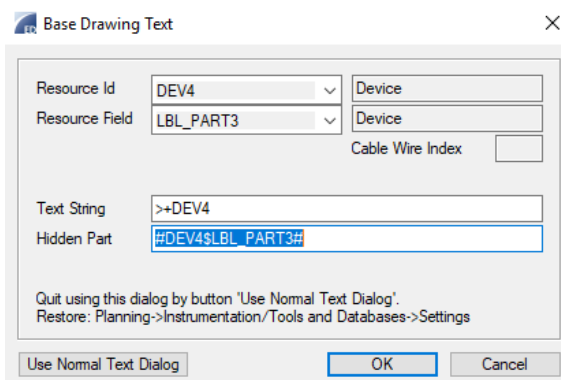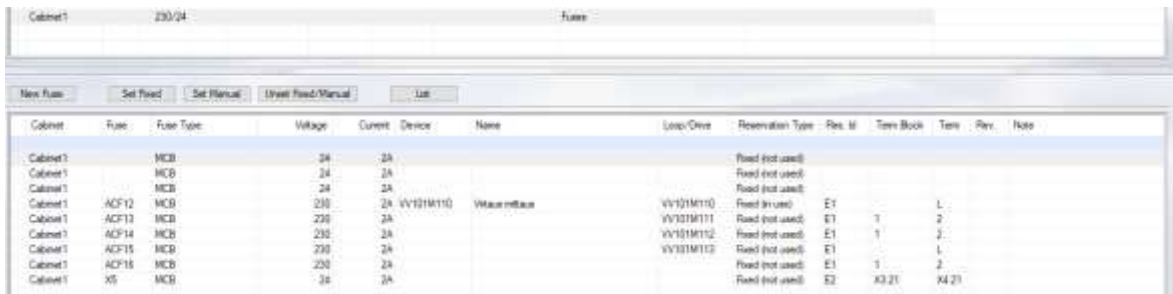
Figure 13. Device coding.

At resource id, we take the device from the resource list. This is device number four, so all the parameters we added for it in the resource options, will be connected to this. This same thing will be needed to be done to all the devices in the drawing.

The fuse information will be taken from the power supply option, where the fuses in the panel have been added. E1 is 230 voltages and E2 is 24 voltages. We can also add the terminal names for the fuses.

Figure 14. Power supplies.

Next step is to add cables to the drawing.
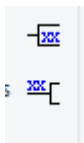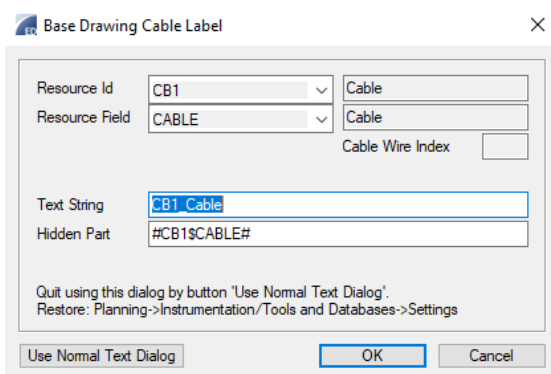
Figure 15. Cable symbols.

With the symbols shown in the above figure, we can add cable symbols to the drawing. The upper symbol adds cable markings, and the latter symbol adds cable types and labels. When double clicking on these, it is the same as with the rest of the components in the drawing, you need to add definitions.

Figure 16. Cable definitions.
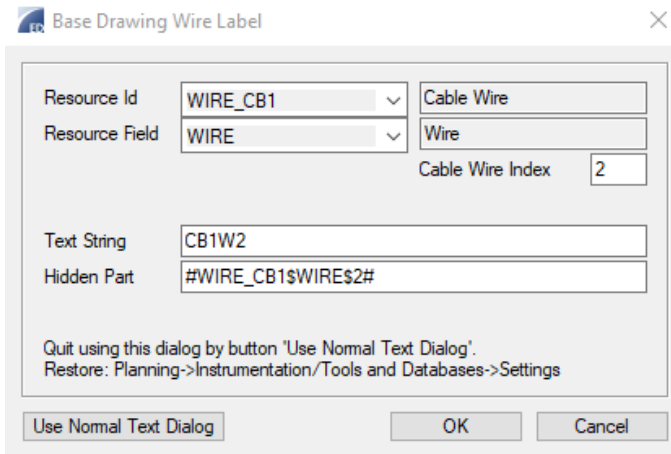
Figure 17. Wire definitions.

When adding a cable label and type, you need to choose which cable it is, and if you want cable label or type label. When adding wire labels, you need to choose which cable it is, and the number of wires.

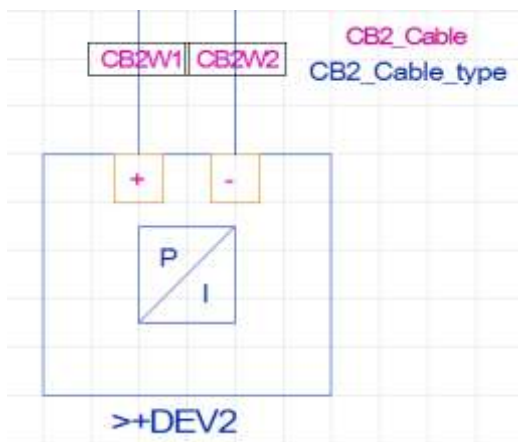After this is done, it will look like following on the drawing.

Figure 18. Cables.

As seen in the overall drawing, there are squares around the analogue input and the fuse. This indicates what position they have. Once again, you will have to click on the position texts and add definitions. Both of these positions will be in Cabinet1. The instrumentation devices are on the other hand in the field.

This is how the base drawing looks now.
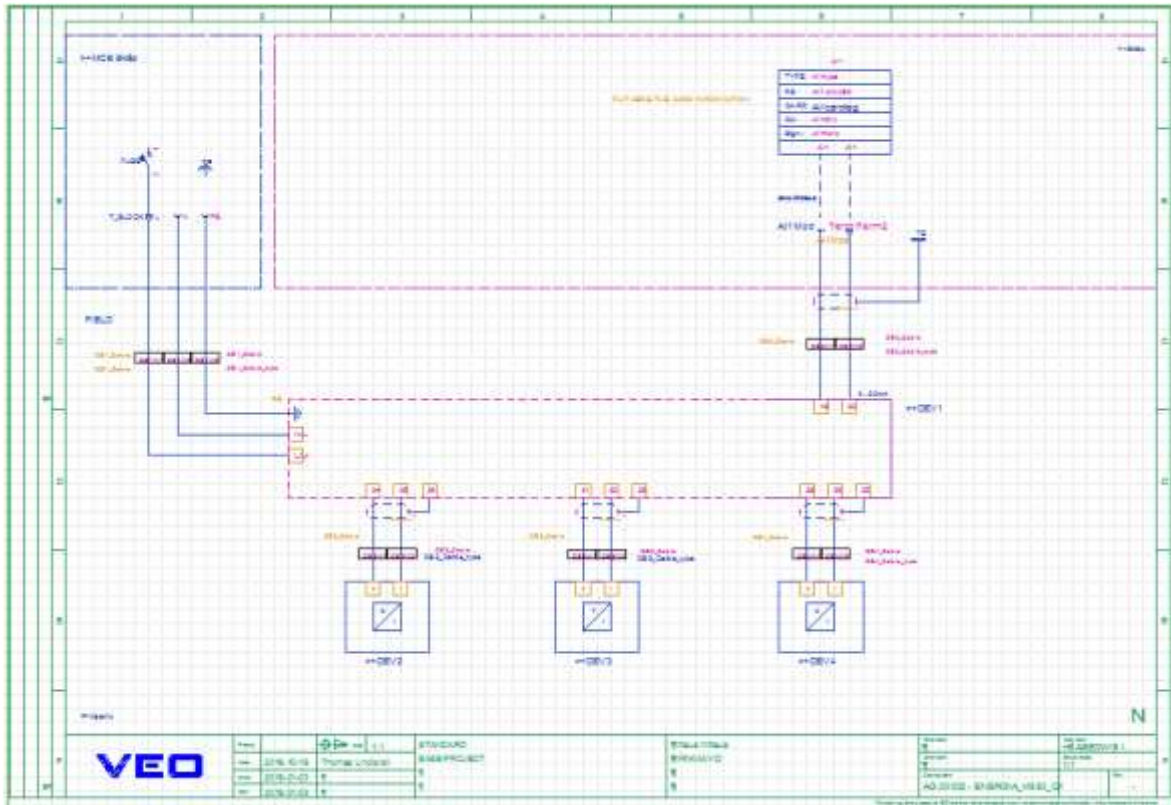
Figure 19. Finished base drawing.

This is how a finished base drawing looks like. As you can see, it does not give a lot of information just by looking at it. This is because it is half complete. Next step is to add a loop. When adding a loop, you need a loop name, drawing name, add a cabinet and add a base drawing. You also need to add information about analogue inputs, outputs, signals and device names.

Figure 20. Loop.

When all the information needed is correct, press the generate button. This will generate the base drawing.

After generating, the following box comes up.

Figure 21. Resources success.

This shows if the drawings resources have been done correctly and are connected to the right information. If any of them are done wrong, it will say fail. As seen above, it says success.

By pressing accept, you get the generated drawing. If you want to change something later, you can press released generated, which means the generated drawing will be deleted. After changes have been made, just generate the base drawing again.

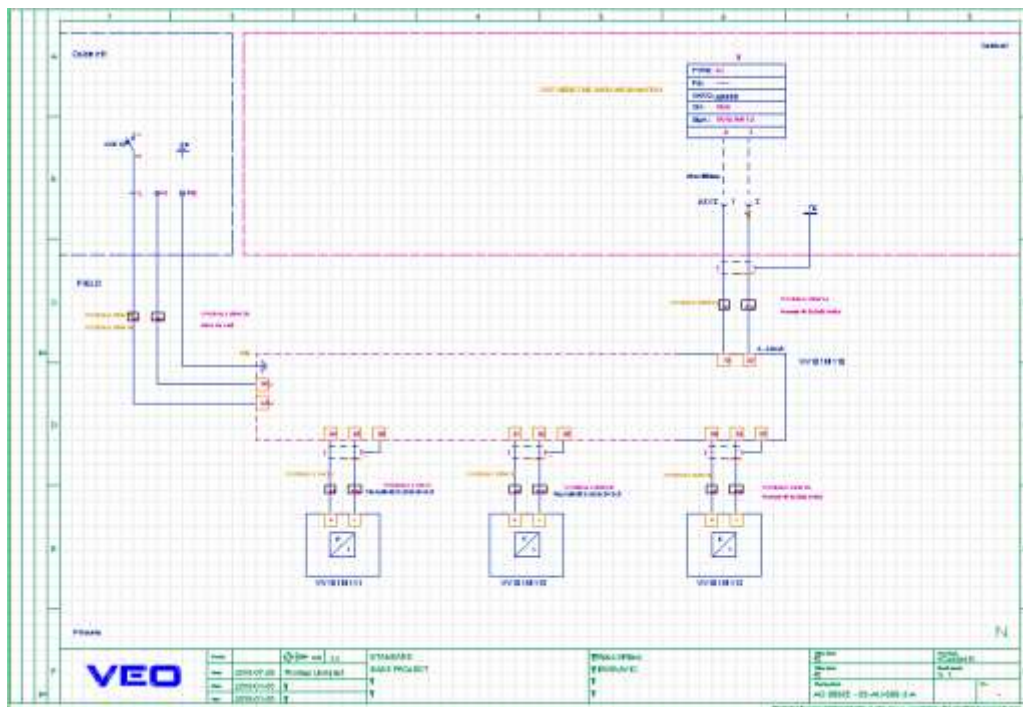This is how the drawing looks now.

Figure 22. Generated drawing.

Now the drawing shows cables and positions. Now we can also go to the cable list. After generated the drawing, all the cables used should be shown here. Press update wires to see that everything is connected correctly. When generating a cable list to pdf, it takes the information from this list.

Figure 23. Cable list.

To print the picture, go the cabinet option and hit generate at the pdf section. Now the picture will go to a selected folder in your computer.

This project will be continued to be built on, as it seems fit. There are still many base drawings that can be added to this project.

7   Resource sharing at Power Generation

Sharing resources within a company is always important. By sharing information between the different departments at VEO, the knowledge will increase in each of them. This will make the company competitive and get better. Even though a company have different departments, it is important to work together.

The planning structure at Power Generation also makes sharing important. Today, the planning tools are AutoCAD, Vertex, Eplan and Microstation. This means that if you need more information about one planning tool, you will need help from another department.

This thesis' main objective has been to introduce Vertex in more details into the Expert Service department. Because Vertex is not used at this department very often, resources have been needed to be shared from the departments, for example, Diesel and Industry. These departments use Vertex daily. By making this thesis, the goal is also that Expert Service will have the knowledge to use Vertex more within its department and more on its own.

This thesis long-term goal is to make the planning structure easier mostly at Expert Service, but also at Power Generation. By researching about the planning structure and the future of these planning tools they use, the result will give more knowledge of which of these planning tools will be more on a long-term usage and if Power Generation can learn to use one common planning tool. Because this thesis is about instrumentation mode, research has also been done to find out if more departments can use this specific mode.
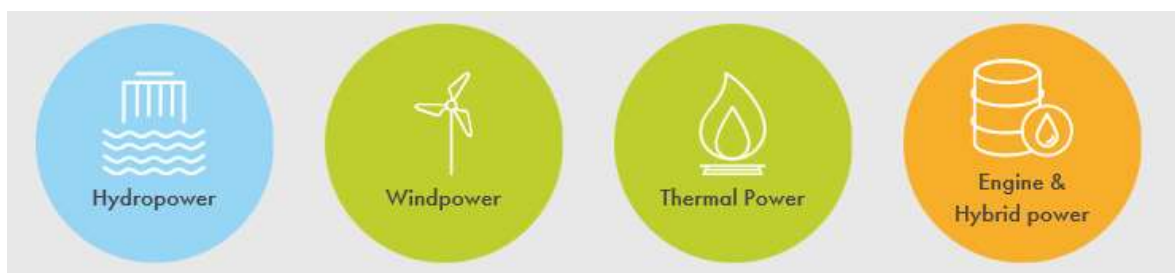

Figure 24. Work areas at Power Generation.

7.1 Vertex at Expert Service

The long-term goal of this thesis is to hopefully bring more Vertex to this department. Before, there has not been much planning done in Vertex, most planning is done in AutoCAD. With a lot of people at Power Generation using Vertex, the hope is that Expert Service department will also start to use it more. Every department, who uses Vertex, has a base project they can get help from. In this chapter, Vertex situation at Expert Service will be investigated.

7.1.1 Today's planning

Most of the planning today is in AutoCAD. Some planning has been done in Vertex, but not much. Today, a typical project contains Word, Excel and AutoCAD documents. A project can, for example, contain a lot of instrumentation documents drawn in AutoCAD, and later made into Pdfs. Planning with Vertex would only have the pdf documents in the project folder.

Planning in these different ways can be confusing and hard to summarize all drawings in the end. Some drawings can be made in AutoCAD and some in Vertex. A panel drawing, for example, would be best drawn in Vertex, where the components are automatically listed.

One problem with today's planning is to know when to plan in AutoCAD, and when to plan in Vertex. A project could be planned in both programs, but this can make a project's planning harder instead of easier. It is tough to share information when multiple parts of a project are in different planning programs. One problem that has occurred is that people who do not use Vertex, have a hard time to follow the Vertex drawings. It is also hard to get help that way.

Another problem is the folder structure. The folders today can be somewhat untidy. It would be good to try to keep all the planning in one folder and to keep some kind of planning structure for it. In some projects, it can be hard to find the right documents because of this.

With using Vertex more, the need of different documents would decrease and the folders would become tidier.

7.1.2 Instrumentation mode

There are already a good amount of instrumentation projects being planned in AutoCAD at this department. Using Vertex instrumentation would work well here also. There has been some planning done in Vertex general mode at this department also. Because of the amount of instrumentation at this department, instrumentation mode is the way to go.

Having knowledge in both general and instrumentation modes would be a great help. At the Vaasa office, there are not many people who use instrumentation mode. This makes it even more important to have somebody who knows it.

7.1.3 Challenges

There are some challenges with introducing Vertex. The first and largest challenge is time. When beginning to plan a project in a new planning program, it is time-consuming. Most projects have a quick deadline. As said before in this thesis, Vertex is hard to learn. Another challenge is motivation. If you have planned in AutoCAD for a long time, the motivation to start planning in a new program might not be so high.

The benefits of Vertex beat the challenges. As also said many times in this thesis, Vertex is a good planning tool. Many at VEO use it. However, the planning structure also depends on what department it is. Some departments might not have the need of this planning program.

Expert Service is also a small department, so not everybody is required to plan in Vertex.

Challenges:

- Time consuming

- Willingness to learn

- Motivation

- Is Vertex the future?

8 Vertex future at Power Generation

The future of Vertex as a planning program depends on the departments. Besides AutoCAD and Vertex, E-plan is another planning program that is heavily used at VEO. The Substation and Hydropower departments use Eplan. Will Hydropower department continues to use Eplan, or is Vertex the future? Diesel department use Vertex, but not instrumentation mode. Is this something that will change in the future?

This chapter will take a short look at the future of Vertex at Power Generation. This has been researched by interviewing the people in charge of the planning at PG.

8.1 Expert Service

By making this thesis, Vertex will have been more introduced to Expert Service. Right now, there are not many people who use this planning program at this department, but this might change in the future. AutoCAD will most likely still be the more used program. But in the future Vertex might change this.

Both Vertex general and instrumentation mode can be used at this department. Thermal power projects are still the centre of this department and therefore instrumentation mode will stay. Panels can be planned in general mode. With Diesel department's knowledge of general mode, there is a lot of help for starting to use it more. The future planning program will be *Vertex general* and *instrumentation* mode.

8.2 Hydropower department

This department uses the planning tool Eplan. Eplan was founded in 1984 in Germany. Eplan offers electrical and automation engineering solutions. Eplan is today used in over 50 countries and have over 120 000 licenses activated (Eplan, 2019).

As you can see, Eplan and Vertex is similar. One goal of the departments is that they want to use one common program. This has been achieved at this department by using only Eplan. Another department that uses Eplan at VEO is the substation department.

8.2.1 Vertex

Vertex will not be used at this department in the near future. Introducing Vertex will be tough and time-consuming. Vertex is installed in some computers, and some people have a clue what Vertex is, but Vertex is not the future in this department at this time. As stated above, this department is in a good position by only using one planning tool. Future planning programs at this department will be *Eplan*.

8.3 Diesel and engine department

This department has been using Vertex general mode for many years. This mode will also be the planning way to go in the future. Eplan will not be introduced at this department for now. The same situation as with Hydropower, if Eplan would be introduced, more people would use different planning programs, and this would create confusion.

8.3.1 Instrumentation mode

Instrumentation mode has not been used previously at this department. Not many people who works at this department is familiar with it. This will change in the near future. Instrumentation mode will be used in the future. There are some thermal projects at work, and a base project will probably be done in the future. Future planning programs at this department will be *Vertex general* and *instrumentation* mode.

9   Result

The main goal of the thesis was to create an instrumentation base project in the planning program Vertex. The thesis reached its goal. The project will be continued to be built on in the future, as more projects and new information comes along. It is possible to make changes and to add to these drawings.

The project has several instrumentation base drawings and some panels, and by help from Industry department's base projects, there is a good ground for future thermal instrumentation projects. The target with this thesis has been to make future thermal projects go easier and faster to plan. I hope that Vertex will also be used more at Expert Service department, because as seen with this thesis, their kind of projects can be professionally made with this program.

The thesis also has given a good insight to the differences between planning in AutoCAD and Vertex. As seen in this thesis, both of them have pros and cons, but in the long term, Vertex is a planning program with more benefits than AutoCAD. It has also been shown what a good system Vertex has for all its documents.

With the short research about Vertex future, you can see that Vertex will stay in some departments. Hydropower department will continue its focus on Eplan, while Diesel department will use both Vertex general mode and instrumentation mode. This thesis can also be used as a short introductory guide for making an instrumentation drawing.

10 Discussion

This thesis has been very educational and very interesting to do. When I started working at VEO in 2018, I was thrown into Vertex immediately. I had no previous experience with it. From the beginning, and from what you can read in this thesis, Vertex is very hard to learn as a beginner. So when planning a project with a fast deadline, it became very overwhelming.

At the start, when doing some projects in instrumentation mode, I had a hard time learning and understanding it. I have received help from instrumentation users, but they do not work at the Vaasa office. This meant dealing a lot of time on Skype, which has its downsides.

Around Christmas, I spent some time with diesel projects where they use general mode. The differences between general and instrumentation mode in Vertex is quite big. After having worked with both of these modes, I think the general mode is easier. General mode is kinder for beginners. They have some similarities though. The biggest difference is that instrumentation uses resources and base drawings, which introduces the "code" system. Everything in instrumentation modes goes through this system.

When I got to know that instrumentation mode would be involved in my thesis, I got quite happy. I got to go back to instrumentation mode, and learn what I never could. This thesis has been very helpful for me personally, to learn all the functions.

I think the most helpful thing has been to spend many hours with the instrumentation mode. If, in the future, I work with instrumentation projects, there is no doubt I can manage it a lot better than when I first started to work at VEO. I also hope that I get to work more with Vertex instrumentation mode after spending so many hours with it.

As said too many times now, this thesis created a base project in the instrumentation mode. I think this thesis will be helpful in a lot of ways. One good thing about this thesis is that I have written how you create a base drawing. I thought this was the way to make this thesis most interesting. This way, those who do not use instrumentation mode might also find it interesting. This will hopefully also help new instrumentation mode users, if they have problems with the mode in the beginning.

It has also been interesting to write about the differences in Vertex and AutoCAD. This made it easy to see which program is better in the end, and which has the better organizing system.

If I continue to use instrumentation mode, I will certainly have good use of this base project. In addition, I will probably continue to do a little work on it in the future. Because the Industry department also have a good instrumentation base project, I have tried to make this base project a little bit different. When planning future projects, you can both take drawing from this project and from the industry project. I have learned a lot.

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