YRKESHÖGSKOLAN NOVIA

Engine 3D and Drawing RPA 3.0

Wärtsilä Finland

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Bachelor's thesis

Degree Programme in Mechanical and Production Engineering

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BACHELOR´S THESIS

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Abstract

The thesis is made for System Engineering, which is a group of Wärtsilä Marine Solutions. The intention of this thesis was to re-design the existing Engine 3D and drawing RPA to also store data in a database. The RPA is to be split into two different steps, one handling the storage of data and the other utilizing data to generate content in CAD tools. The programming was done in the RPA development application UiPath.

The aim was to gather all requirements for the new RPAs, create an updated description for the new RPA functions, and by using the tool UiPath to build the RPAs by also utilizing the existing API. The testing of the tool and any necessary updates to other tools utilized by the RPAs were also to be listed. Implementation and rollout of the RPAs were done in cooperation with dedicated persons.

Material for this thesis was gathered from web pages, articles, and books. Attended courses were RPA basic training, hosted by Wärtsilä.

The result of this thesis was a creation of a functional RPA to automate the process and the way of working. The updated version of MODA00252 RPA can now be run as two separate RPAs. With its new database function, saving functions and the smart logic to only trigger the RPA depending on what data have changed since the last time run. Furthermore, the testing of the tool and initiating the implementation for other Wärtsilä employees' usage is also included to this thesis work.

Language: English
Key Words: Wärtsilä, robotic process automation, automation

EXAMENSARBETE

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Titel: Motor-3D-och ritning-RPA 3.0

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Abstrakt

Detta examensarbete är gjort för avdelningen System Engineering, som är en del av Wärtsilä Marine Solutions. Syftet med detta examensarbete var att omskapa den existerande 3D-motor och ritning-RPA och att även spara informationen i en databas. RPA:n måste delas upp i två delar, en som hanterar förvaringen av data och den andra använda sig av informationen för att generera innehåll till CAD-verktyg. Programmeringen gjordes i RPA-utvecklingsapplikationen UiPath.

Syftet var att samla alla krav för de nya RPA:n och att skapa en uppdaterad beskrivning för de nya RPA-funktionerna och genom att använda verktyget UiPath bygga RPA:n genom att använda existerande API. Testandet av verktyget, alla funktionerna som hör till samt behövliga uppdateringar av andra verktyg som används av RPA:n gjordes även. Implementering och införande av RPA:n gjordes tillsammans med involverade personer.

Material till detta examensarbete samlades från webbsidor, artiklar, och böcker. Kurser som deltogs i var RPA Basic training, som ordnades av Wärtsilä.

Resultatet av detta examensarbete var att skapa en funktionell RPA för att automatisera processen och arbetssätten. Den uppdaterade versionen av MODA00252 RPA kan nu köras som två skilda RPA:n. Med dess nya databasfunktion, sparfunktioner och smarta logik körs endast RPA:n ifall ändringar skett beroende på vad som har ändrats sedan den sist blivit körd. Testande av verktyget samt implementering för övriga anställdas bruk på Wärtsilä hör också till examensarbetets uppgift.

Språk: engelska
Nyckelord: Wärtsilä, robotiserad processautomatisering, automation

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Päivämäärä: 16.5.2022 Sivumäärä: 35

Tiivistelmä

Tämä opinnäytetyö on tehty System Engineeringille, joka on osa Wärtsilä Marine Solutions -osastoa. Opinnäytetyön tarkoitus oli suunnitella uudelleen olemassa oleva moottori- ja piirustus-RPA ja myös tallentaa dataa tietokantaohjelmiin. RPA oli jaettava kahteen osaan, joista toinen käsittelee datan tallentamista ja toinen käyttää dataa generoimaan sisältöä CAD-työkaluihin. Ohjelmointi tehtiin RPA-kehityssovelluksessa UiPath.

Tarkoitus oli kerätä kaikki vaatimukset uuteen RPA:han, luoda ajantasainen selitys uuteen RPA-funktioon ja käyttäen UiPath-työkalua rakentaa RPA, hyödyntäen myös olemassa olevaa API:ta. Työkalun testaus, kaikki toiminnot, jonka siihen kuuluu ja tarvittavia päivityksiä muihin työkaluihin RPA:n hyödyntämiseksi tehtiin myös. Implementointi ja käynnistyminen tehtiin osallistuvien henkilöiden kanssa.

Materiaali tähän opinnäytetyöhön kerättiin verkkosivuilta, artikkeleista ja kirjoista. Osallistuin RPA basic training -kurssiin jonka Wärtsilä järjesti.

Opinnäytetyön tuloksena on toimiva RPA, joka automatisoi prosessia ja työskentelytapoja. Päivitettyä MODA00252 RPA-versiota voi nyt käyttää kahtena erillisenä RPA:na. Uudella tietokantatoiminnolla, tallennustoiminnolla ja sen älylogiikalla RPA käynnistäisi ainoastaan, jos muutoksia tietoon ovat tapahtuneet viime käynnistämisen jälkeen. Työkalujen testaus ja implementointi muihin Wärtsilän työntekijöihin käyttöön kuuluu myös opinnäytetyötehtävään.

Kieli: englanti
Avainsanat: Wärtsilä, ohjelmistorobotiikka, automaatio

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LIST OF ABBREVIATIONS

RPA	Robotic Process automation
AI	Artificial intelligence
API	Application programming interface is a connection between computers or software that replaces the usage of the user interface.
HFO	Heavy fuel oil
LFO	Light fuel oil
Pilot fuel	In diesel engines a small amount of fuel is used to ignite the main fuel
Emulsified fuel	Emulsified Fuels are emulsions composed of water and a combustible liquid, either oil or a fuel
MODA00252	RPA identifier that creates 2D drawings and 3D CAD content
Macro	A macro is an automated input sequence that imitates keystrokes or mouse actions
Greasemonkey	An extension made for the browser Mozilla Firefox that allows the installation of scripts that make changes to webpages before shown to the user
Dependencies	Packages of activities in UiPath that can be installed
Robot	A machine that is programmable and capable of performing a complex series of tasks on its own.
Standalone	Software or computer that runs on its own, without being part of a set or connected to other computers

Figure explanation

1 Introduction

During the summer of 2021, I was working as a summer trainee at System Engineering, Wärtsilä Finland. I was given the opportunity to do an updated version of the Robotic process automation MODA00252 as my thesis work. MODA00252 is an RPA that creates 2D drawings and 3D CAD content automatically and saves it to a database. This Bachelor´s thesis is made for Wärtsilä Finland for a department named System Engineering that is in the Smart Technology hub in Vaskiluoto, Vaasa. I am studying Mechanical and Production Engineering in Vaasa and as a specialization, I have chosen Mechanical Construction Systems.

1.1 Background

The background to why the RPA system is being invented for this kind of task is that it has earlier been routine work that was done manually for a long time. This was evaluated and the conclusion was that with the help of RPA technology this routine work could be automatized. Today the older version of the MODA00252 RPA is extremely complex and modifications are needed to be done within this thesis. The need for this thesis work to be done is needed, since saving of all the data and also the modifications on how to run it. It is now run as a standalone, but the intention is to get it to run directly on the object (project). The benefit of running it straight on the object is that the RPA is saving it also directly on the object in this way of running it. Other benefits are that when the split into two different parts is done, they are not connected in a way that creates waiting time, and simplification of the second part can more easily be done.

The chain of tasks is a combination of tools and manual steps nowadays to check outputs for example. The goal in the future is that the whole chain of RPAs will be triggered one after another to replace the manual labor done at present. Triggering of the RPA is done via email nowadays, by sending an email directly to the robot. In theory, many other possible ways of triggering an RPA are existing for example buttons can be placed inside a tool or equivalent. A rule is that the trace is always needed to exist before triggering the RPA so it can be tracked later. Another aspect of the benefits of this update of the MODA00252 is, that when the data is centralized it eliminates the waiting times to get the RPA to finish its task.

1.2 Purpose

The intention of this thesis is to, re-design the existing Engine 3D and drawing RPA to also store data in a database. The RPA is to be split into two different steps, one handling the storage of data and the other utilizing data to generate content in CAD tools. The RPA will be implemented with the help of the RPA development team, when the MODA00252 is tested and fully functional and will later be launched for Wärtsilä employees' usage. The MODA00252 will be a part of a whole chain of RPAs that will be triggered after people are nominated. Other purposes for this thesis work are to get a deepened knowledge of AI and RPA development, and also when the data is centralized the waiting time is minimized when running the RPA.

1.3 Delimitation

This thesis work will be restricted to the MODA00252 RPA development. MODA00252 is an RPA that is split into two parts, one handling the data in the engine tool and another one creating the 3D CAD content and 2D drawings. The development of the RPA will be done according to the requirements.

1.4 Company introduction

Wärtsilä Oyj is founded in 1834 as a sawmill in the small village of Värtsilä in northern Karelia. Wärtsilä is nowadays a global leader in advanced smart technologies and complete lifecycle solutions for the energy and marine markets. Wärtsilä net sales were 2021 4,6 billon EUR and the personnel globally were about 17 500 in 70 different countries at 200 different locations. The company can be divided into six different segments:

Energy solutions where powerplants and energy solutions are delivered. Solar cell plants are also delivered. There are different types of powerplants,

• *Gas power plants* can be run on gas which is also the cleanest fossil fuel available.

• *Liquid power plants* are possible to run on heavy fuel oil (HFO), light fuel oil (LFO), crude oil, emulsified fuels, or liquid biofuel.

• *Multifuel powerplants* can be run on multiple different fuels. The benefit of multifuel powerplants is that they can be switched while running and that it's a barrier against increasing fuel prices or current local availability.

• *Biofuel powerplant* can run on both crude vegetable oil and animal fat. These oils can easily be extracted with simple methods, so emissions of CO2 are minimized already in the production of the fuel.

Marine power is where engines, propulsion systems, hybrid technology, and integrated powertrain systems are delivered.

Wärtsilä Marine Power leads the industry in its journey towards a decarbonised and sustainable future. Wärtsila's broad portfolio of engines, propulsion systems, hybrid technology, and integrated powertrain systems delivers the efficiency, reliability, safety, and environmental performance needed to support its customers. Our offering includes performance-based agreements, lifecycle solutions, and an unrivalled global network of maritime expertise.

Wärtsilä Services, Services are available to assist customers throughout the life cycle of the installations. Both in terms of replacement parts and installation optimization.

Marine systems offer the customers products and lifecycle services related to navigation systems, underwater repairs, exhaust treatment, and electrical integrations.

Wärtsilä voyage are delivering advanced assistance systems, coastal surveillance systems, and different types of communication systems used in harbors and offshore. These are done mainly using AI-driven software and state-of-the-art technology and algorithms.

Wärtsilä's portfolio business consists of independently run business units that accelerate the performance improvements and helps to solve demanding tasks. Included in the portfolio business are Tank control systems, Water and waste as well as American Hydro, a hydropower solution and turbine service company. (Wartsilä.com, 2021)

1.5 Smart Technology Hub

Wärtsila's Smart Technology Hub in Vaskiluoto, Vaasa, is a new integrated center for research, product development, and production. The Smart Technology Hub is Wärtsila's newest meaningful move toward decarbonization in the Marine and Energy industries. This new hub will focus on research, product development, and innovation of new technologies and fuels. This facility will have office personnel, production, and Research and development in the same hub, allowing collaboration to be maximized.

The smart partner campus is a part of the hub where cooperation will take place, and students and other experts have the chance to exchange ideas and gain a win-win situation. Wärtsila's customers and suppliers, as well as start-ups in the industry and universities, collaborate on research and product development at the Smart Partner Campus.

Wärtsilä has invested 83 million euros in the Hub's modern testing and manufacturing technology. The Smart Technology Hub has a total investment of approximately 200 million euros, which includes office and manufacturing buildings, logistics, and infrastructure. All Wärtsilä functions and people in central Vaasa, as well as the logistics and repair workshop operations from Runsor, Vaasa, will be relocated to the new Hub in 2022.

Wasalines' new ferry Aurora Botnia is also docked in Vaasa's port. It is one of the world's most environmentally efficient passenger ships, as well as a floating test laboratory for the Smart Technology Hub, allowing for real-time monitoring. In addition, an LNG port will be constructed this year in Vaskiluoto, Vaasa, from which liquefied natural gas will be delivered to the Smart Technology Hub and Wasalines' new passenger ship. (Wärtsilä Corporation, 2022)

Figure 1 Wärtsila's new Smart Technology Hub in Vaskiluoto, Vaasa. (Wärtsilä Corporation, 2022)

2 Theory

This chapter consists of theories about the programs and platforms that are involved in this thesis work, these will help to understand this thesis work and the subjects associated with it. The theories are followed up by figures and a figure explanation can be found below the references chapter. A list of abbreviations can be found ahead of the introduction.

2.1 Robotic Process Automation

A software robot Robotic Process Automation (RPA) is software technology that is easy to learn and automate digital tasks and processes. RPA is the use of software with artificial intelligence and machine learning capabilities to handle those repetitive tasks that earlier required humans to perform. RPA software robots can learn, mimic and execute business operations based on rules that are given. The definition of a robot is according to the Cambridge dictionary "a machine controlled by a computer that is used to perform jobs automatically", which can be interpreted as both software robots and also traditional physical robots. RPAs are usually suitable for high volume repetitive tasks that are time-consuming, those can be calculations, form filling, performing transactions, or creating content in programs. Robotic process automation software bots can interact with any application or system that humans can, with just the exception that RPA bots can work nonstop and with perfect accuracy. (automationanywhere.com, 2021)

When you think about the word robot, by most people it is usually a physical robot that is being imagined. A robot can be a welding robot, a human-like robot that can talk, but a robot can also be a software robot. What exactly is a software robot? A software robot is just like another robot, it can be programmed and later used to automate and execute tasks. Software robots can do tasks on the computer just like a human could do. The tasks can be everything from paying bills, being a chatbot, filling forms, run simulations, the creativity of the programmer is the only limit. The definition of a robot is "a machine that can do a range of jobs in place of humans, either on-demand or by being pre-programmed." (YourDictionary.com, u.d.)

The word automation comes from the Greek words autos, which means "self," and motos, which means "moving." It is thought to have been invented in the 1940s when the Ford Motor Company began to deploy automated devices in mechanized production lines. (McLean, 1961)

Automation, to put it simply, is a branch of technology concerned with the use of machines and computers in the production of goods and services. This helps in the completion of tasks with little or no human involvement.

What should be automated?

- High-risk tasks
- Time consuming tasks
- Repetitive tasks
- Tasks involving multiple people and multiple steps

Robotic process automation allows employees to focus on more creative and difficult tasks by eliminating those repetitive tasks with RPA technology. The RPA software robot is trained via illustrated programming rather than code, which is a significant difference between RPA and traditional automation. (Tripathi, 2018)

2.1.1 What was used before RPA?

What has been used before RPA? Custom software development is the process of creating new software to do repeated activities. Runbooks are commonly used for IT-related processes. They are made up of a set of orders or actions that are carried out for maintenance and other purposes. Runbooks, also known as run commands for conducting a collection of actions, can be used offline. Batch files were once very common. They were used to put together a list of commands that could be executed with only one click or command. The scheduler can also be used to schedule them to execute at a certain time. The wrapper is a program that wraps around other software or hosts a client application. The wrapper keeps track of what's going on in a client app and takes action depending on rules.

Browser automation was helped by Greasemonkey and other web macro applications. It can read from a webpage and save the data to a database. It can also use rules to write to fields. A full website can be altered with this technology, and components can be added or removed from the website. Web scripting or web injections are other terms for the same thing. Automation on the desktop traditionally meant weaving together numerous screens on a desktop to present a single screen and transferring data from one screen to another could be done automatically. Some companies have recently considered assisted robotics process automation for desktop automation. With *database integration* reading and writing is done straight to the client database. In *web service integration*, communication is done by using the web service system. (Tripathi, 2018)

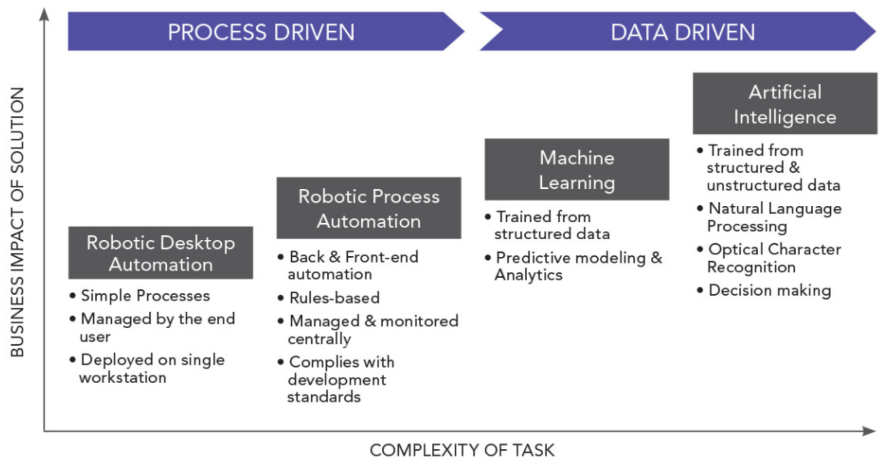


Figure 2 Differences between Process-driven and data-driven automation solutions. (Roe, 2021)

Robotic process automation is today usually used as unattended automation as seen in Figure 2. Artificial intelligence can be combined with RPA, but RPA by itself is not artificial intelligence since it cannot analyze and think on its own. RPAs are only making decisions depending on if the programming has been taken into consideration.

2.2 UiPath

UiPath is a Romanian American IT company founded in 2005. Since 2021 it is noted on the New York Stock exchange (NYSE). UiPath is developing IT platforms for the automation of repetitive tasks. Time-consuming work is minimized with automation and employees are therefore allowed to focus on more creative and challenging problems. To this day UiPath is the most used digital platform for developing RPAs. The efficiency with software automation can be seen in Figure 2, where UiPath RPA to this day has very intelligent features such as computer vision (AI screen recognition). (UiPath.com, 2021)

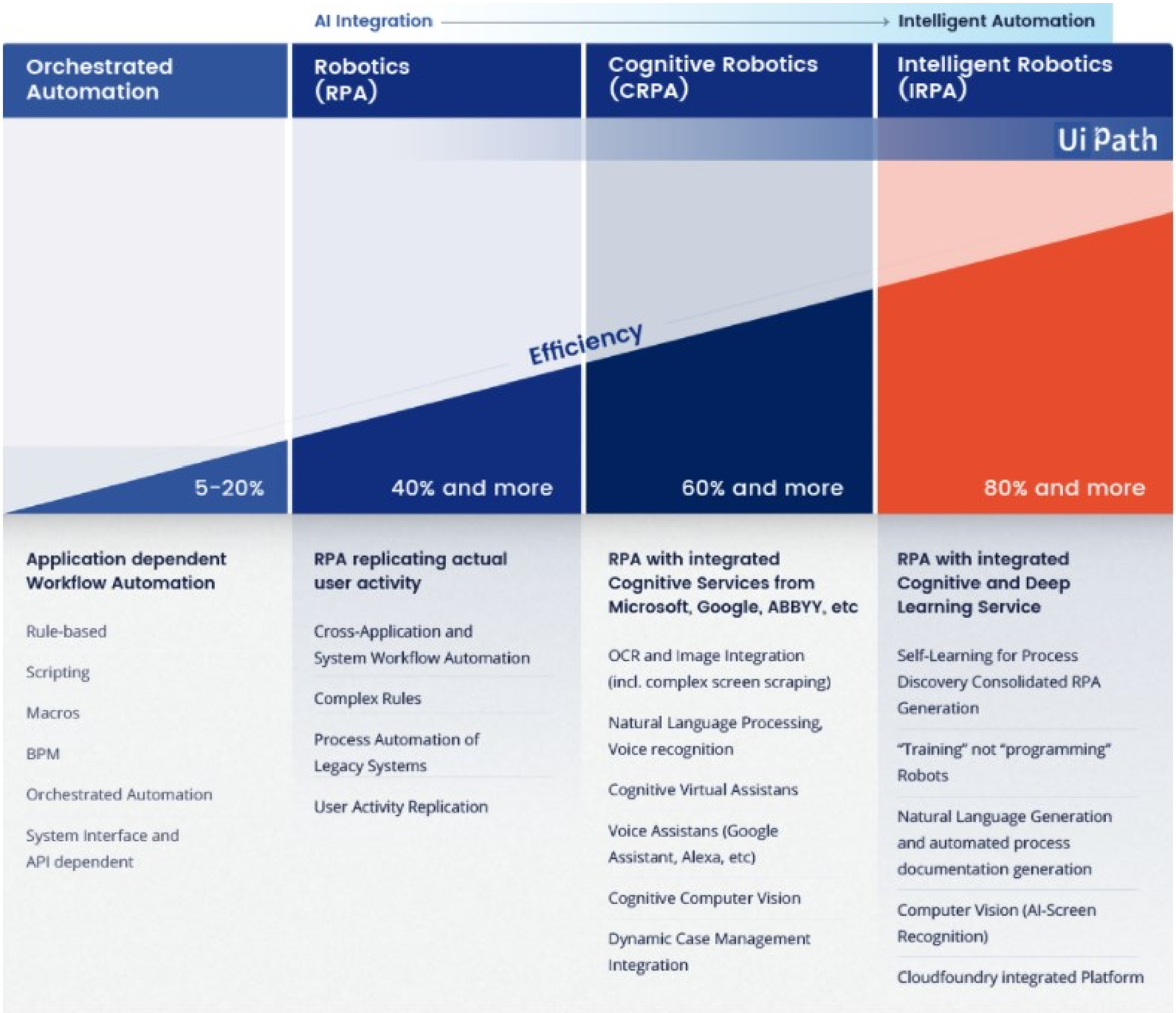


Figure 3 Efficiency with different types of digital automation. (CFB Bots, 2018)

2.2.1 Components of UiPath RPA software

UiPath Studio is the environment where the RPAs are developed. No coding experience from earlier is needed for this kind of programming technology but it is recommended to attend some basic training course to get to know the program and all its functions. The programming is done visually with so-called drag and drop functionality. With this type of programming, it is easy to see where problems occur, and potential replacement of functions is done very easily. The UiPath robot is the digital worker who performs the scheduled work on its own without human inputs. Applications can be opened and closed within the UiPath robot, and all decisions are done according to the programmed flowchart in UiPath Studio.

The UiPath robot can execute and perform tasks like:

- Business App Automation could be Microsoft office applications like Excel or Teamcenter PDM software.
- Screen scraping is a method for a computer program to extract data from a human-readable output generated by another software.
- Robotic API is an application programming interface used in robotics. An API is a software intermediary that enables two apps to communicate with one another.
- Auto Login Windows Session, automate the login process for better time efficiency.
- Computer Vision-Based Automation, used in UiPath and other automation programs for analyzing the screen, to trigger buttons and functions with help of artificial intelligence.
- Email Automation, at the end of an automated task, can email automation be used to let the user know the task is completed and to send the finished product to selected people.
- Run Processes Under Locked Screen, tasks and processes can be run without the need of having the screen to be turned on.
- Text-Based Automation is used frequently in customer-oriented industries for sending special offers or reminders to customers by SMS.
- Data Automation is defined as the process of uploading, handling, and processing data using automated technologies rather than conducting these processes manually.
- IT Automation is the process of developing software and systems to replace repeated operations and eliminate manual involvement.

UiPath Orchestrator is a management control panel for licensing, configuring, and deploying UiPath robots. It may assign robots automation and job lists, as well as plan activities for them. All mission-critical enterprise responsibilities are likewise handled centrally by the orchestrator. Asset management, workload management, remote control, auditing and monitoring, and centralized reporting and logging are just a few of the responsibilities. (Tripathi, 2018)

2.3 How is the programming done in UiPath?

The programming in UiPath is a bit different from traditional programming. UiPath is using the "drag and drop" functionality, which means activities can be dragged to the flowchart which is the field for programming, and customization is done if needed for the task. Like traditional programming, variables are also used in UiPath. In Figure 3 different variables are being mentioned. A data type defines the data a variable can hold, for example, a string can hold text, integer (INT32) numerical values, Boolean which can be true or false, or a data table which also is a data type.

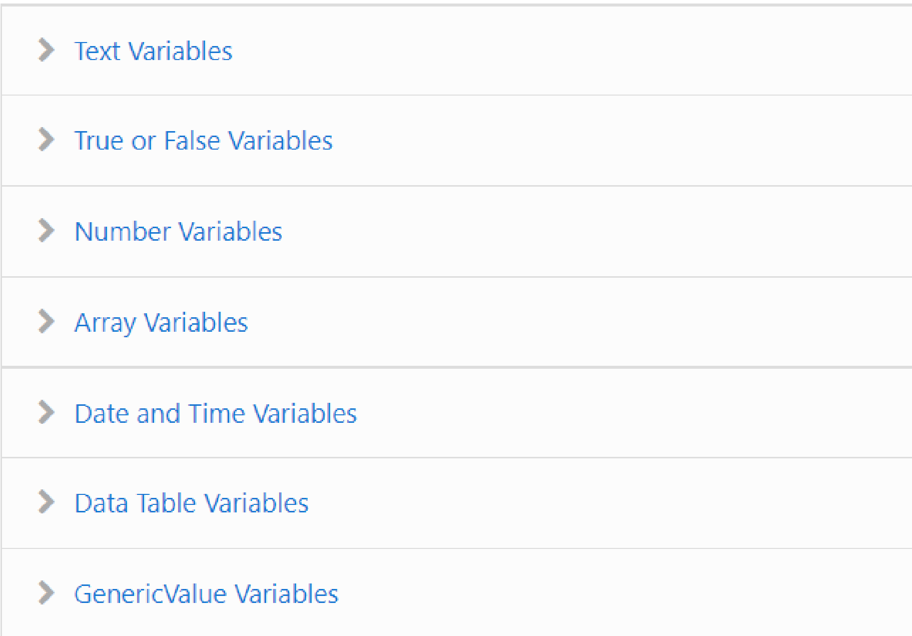


Figure 4 Different types of variables in UiPath.

Before starting programming, a project template can be used or customized. Depending on what task is needed to be automated, choosing an already existing and suitable template speeds up the programming process even more. The built-in templates can be everything from a background process that does not need any interaction from the user to a transactional process or a mobile testing project. The one used in this thesis work is a "process".

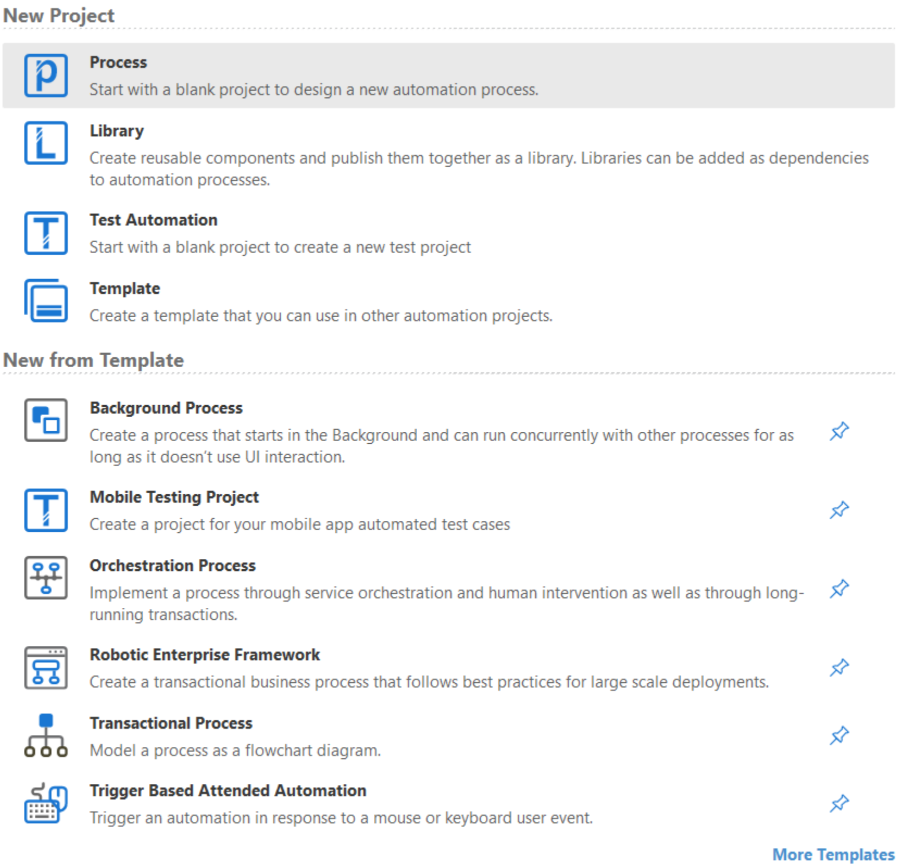


Figure 5 Different types of project templates in UiPath.

In Figure 5 the main screen in UiPath is shown. Here is where the programming is done. A screenshot from my thesis work from the first part is chosen for demonstration. To the left, the activity and project tabs are located. The activity list is a collection of all UiPath functions which all can be chosen to be used in the programming. An activity replicates a manual task that you would perform on your computer. A short description of the activity is shown when hovering over them which eases the selection. An activity can be a click, a selection, or anything like this. The ribbon is located at the top, here are saving functions and UiPath special commands like recording, screen scraping, and data scraping.

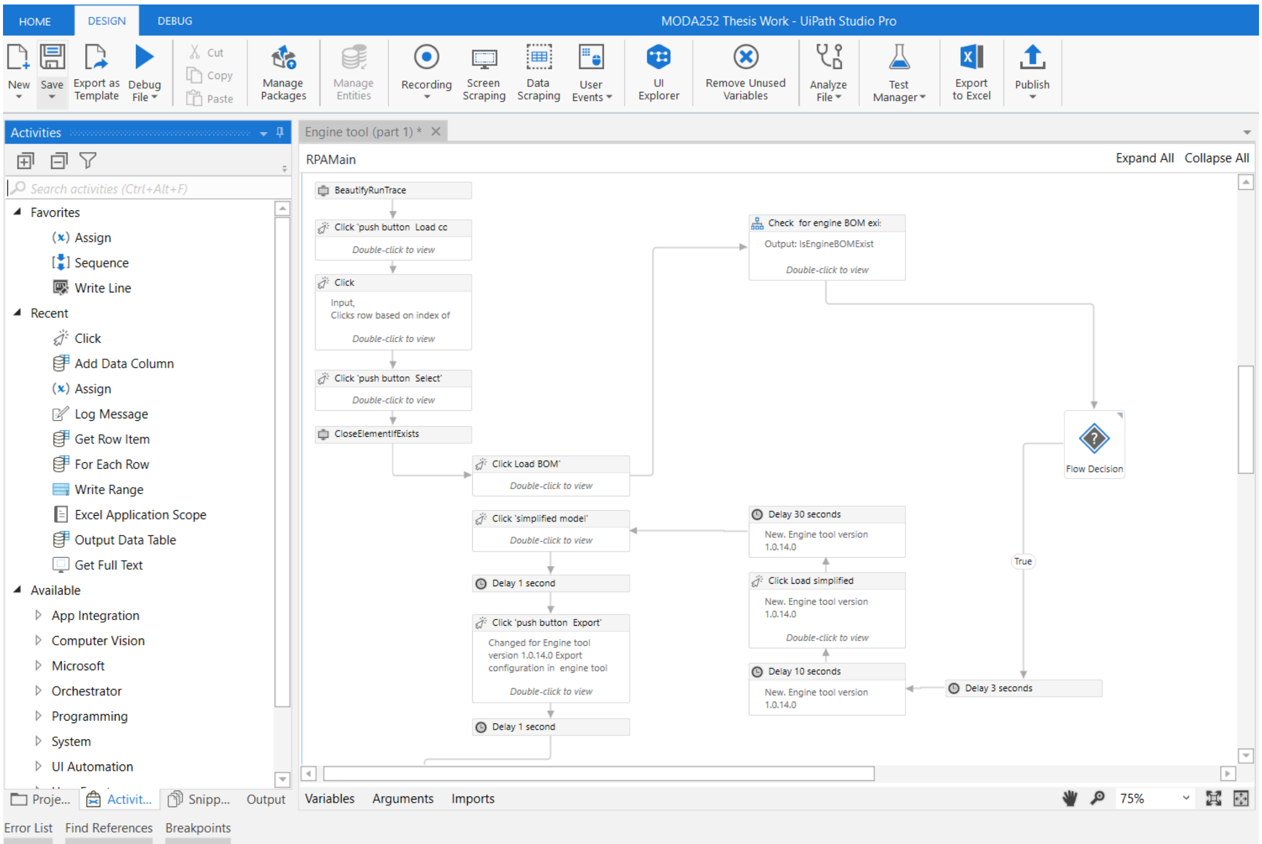


Figure 6 How the programming in UiPath looks like.

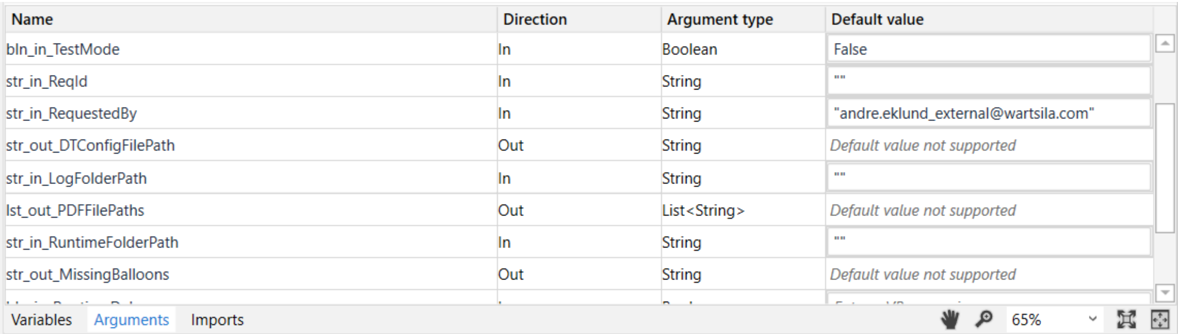
Name	Variable type	Scope	Default
ReadOnlyObjectWindow	Boolean	RPAMain	Enter a VB expression
strAllConfigurations	String	RPAMain	Enter a VB expression
AllConfigurations	DataTable	RPAMain	Enter a VB expression
extractdatatableOLD	DataTable	RPAMain	Enter a VB expression
temp	GenericValue	RPAMain	Enter a VB expression
arrConfigs	String[]	RPAMain	Enter a VB expression
DTConfigs	DataTable	RPAMain	Enter a VB expression
PSLFilePath	String	RPAMain	"C:\users\aekx02\desktop"

Variables Arguments Imports 75%

Figure 7 Variables list.

The variables and arguments tab is down on the main screen of UiPath. Variable and argument creation is done here, and their types and scopes are easily changed. In the default expression tab specification of the variable is expressed. This could be for example in the “PSLFilePath” that is a string by type, the scope is in “RPAMain”, and a local saving is done in the default folder in the desktop called “C:\users\aekx02\desktop”.

An argument can on the other hand can be an input, output, or property. The argument type can be chosen in the same way as variables can. In this thesis work my own Wärtsilä e-mail is used while trying out the RPA during the programming process so the logging is not done in SPEAR and content is not saved anywhere. The 2D drawings and 3D content are only sent directly to my mail this way before the official launch of the RPA are done.



Name	Direction	Argument type	Default value
bln_in_TestMode	In	Boolean	False
str_in_ReqId	In	String	""
str_in_RequestedBy	In	String	"andre.eklund_external@wartsila.com"
str_out_DTConfigFilePath	Out	String	*Default value not supported*
str_in_LogFolderPath	In	String	""
lst_out_PDFFilePaths	Out	List<String>	*Default value not supported*
str_in_RuntimeFolderPath	In	String	""
str_out_MissingBalloons	Out	String	*Default value not supported*

Figure 8 Arguments list.

When inside an activity, the properties, input, and output can be set. Depending on which activity is used, the options are different also. Custom activities like Wärtsila's own are also available, which are created to satisfy Wärtsilä desktop applications needs.

Wärtsilä has its API, which means an application programming interface. The definition of an API is "a set of protocols that programmers use to build applications for a given operating system or to connect the various modules of an application." Wärtsila's API can fetch data, and write and save objects to the data model. It can handle everything from objects to sub-objects which allows it to be considered a powerful and variable tool. (Dictionary.com, 2022)

2.4 Artificial intelligence (Computer vision)

Artificial intelligence is the study of how to program computers to perform tasks that humans excel at. Artificial intelligence is a branch of computer science that deals with systems that display the features we associate with intelligence in humans. Artificial intelligence is an area of computer science that deals with how to represent knowledge using symbols rather than numbers, as well as how to process data using rules of thumb or heuristic methods. UiPath has features called computer vision (CV). The computer vision can see all the elements of the interface, no matter if the resolution differs or the operating system. Computer vision is a great tool since bars and buttons' location can change in updates. By using Computer Vision in UiPath, the robot will still find it and no update of the RPA is furtherly needed. CV Screen Scope activity is used in the second part of the MODA00252 RPA to find the bars and buttons no matter if updates of the program are being released. All Computer Vision activities are listed in Figure 5.

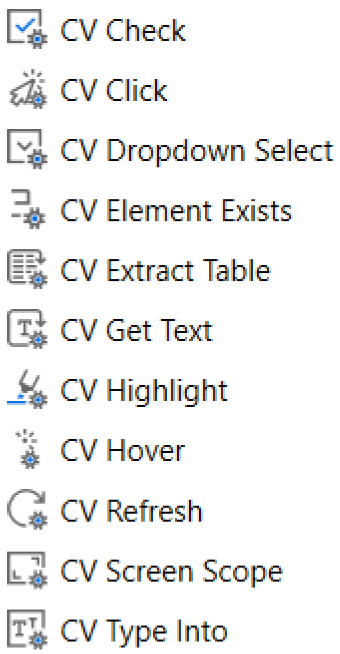


Figure 9 All Computer Vision activities are listed from UiPath.

2.5 Teamcenter / NX

Teamcenter software is a PLM system that is designed to be synchronized to other Siemens software. Within Teamcenter PLM software, 3D contents, drawings, information, and bill of materials (BOM) can be shared and sent for approval to other design groups. Teamcenter is a flexible software where different departments such as manufacturing, cost engineering, quality, and supply chain can search information and share information with each other. Siemens NX is integrated and started via Teamcenter at Wärtsilä.

Siemens NX is a very powerful software where product design, computer-aided design (CAD), computer-aided manufacturing (CAM), and simulations can be run. Siemens NX has a lot of add-on options such as finite element analysis, additive manufacturing, and topology optimization. Siemens NX is highly customizable, and many own functions have been made for Wärtsila's own needs. (Siemens.com, 2022)

2.6 Data management

Data management is having a central role in this thesis work. Instead of running the RPA as a standalone, it will be programmed to run directly on the engine object. The data is saved in the first part of the RPA in the object data model, and in part two the content is saved in Teamcenter. The run log is saved in SPEAR under the name "RPA Engine tool "runlog". SPEAR is a task management and database application used by engineering groups. Generated content is sent to the person that triggers the MODA00252 RPA and any additional persons if the distribution group is specified via email to the robot. The robot will check inside SPEAR if it has been run earlier. In the future, it is planned that the RPA will check if anything has changed since the last time being run, and later decides to run a revision instead to create new content.

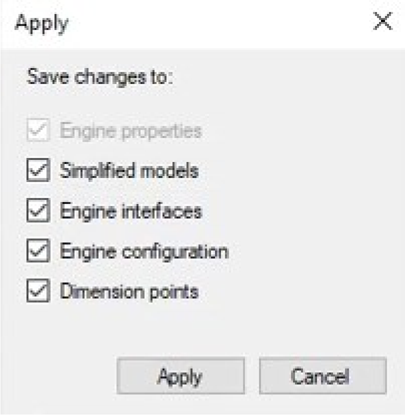


Figure 10 How the saving is done inside the Engine tool.

Figure 10 it is shown how the saving is done inside the Engine tool. After configuration, simplified models, and engine interfaces are loaded these checkboxes are checked, and apply button is triggered. Content will be saved in the object data model from part one, and content from part two will be saved in Teamcenter's database.

2.7 Requirements for the update of MODA00252

The requirements for the first part of the RPA are that it will be run directly on the object. This means that the data will be saved to the object data model, everything is run straight on the project number and after the engine tool has been run the data is saved to a database.

The second part of the RPA is very complex and expanded, even up to this day it is one of the most complex and difficult RPAs in Wärtsilä. It is required to become more compact, and some features will also be removed and integrated into the first part instead. All saving of the created content is done within the second part of the PDM system (Teamcenter). Integrated activities will replace many “traditional” programming activities to create a more compact and easily understandable RPA. The new version of the MODA00252 will be easier to maintain and update in the future when it is not as many activities in one RPA.

3 Methodology

This chapter explains the approaches used to accomplish this thesis work. The programming was done by considering the requirement. The most efficient and beneficial way of choosing the activities and programming was not the easiest, by testing and validating the best result is achieved and it has been chosen to be in the final version of the MODA00252 3D CAD and 2D drawing RPA. Explanations of how I got to the result are described in subtitles 3.1 and 3.2.

3.1 Part 1 of MODA00252 Development (Data handling in Engine tool)

This chapter explains how the different approaches used to accomplish this thesis work. The principles and how everything works right now were told to me by my manager and the new requirements were listed when beginning this thesis work. The correct dependencies were installed according to what was needed for this very complex RPA. The programming was done according to the requirements and some parts from the earlier version of MODA00252 were copied to be used as a template.

The first thing to get accomplished in the new MODA00252 in the first part was to modify how the projects are being searched inside the Engine tool, the earlier version of the MODA00252 is running as a standalone. This means it is being run on the project number and not on the object itself, meaning nothing will be saved on the object in the database.

In the new version, the robot will be doing the following: Run directly on the objects, for each object run the engine tool and save all the data back to the database. The saving is done inside the Engine tool application which also creates all needed sub-objects and or revisions.

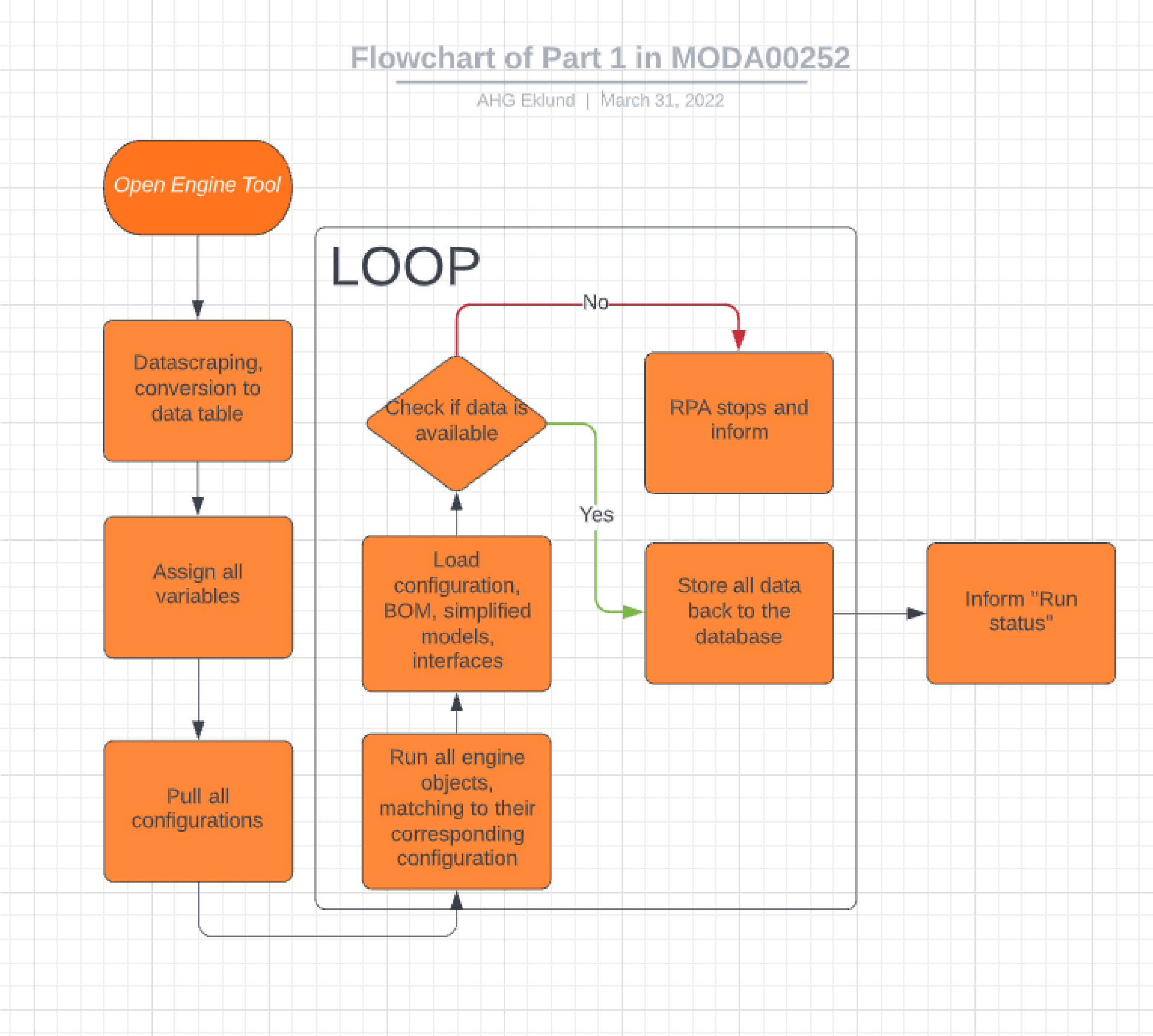


Figure 11 Simplified flowchart of Part 1 in MODA00252 drawn in LucidChart.

A flowchart with a simplified process of what the RPA should do is drawn in LucidChart for both parts of the RPA. The description of how the first part of the RPA should work can be seen in Figure 11. It all begins with the RPA opening the Engine tool application and right after the activity data scraping is being used to get the info from the configuration list, this is later converted to a suitable form into a database. Excel was used in the programming stage to get an exact view of how the output is. All variables are assigned. Inside the Engine tool, the select button for objects is triggered and the project number, that is also called the SP number is typed in by the robot and after that, it searches for configurations. The configurations are being pulled to search for matches. The run of all engine objects is done and a search for corresponding matches. Load configuration, load BOM (bill of materials), load simplified models and load interfaces are clicked one after another. This is looped until all configurations are being run that have been listed. A check is taking place to see if everything has been created, and if not, a message will inform you that the RPA has stopped. When everything has been created the PSL file will be exported and saved in the chosen file path. The click load interface button will be triggered and after it will save all the created data and move on to the second part of the RPA and inform the run status.

3.2 Part 2 of MODA00252 Development (Generate content in CAD tool)

The second part of the RPA will check if the project has been run earlier. Depending on the case, the following actions will take place; if it has been run before, it will inform the user that the RPA has earlier been triggered. If the simplified models have changed, it will create a revision of the content. If the interfaces have changed the coordinate table is updated. If not run before at all, the loop inside Figure 12 begins. Inside the loop it will open the Siemens NX application, the hotkey CTRL+O will be used to get to the open tab. The NX Dummy number is filled into the field and OK is clicked. The powerful Computer Vision activity Screen Scope is used to locate the Structure icon in NX. CTRL+O is used to open template drawing. A check is used to make sure that NX is at the structure icon. Saving of the 3D assembly is done and CTRL+TAB is used to switch to 2D drawing. Saving of the 2D drawing is taking place and the hotkey CTRL+U is used to execute NX open. The IPS2 Macro is being run that opens DLL files and saves them locally by the robot. In simplified words, the macro loads in the models and places them according to the data that is received from the export file.

The PSL file name is typed in and after the read-only prompt appears, the click activity is triggered. Another saving is taking place to make sure it is correctly saved, by this time the 3D is loaded in, and everything is in its' correct locations. The hotkey CTRL+SHIFT+TAB is used to update the views on the drawing and 3D assembly. The robot waits until all 3D models have been loaded. The activity clicks on is used to make sure the NX screen is selected, if the RPA has another prompt or window open. The hotkey SHIFT+T is used to get to the title block and in the appearing dropdown list, the drawing template type "Common" is chosen with the help of the activity "Check". The two checkboxes that will be checked are" Update title block and frame" and "All drawing sheets". The filling in of info to the title block is happening next, starting with the creator of the drawing, in this case, MODA00252 is written in since the robot is creating the drawing and 3D assembly. Today's date is filled to the title block with the CV screen scope activity. After this activity, the title block is inserted automatically into the drawing. Before the drawing is finalized and released, the creator’s name will be changed by the person releasing the drawing.

The coordinate table is automatically created by running a Macro that will also place all the balloons in the right locations on the drawing. Another check is taken place and the fault message "Some balloons missing" is logged to the user if not every one of them is placed onto the drawing. The macro is in simplified words generating a data table from the export file. The drawing is now saved after everything is correctly run and positioned. The drawing is now printed to PDF and saved locally on the RPA.

An API is run to log each loop that has been made into the task management system SPEAR by using an invoke method and a new row is added and saved for each loop. In the log message, the robot will store the assembly number, drawing number, SP (project) number, and requested by. This log is used by the robot to check if the content has been created earlier. In addition to this also a separate log is sent to the person triggering the RPA. That log will also show the status of the run e.g.if the run was successful or if any errors occurred. Another saving is taken place in NX to make sure the final result will be saved. The content is sent to the user along with the log file via email and after that, all the applications are closed.

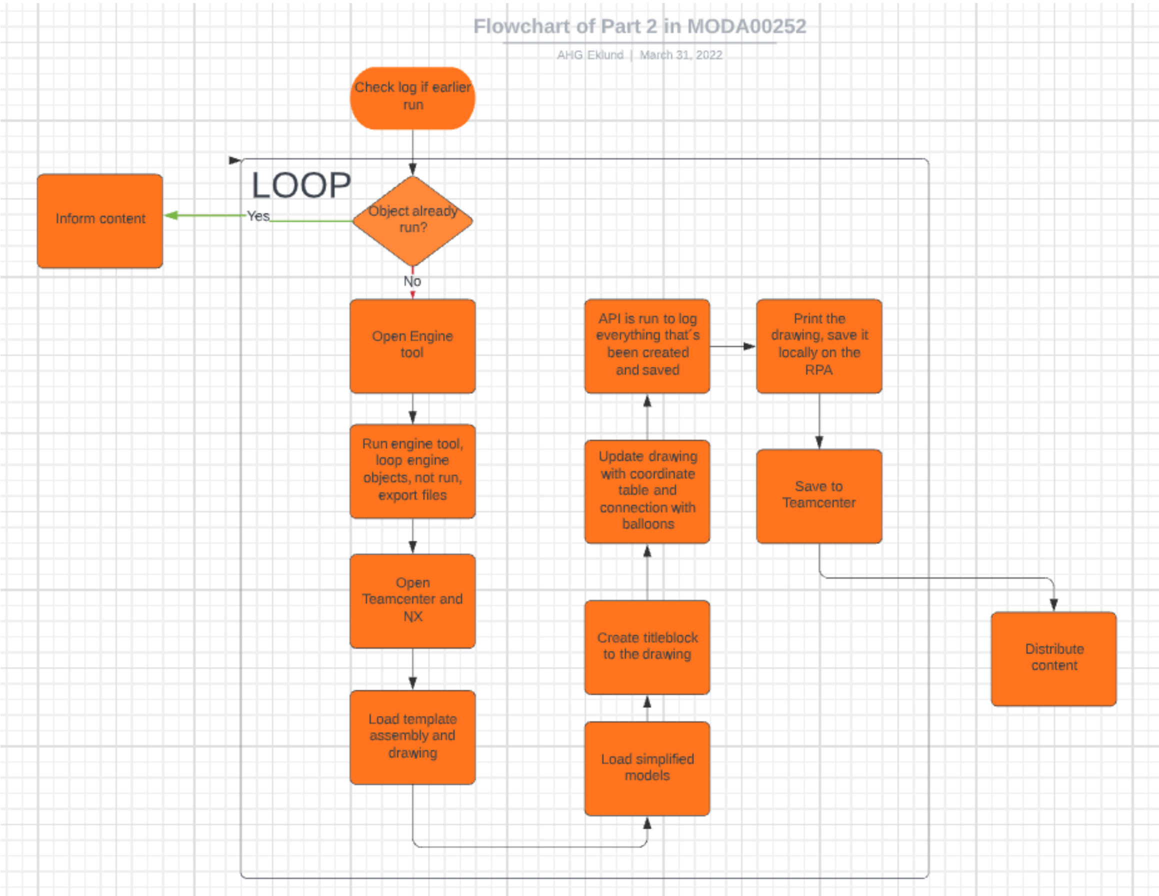


Figure 12 Simplified flowchart of Part 2 in MODA00252 drawn in LucidChart.

4 Result

In this chapter, the result of this thesis will be presented. The result is divided into two subchapters, one for each part of the RPA. Figures showing the final programming will be included as part of the result.

4.1 Part 1 of MODA00252 Development (Data handling in Engine tool)

The result of this thesis work is a fully functional MODA00252 RPA that is split into two parts according to the requirements. The testing of the final programmed RPA was done, and bugs were located and fixed. The MODA00252 RPA will be implemented by the RPA development team at Wärtsilä. The programming of the RPA was done in a correspondingly way to decrease future potential problems because of software updates. The result from the programming of the first parts database function and saving function can be seen in Figure 13.

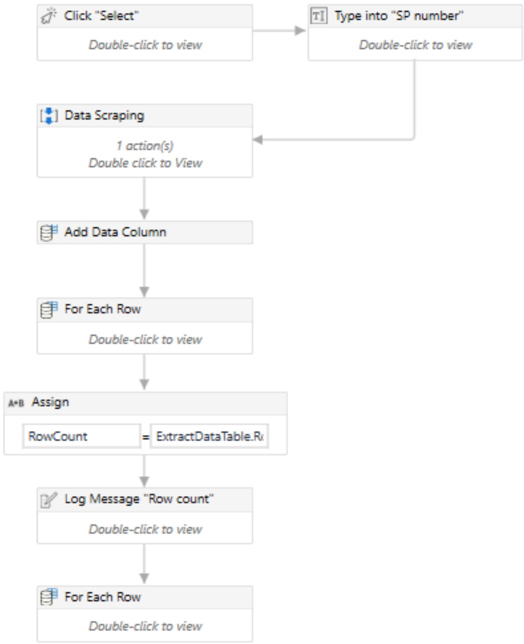


Figure 13 The database functionality programming of part 1 to MODA00252 in UiPath.

Part 1 of the RPA begins with starting the Engine Tool application and directly after the push-button “select” on the object tab is pushed. The SP (project) number is typed in and searched. Data scraping is done with the integrated activity data scraping. To get the scraped data output right following activities had to be added, add a data column, for each row, and the activity Excel application scope was used during the programming phase to see exactly how the data has been scraped and the data table was created.

Inside the first for each row activity variables are assigned, and a log message is used to know if all variables have been correctly assigned.

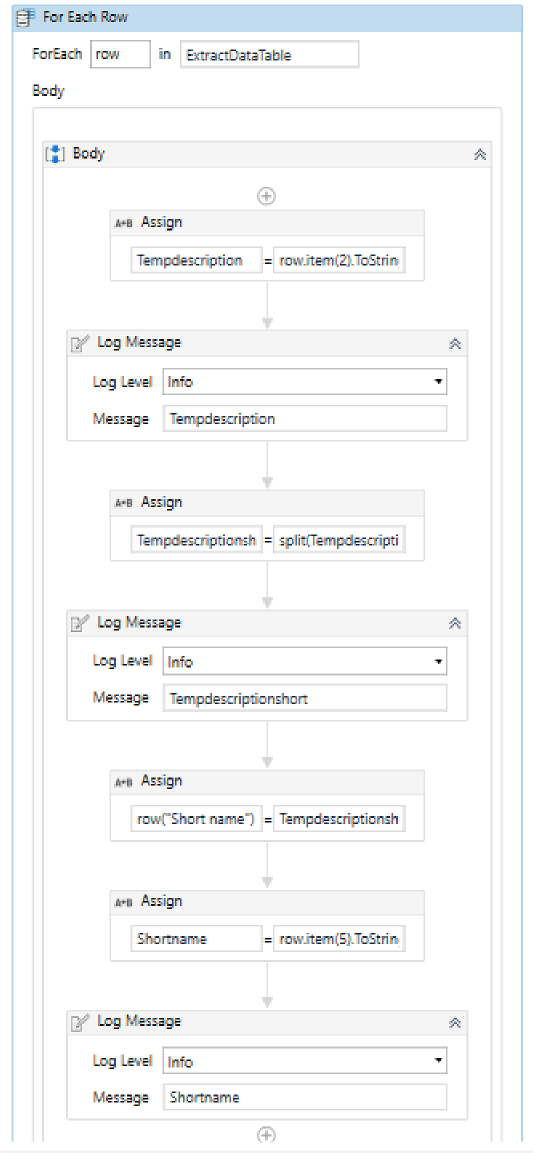


Figure 14 The assignments of variables and log messages in the first "For each row", which can be seen in Figure 13.

Inside the second "For each row" activity, a flowchart was created and called Flowchart "For each". This is a loop, and it is doing the same thing repeatedly until all data for each configuration row are loaded in and saved. This loop can be seen in Figure 15.

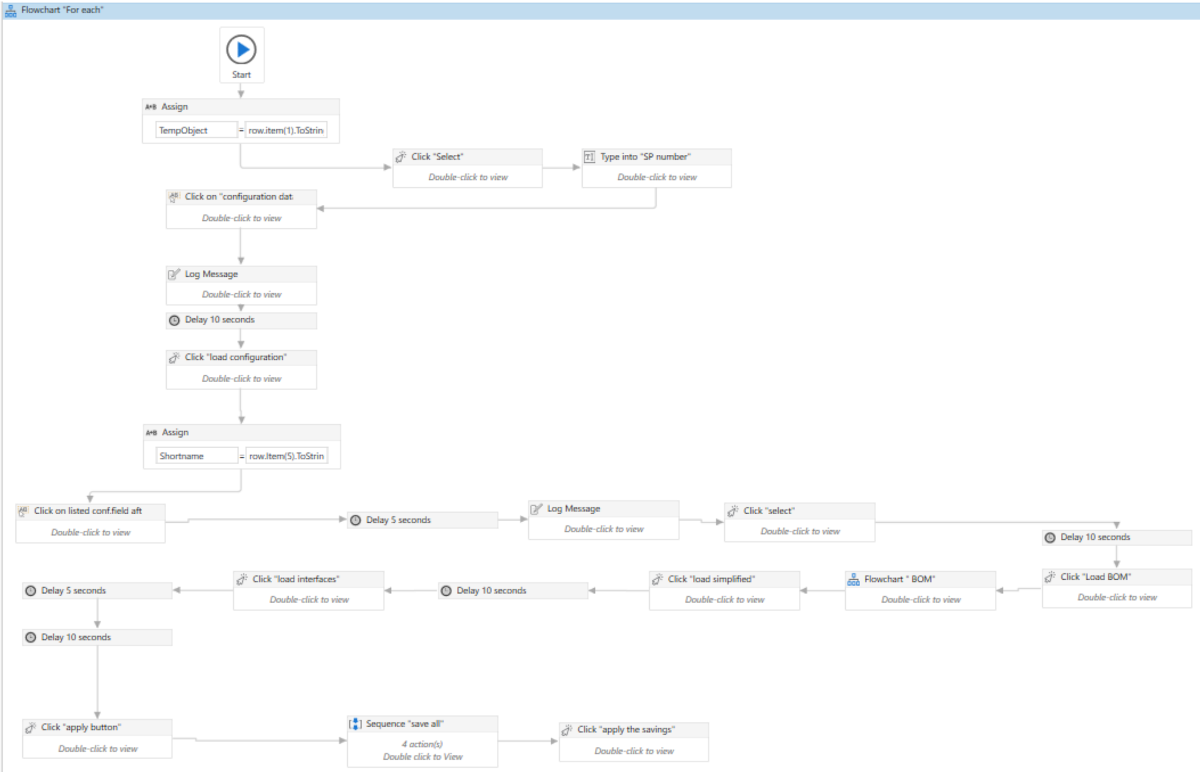


Figure 15 Inside the second "For each" loop in the first part of the RPA where database functionality is integrated.

Another flowchart is integrated inside the Flowchart "For each" called Flowchart "BOM" which can be seen after the activity Click "Load BOM" in Figure 15. The flowchart itself is to be seen in Figure 16 where flow decisions have been used to create a loop in case of BOM is missing. With the help of this loop, the robot can wait for the BOM to be loaded independently of the time needed. By using the flow decision activity, it will automatically loop until the "IsLoadingBom" and MAXWAITCOUNTER equals the counter.

If the "MaxWaitCounter" equals the counter the "BOM is missing" message will appear. If according to the check condition the BOM is missing the error message "BOM is not available " and otherwise if the BOM is not missing according to the check it will message "Seems to be something wrong with Engine Tool".

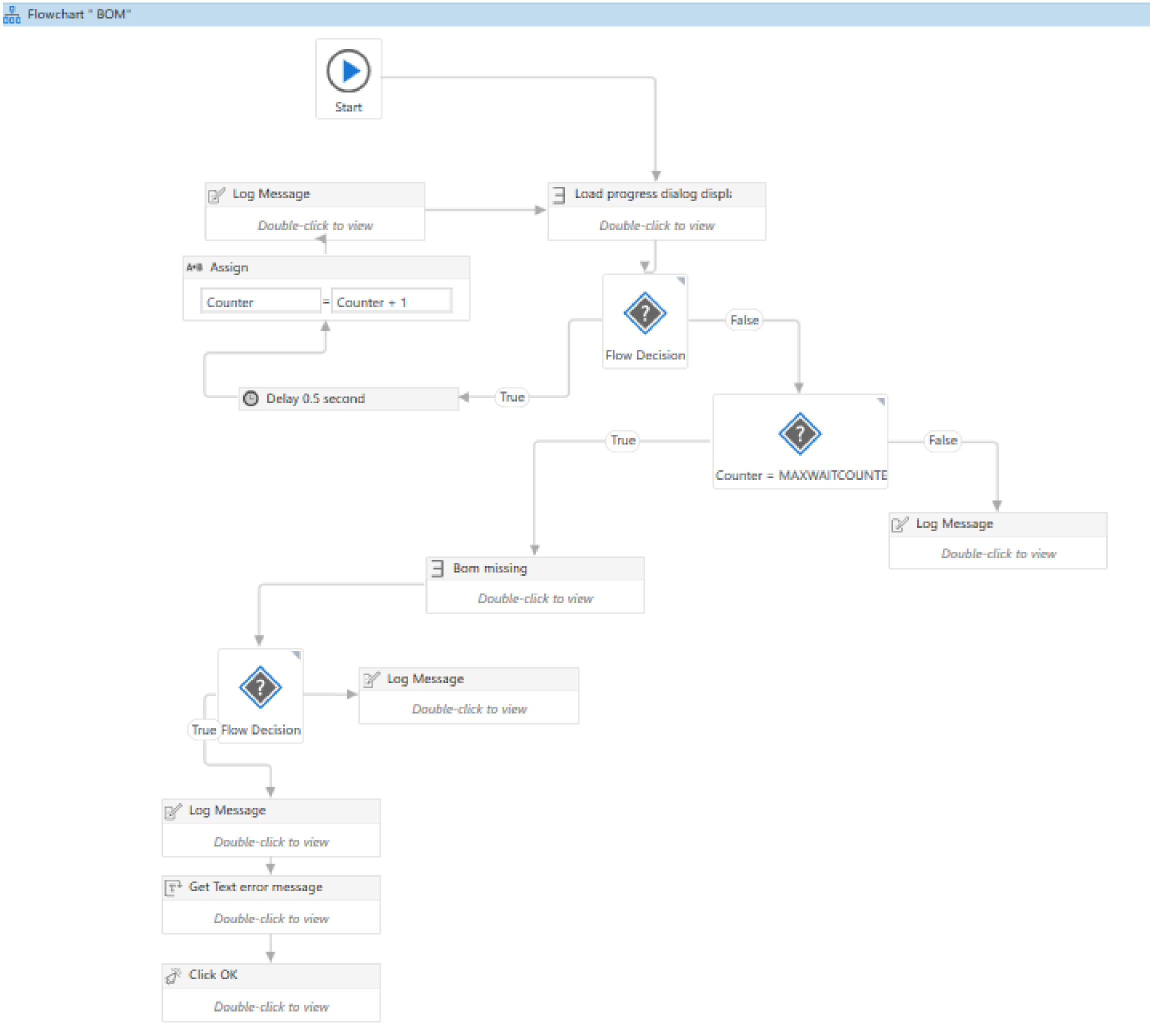


Figure 16 Inside the second "For each" Flowchart exists another Flowchart called Flowchart "BOM".

4.2 Part 2 of MODA00252 Development (Generate content in CAD tool)

In the second part of the RPA Engine tool is run and the loop is done similarly as in part 1 once again. To determine if changes have arisen and also to determine if the content has been created earlier and therefore should be revised. Part two will also take care of revising if needed. If no earlier content has been created, the RPA will generate new content. The Siemens NX part of the RPA is run as earlier versions of the MODA00252, so many activities can be utilized from the earlier version. The flow decisions are used in such a way, that it checks if the data from part 1 of the RPA is different from when it is run at part 2 and consequently can decide to trigger part 1 again. A new function that is used in part 2 of the RPA is depending on if changes are noticed, and therefore different actions are taking place. In the programming, the usage of the integrated activity "Data scraping" is chosen to see the differences in what is changed also utilizing the API to check if it has run earlier. Following actions will take place; if it has been run before, it will inform the user that the RPA has earlier been triggered and also decide to revise the content based on any changes detected to the data. If the simplified models have changed, it will create a revision of the content. If the interfaces have changed it will create a revision of the content including updating the coordinate table on the drawing. If not run before at all, new content will be created.

In Figure 17 below, the programming of part 2 can be seen. Similar activities are added from part 1. The new things in the programming are the assignment of SPEAR API, the retrievement of SPEAR log data (Figure 18), the for-each loops for missing assembly numbers (Figure 19), and the for each loop to run all DTConfigs can be seen from Figure 21 to 23.

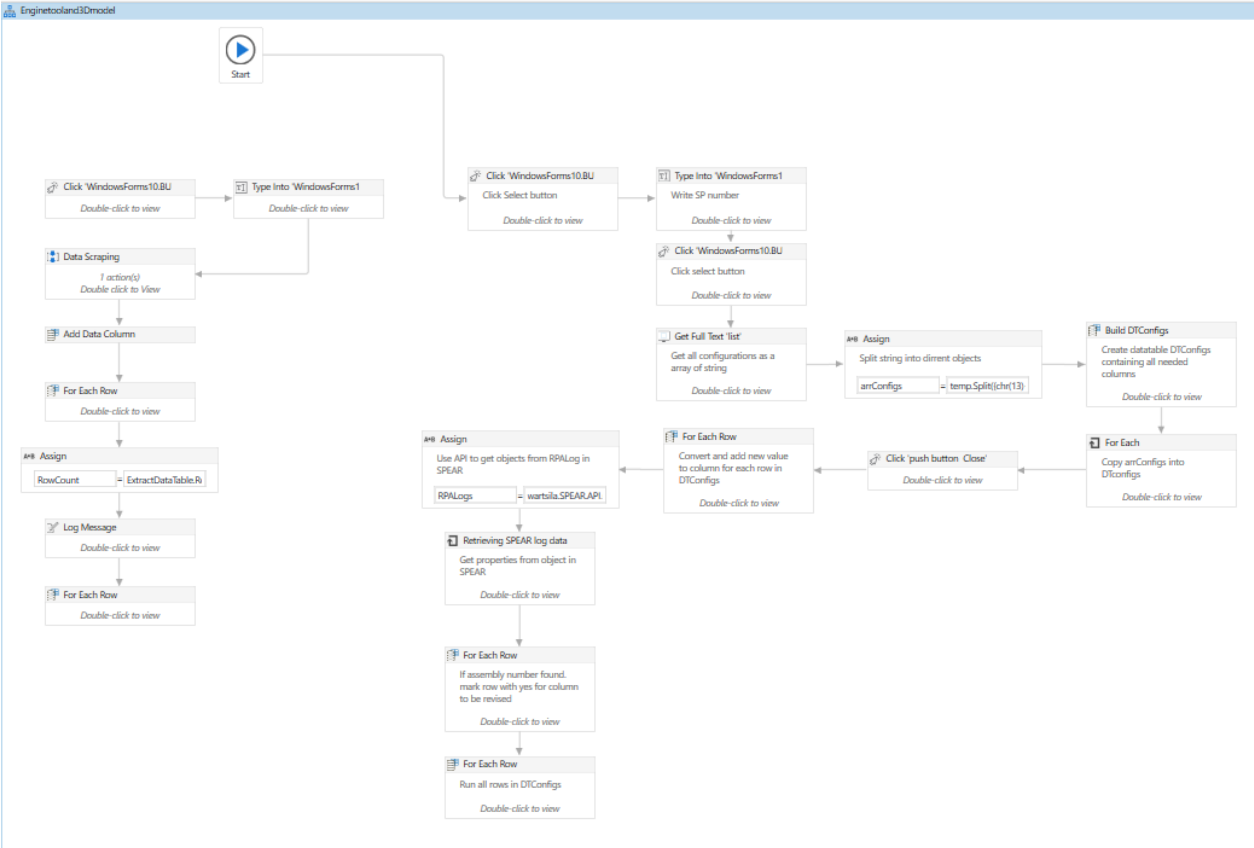


Figure 17 The programming solution of Part 2 of MODA00252 RPA.

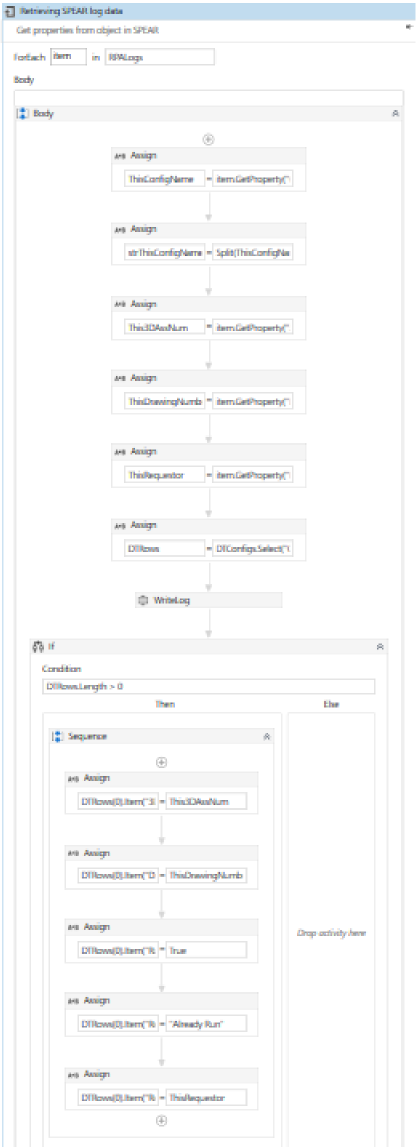


Figure 18 Retrieving spear log data, getting properties from the object in SPEAR.

In Figure 18 the activity" Retrieve SPEAR log data" is used to get straight into the database inside SPEAR to retrieve the objects. Inside the objects, the values are fetched from the properties, and the assignment of the variables is taking place.

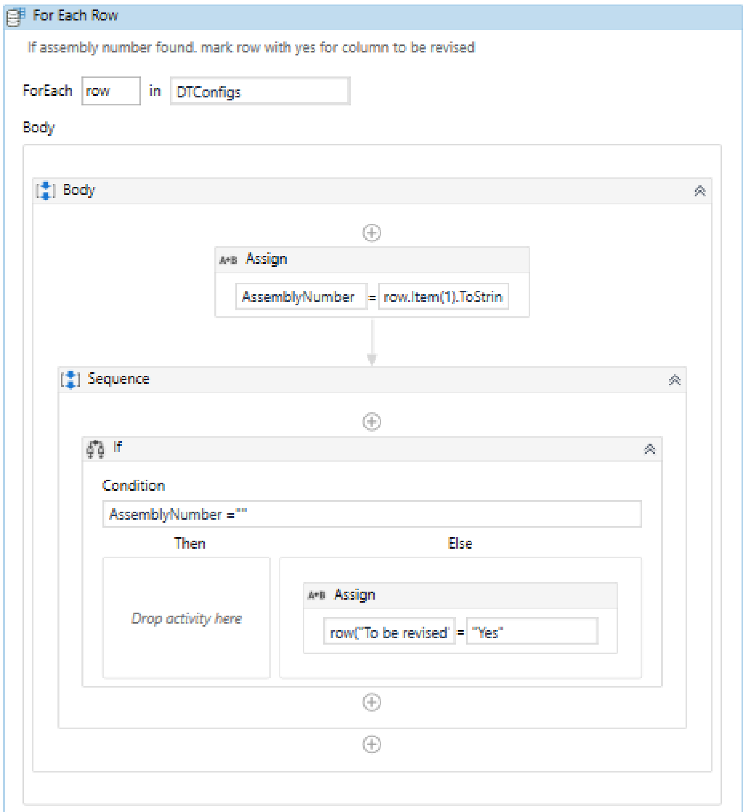


Figure 19 For each row loop in DTConfigs.

Figure 19 for each row loop is using the data table to check inside the data table if everything has been assigned. This activity is used as a doublecheck to make sure it is done properly.

Inside the last for each row loop, the most relevant programmed activities will be described since the programming is so broad. In the last for each row loop, which runs the DTConfigs, the process begins with assigning the assembly number, and after it has been assigned a sequence with the activity "If" is used to check if the assembly number was already available from an earlier run.

Assignment of the variable “TempObject” is done to be used to fetch a value from the data table to secure that no other value is present on the variable. While inside the engine tool, the select button is pressed and the SP number is typed into the data field. The robot clicks on the data field of the text cells that pop up. The load configuration button is pressed, and the RPA selects the corresponding configuration which is handled in the present loop. Select button is pressed to choose the engine configuration.

Data scraping activity is used to scrape the data from the Engine properties tab that is visible after the select button is pressed. A loop called for each “Configurations” value will trigger RPA part 1, if the condition “ConfigChanged” = “null” the RPA will continue to loop. If the RPA detects a change, it will immediately set a value on the property ConfigChanged, and consequently set the value property TriggerRPA1 to true. The info message will say “Something has changed in the configuration, please Run RPA part 1 again” and end the loop.

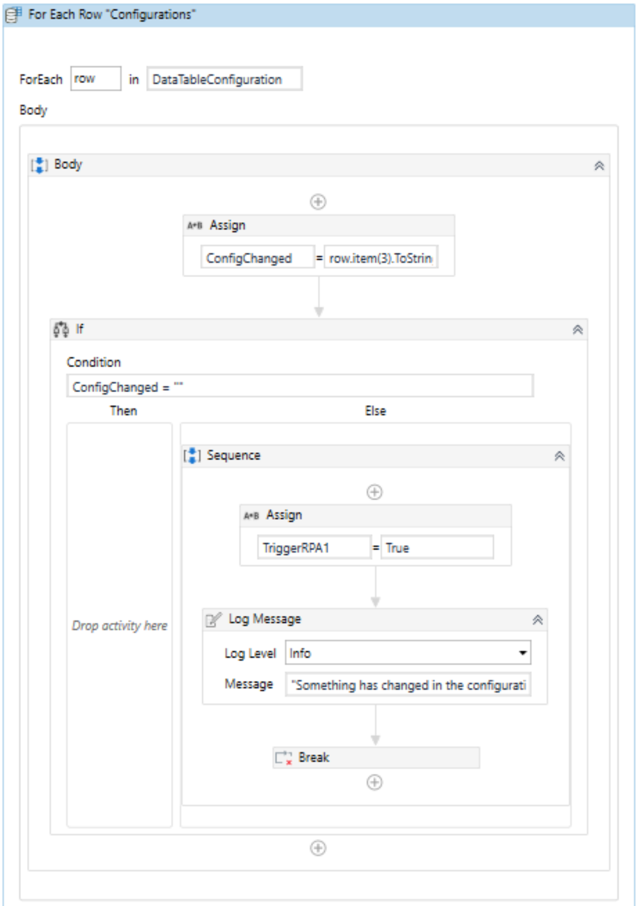


Figure 20 The for each row loop “Configurations”

The loop for each row in “Configurations” can be seen in Figure 20. The activity “If” is used to check whether the condition “ConfigChanged” equals “null” is true or false.

Load” BOM” button is clicked and after that, the process enters the flowchart "BOM". Inside flowchart "BOM" a similar process takes place as in part 1 of the RPA in Figure 16.

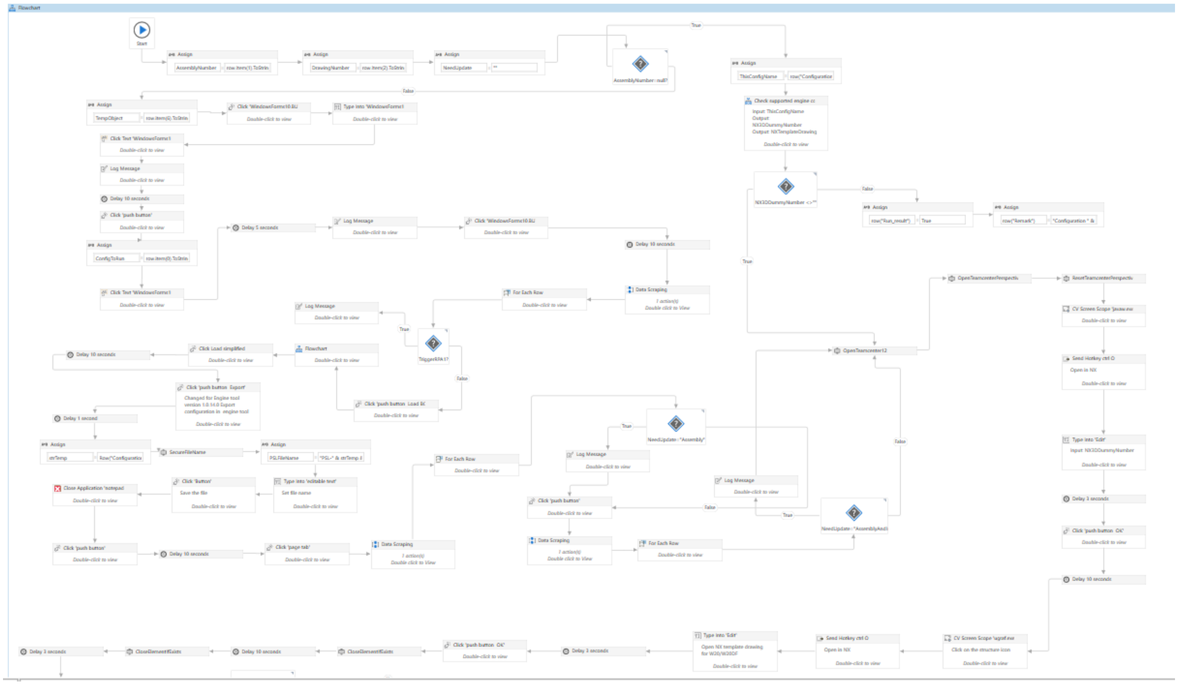


Figure 21 First picture of the loop in the last for each row "Run DTConfigs".

After this, the load simplified button is pressed and after that the load interfaces button. Now everything that can be loaded to the object is loaded in, and the simplified models' tab will now be pressed. Inside this tab, the data will be scraped, and for each loop that takes place, called for each row "Simplified models data table". Here the condition states that if the "SimplifiedModelsChanged" equals null, then the assembly update is needed and a log message saying, "Simplified models have changed". When the process arrives at the following Flow decision, with the condition "AssemblyNeedUpdate", false will trigger a message saying, "Nothing has changed in the list of simplified models". The process proceeds further by clicking on the "engine interfaces" tab. The data is scraped from here and a loop similar to the other loops mentioned earlier will take place, with the condition "InterfaceChanged" = null, then if false an update is run, and otherwise, the info message will tell "Interfaces have changed". When the process is arriving at the next Flow decision, the condition is if the Interfaces are needed to be updated, if false the log message will say "None of the interfaces have changed".

A flow switch activity is a flowchart activity that divides the control flow into three or more branches, with only one branch being executed based on a given condition. These are used in the last for each row loop "Run DTConfigs" activity part of the programming. At the end of Figure 21 Teamcenter is opened and Siemens NX.

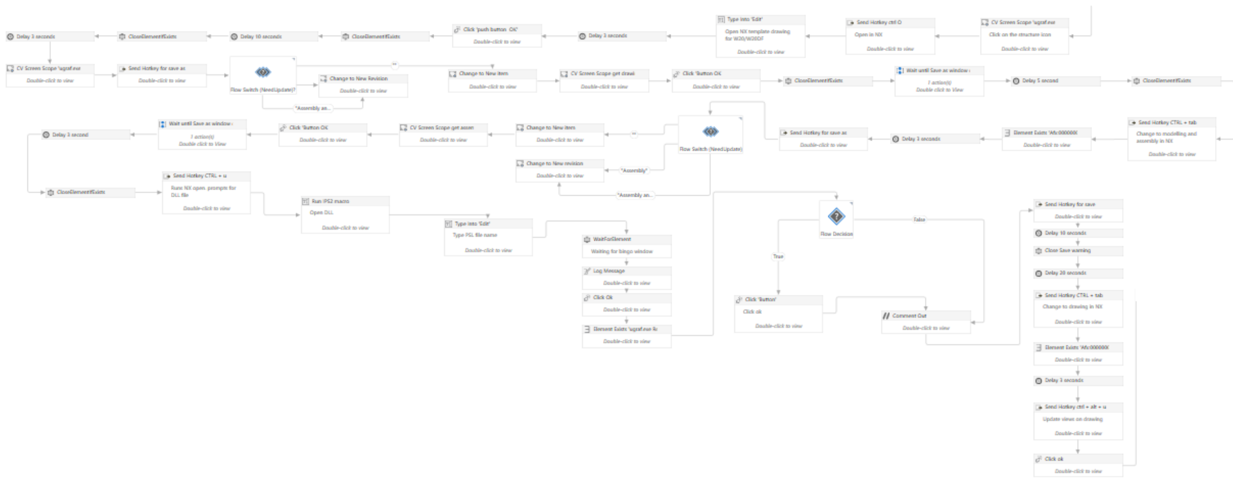


Figure 22 Picture two of the loop in the last for each row loop “Run DTConfigs”

Flow switches are used to trigger the RPA to create a revision or new content, based on the same property “NeedUpdate” with value “null” or “Assembly” or “AssemblyAndInterfaces”. The rest of the NX and Teamcenter part of the programming is done similarly as in the earlier version of MODA00252, except for the flow switches and flow decision activities.

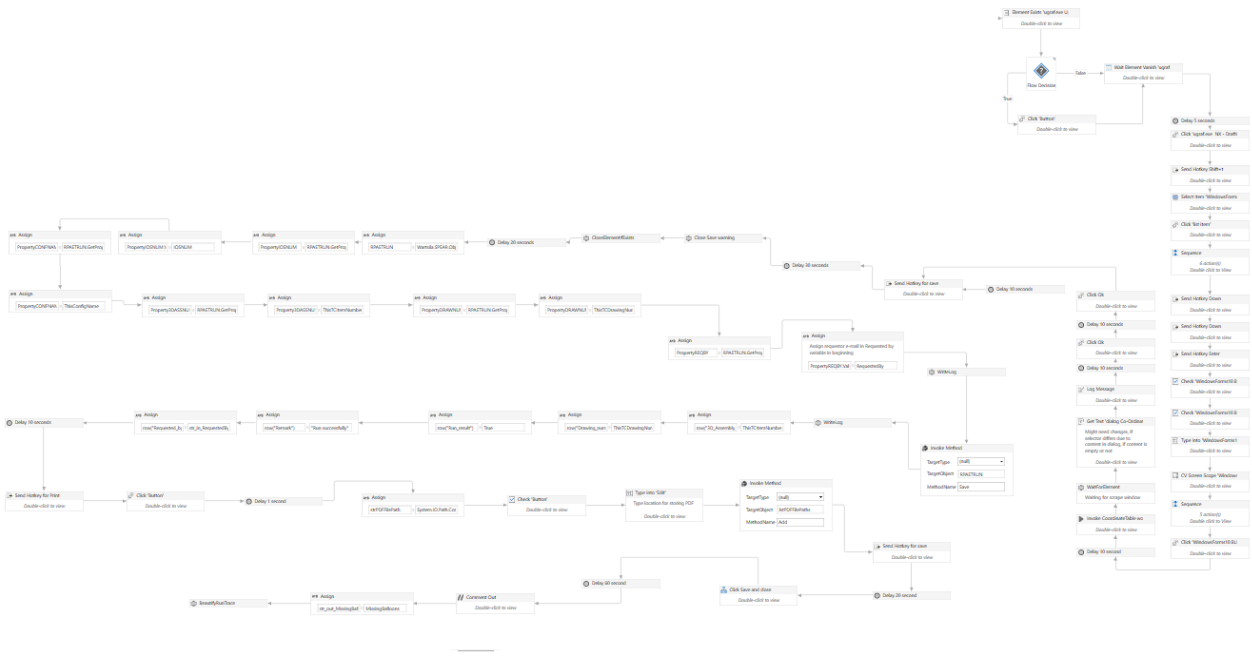


Figure 23 Picture 3 of the loop the last for each row loop “Run DTConfigs”

After these existing activities are used to handle NX and Teamcenter along with activities to log the run in SPEAR also writing variable values back to the data table. The RPA will finally create a PDF of the generated drawing and send a notification back to the end-user.

5 Discussion

In this chapter, I'll discuss the project in general, what was accomplished, what went well, and what could have been done better, as well as a comparison of the result and the purpose.

5.1 Summary

The purpose of this thesis was to create an updated version of the MODA00252 RPA that is a 3D engine and drawing RPA. The RPA is creating 3D CAD content and 2D drawings by retrieving data from the engine tool. The updated version of the RPA is more compact and modifications have been made. The UiPath activity "build data table" is used in the first part to create a data table of the Engine objects for a certain project. In this way, it is possible to loop the RPA through all different configurations.

In the second part, the programming was done with having flow decisions and loops as well as integrated activities to create functions. These were to create a revision if the content has changed. If it has been run before, it will message the user that it has already been run and the robot will stop. If the interfaces have changed, the coordinate table will be updated.

The programming went well from beginning to final design. A lot of modifications in the programming were done, before finally reaching the perfect programming and activity combinations for this MODA00252 RPA. This was somehow time-consuming and could be minimized if programming knowledge were more extended when starting this project. When comparing the result and the purpose was reached, and even smarter programming was used than required for the second part of the RPA. This causes when the RPA now knows what to do if been earlier triggered as earlier described situations. This extra function lowers the waiting time and unnecessary running of RPAs since it is only updating needed content if triggered before. This is a great feature since the Wärtsilä RPA robot can have a queue otherwise since it can only handle one RPA at a time, if many RPAs are time-consuming to get run through the queue can grow large. Part 1 is programmed accordingly to the requirements of the new database function so that result is also fulfilling its purpose. What could have been done better could be that part 2 of the RPA could be gotten more organized visually, there is a chance it could be tricky for the reader to follow along with the flowchart.

5.2 Further development

This MODA00252 is now updated, and other RPAs are under development to create further content utilising the output of this RPA. The rest of the chain of RPAs needs updates and some are not even created and programmed yet. In the future, the whole chain of RPAs will trigger each other after people are nominated for a project. Those other RPAs are not updated or created in this thesis work.

5.3 Reflections

When I was a summer trainee for System engineering in 2021, I had the opportunity to attend the RPA basic training course that was helpful with understanding and programming this thesis work. I also had a lot of help from both my supervisors Tomas Södö from Wärtsilä and Kenneth Ehrström from Novia UAS. Help was also received from Magnus Österberg from the RPA development team for sending me informational videos of programming tasks used in advanced RPA advanced training development courses. The programming itself was a real challenge since the requirements were somewhat broad. There are also very many ways of getting the same result in a better or less good way. The schedule for this thesis was quite tight since I got my Wärtsilä computer first until December and my account to my Wärtsilä computer was frozen in March for almost two weeks for an unknown reason. Overall, it was a very educational and interesting project that gave me an insight into how publicly quoted companies like Wärtsilä are heading more and more towards digital automation. Digital automation can not only be used in the manufacturing industry, it can be used in various businesses. In my opinion, digital automation will be more frequently used in the coming years, since businesses have a lot of usage of it to save time and money, but also to free up time on tasks where creativity and outside the box thinking are needed.

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