Suitability of Rokoko Motion Capture Products for Content Creation in Simulation Training

Assessing Overall Usefulness of Rokoko Products

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TIIVISTELMÄ

Tässä ylemmän ammattikorkeakoulun opinnäytetyössä arvioitiin Rokoko – liikkeenkaappaus tuotteiden yleistä soveltuvuutta simulaatiokoulutuksien sisällön luomiseen. Sen tilasi HAMK Smart -tukimusyksikkö edistämään tietyn alueen tutkimustavoitteitaan. Unreal Engine ja MetaHumans olivat kohde työkaluja liikkeenkaappaus datan käyttämiseen. Tämä opinnäytetyö yhdisti teoreettiset ja käytännön näkökohdat yhdeksi johtopäätökseksi. Suunnitteluajattelua ja sen Double Diamond – menetelmiä käytettiin ohjaamaan prosessia. Ensin teoreettisessa osassa syvennettiin tuotteiden sisällä olevan teknologian ymmärtämistä. Teknologian toimintatapojen tuntemuksella oli tärkeä rooli käytössä olevan teknologian arvioinnissa, sillä aikaisempia arviointimatriiseja ei löytynyt, siksi yhtenä tuotoksena tehtiin uusi arviointimatriisi. Kokonaiskäytettävyys koostuu kahdesta osasta; käytettävyys ja hyödyllisyys, ja molemmat otettiin huomioon matriisissa. Lopuksi tuotteita ja työkaluja kokeiltiin ja käytettiin demonstraation tallentamiseen käytännön osuudessa. Demonstraation luomista ja tulosta arvioitiin uuden matriisin avulla. Arvioinnin ja havaintojen perusteella tuotteet tai niiden algoritmi eivät olleet riittävän tarkkoja animaatioiden tallentamiseen ilman laajaa määrää käsitöitä jälkikäteen. Tuotteet olivat silti parempi vaihtoehto kuin animaatioiden luominen täysin manuaalisesti, mutta parempia vaihtoehtoja liikkeenkaapppaukselle oli markkinoilla. Rokoko tuotteiden hinta verrattuna muihin ratkaisuihin on syy, miksi niiden tuotteiden kehitystä kannattaa seurata jatkossakin.

Avainsanat Liikkeentunnistus, Unreal Engine, MetaHumans, Rokoko,

Sivut 74 sivua ja liitteitä 2 sivua

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Älykkäät palvelut digitaalisessa toiminta ympäristössä **Abstract**

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ABSTRACT

This master´s thesis assessed the overall suitability of Rokoko Motion Capture products for content creation for simulation training. It was commissioned by the HAMK Smart research unit to advance its specific research area goals. Unreal Engine and MetaHumans were the target tools to use the captured data. This thesis combined the theoretical and practical aspects into one conclusion. Design Thinking and its Double Diamond methods were used to guide the process. First, understanding the technology inside the products was deepened in the theoretical part. Knowledge of how the technology works played an important role in assessing the technology in use as no previous assessment matrixes was found; therefore, a new one was made. Overall usability consists of two parts; usability and utility, and both were taken into account in the matrix. Finally, the products and tools were tested and used to record a demonstration in the practical part. Creating the demonstration was then assessed with the help of the matrix. Based on the assessment and findings, the products or their algorithm were not accurate enough to record animations without extensive manual labor afterward. They were a better and more efficient option than manually creating the animations, but better options for motion capture existed in the market. The price of Rokoko products compared to other solutions is why one should still watch the development of their products in the future.

Keywords Rokoko, Motion capture, Unreal Engine, MetaHumans.

Pages 74 pages and 2 appendices pages

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1 Introduction

In 2021, the writer of this thesis worked in HAMK Smart Research Unit as a solution specialist and as a small team leader. The team's target is to advance the beneficial use of game engines and related technologies. The target plays a big part in this research project and gives insight into previous knowledge of the used technologies.

These and other 3D technologies are evolving rapidly, and the Covid-19 pandemic accelerated that even further. New companies, solutions, and technologies appear at a faster pace. It is getting harder and harder to keep up with the latest information, technology, and possibilities that they bring. New companies and solutions are also the background story for this thesis´s topic.

1.1 Purpose and goal

HAMK Smart Research Unit is one of the four research units in Häme University of Applied Sciences. The others are called HAMK Edu, HAMK Bio, and HAMK Tech.

Bio- and circular economy, education, wellbeing, and industry and transport are the main focus areas of the HAMK Smart Research Unit. There are also Digital Solutions & Platforms and Data and Business Analytics teams that enable the use of the latest technologies and methods. The experts within the focus areas and both teams form a well-balanced combination of theory, research, and technology in practice. (Häme University of Applied Sciences, 2021)

The small team, talked about previously, is part of the Digital Solutions & Platforms team, and the main goal is to advance the beneficial use of game engines and related technologies like augmented reality (AR), virtual reality (VR), and extended reality (XR). The team´s focus is not very strict when talking purely about technology. For example, it might research or

work on game engines or technologies integrable into them. Part of the job is to explore new technology and study how they can be used in different workflows and their real restrictions and possibilities.

Inside the Education focus area, there are Digital solutions in the pedagogy research area, which the team is mainly focused on advancing. The research area produces research-based data on the use of digitalization in vocational education, higher education, and working life. Technology will have a more significant role in teaching and education activities in the future. Within the research area, its aim is to develop and study the use of new technologies (for example, VR and XR) in education and to assess the development of competence and learning experience. These are done through a diverse use of research methods; particularly focusing on learning analytics. The aim is also to combine the expertise of the HAMK Edu research unit in professional education with the expertise within the HAMK Smart research unit. (Häme University of Applied Sciences, 2020)

A part of this is to study and develop simulation training continuously. As simulation training aims to replicate real-world events in virtual environments, it is essential to research and know about the latest technologies on how to do this. Especially in healthcare, most simulation training has humans involved in real-world events. Replicating everything they do (movement, speech, facial expression) is not easy to re-create with the standard animation tools. It is manual labor, and polishing the animations to look natural can take a vast amount of time. Therefore, motion capture technologies and solutions are potential solutions to ease capturing humans or change them.

This thesis will be beneficial for the whole research unit. It will also benefit companies and others as the information gathered can be spread through HAMK Smart Research Unit. Finally, it will also be helpful to anyone interested in using these technologies by themselves.

1.2 Research question and knowledge interest

HAMK Smart Research Unit´s strategy states that researching and advancing utilizing digitalization in learning is soon one of the main goals. In general, this can mean many

technologies and things. However, discussions within the research unit revealed that researching and advancing simulation training became the most exciting topic in that area. Therefore, to get a more accurate picture of the research unit´s strategy and this thesis´s purpose to support it, more discussions were held during January and March 2021 to determine more specific needs and interests related to simulation training.

HAMK Smart Research Unit had acquired a Rokoko smart suit pro, Rokoko smart gloves, and Face capture through Rokoko´s website (Rokoko, 2021). There was a plan to research how to use these technologies and their suitability for simulation training through student work. Unfortunately, due to Covid-19, this delivery was delayed by several months, and the student work was impossible. However, as studying and trying these in practice were of high interest, this thesis was a solid next option. If possible, there was a desire to research both pre-recorder and real-time approaches for the workflow. Pre-recorder means that the captured motion data is saved and used later. Real-time means that the captured data is projected onto a digital human in real-time.

Previously for developing simulation training and other applications, unit developers had mainly used a game engine called Unreal Engine by Epic Games (Unreal Engine by Epic, 2021). Unreal Engine was seen as a natural choice for this project since it is also the forerunner in virtual production (Unreal Engine Virtual Production Hub, 2021) which could benefit this project and create simulation training. The choice determined the end-use platform for the possible captured motion data. There is a need for a virtual character or avatar to present the captured motion data visually through Unreal Engine. Unreal Engine has a “placeholder” mannequin, but this was not seen as a choice as you can not replicate facial expressions on it. Developers had previously come across an auspicious tool made by Epic Game called MetaHuman Creator. It is a tool with which everyone can create a digital human in minutes. The difference is that its digital humans are technically on another level than any other tool. At best the digital humans can be mistaken for real persons. Travers sees the tool as a world-changing piece of software (Travers, 2021), which is easy to agree with. For these reasons, the tool seems like the best add-on technology for this project.

The research question is: How suitable Rokoko motion capture product family is for content creation with Unreal Engine and MetaHuman for simulation training?

1.3 The target of research and development

Researching information on technologies or use cases through previous research, articles, books, websites, user videos, studies, thesis works, and any other media is vital to understanding these technologies. Understanding the basics of these technologies is the key to directly assessing how they suit the desired purpose and understanding the limits and possible problems if they happen to occur. Primarily it will be helpful to understand what is occurring because of the chosen products or the chosen technology, which can have a significant impact. The chosen technologies may have limits or defects for the use HAMK Smart research unit has that was not known before.

Rokoko Smart suit Pro, Rokoko Smartgloves, and Rokoko Facial capture are the technology choices used in the case study research. The first target is to capture human movement. The second is to use that motion capture data in Unreal Engine and MetaHuman character to visualize the data. The case study research aims to understand the process and workflow and learn restrictions thoroughly, and similar information found only through usage. The best way to achieve this is by a well-structured practical approach. The outcome of this project is knowledge, a small guide on how to set up this workflow, and the findings of the study research case, which has more value and importance.

2 Concepts and knowledge base of development work

In this section basics of used and related technologies and their use cases and phenomena are researched and explained. It gives a deeper understanding of the process involved in the development work instead of focusing heavily on one or two topics.

In general, no scientific studies, research, articles, or previous works were found at the time of research (Q3 2021) that had precisely the same topic and subject as the development work. Mainly because of this, the concepts will be investigated in general aspects.

2.1 Simulation training

Simulation is not a technology; it is a technique. A technique to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner (Gaba, 2004)
Simulation training or simulation-based training is a non-area-specific way of teaching, where the learner is taught to perform tasks or activities in different real-world scenarios. The real-world scenarios are created using different equipment, technology, and software. Although the events in the scenarios should mimic a real-world scenario event, the training itself can happen in a made-up virtual world. The purpose of simulation training is to prepare the learner for the taught scenario in the real world if it happens to occur.
No more first-time on live patients -the motto is one of the fundamental principles in modern simulation training in the field of health care (Rall, 2013). Moreover, the motto sums up the purpose of simulation training very well.

2.2 Motion capture technology

Motion capture (sometimes referred to as mo-cap or mocap, for short) technology´s general purpose is to capture motion and transfer it to secondary use. Motion capture can be achieved with different technologies and devices. Central systems to capture motion can be categorized into mechanical, optical, magnetic, acoustic, and inertial trackers. From these, optical and inertial tracker systems are most used. (Xsens, n.d.) The equipment and solutions used in this thesis are Rokoko smart suit pro and Rokoko smart gloves, which use inertial motion capture, and the Rokoko face capture, which uses optical motion capture.

Motion capture technologies are widely used in entertainment, sports, military, medical applications, robotics, and other fields. The entertainment field includes film making and video game development, where motion capture mainly refers to capturing human body motion. Motion capture focuses only on capturing the actor's movements and not their visual appearance in these fields. The captured motion is then used to recreate the same movements and facial expressions in a digital 2D or 3D animation. Motion capture data can be replicated in two ways, pre-recorded or real-time. Pre-recorded means saving the

captured data for later use, and real-time means we project it directly on an animated digital character.

Animator Lee Harrison III created the first motion capture suit to do real-time capturing and animating in the 1950s. It could only create rough animations, but it sparked interest in developing these methods and processes further. (Motion Analysis, 2020) The second Lord of the Rings movie, “The Two Towers” that came out in 2002, was the first film to utilize real-time motion capture and filming, where the actor (Andy Serkis in this case and his character Gollum) could perform the scenes with the other actors in the movie. Before this, all the CG characters (Computer Generated) were shot, created, and edited afterward into the main film. The method meant no real interaction between the filmed actors and CG character actors was possible before this. (Motion Analysis, 2020)

Through motion capture technologies and CG characters, films have given us incredible characters like Gollum (Lord of the Rings & The Hobbit), Jar Jar Binks (Star Wars), Neytiri (Avatar), Caesar (War for the Planet of the Apes), Davy Jones (Pirates of the Caribbean: At World´s End), Beowulf (Beowulf), Alita (Alita: Battle Angel), Sonny (I, Robot), Parzival (Ready Player One), Kong (King Kong 2005), Thanos (Avengers: Infinity War).

The video game industry tried to use motion capture technologies from the 80s in games like Reikai Doushi and Prince of Persia, but they did not use actual motion-capture technology. The first proper motion capture suit to record the actors' movements and be used in a game was in 1994, Virtua Fighter 2. The usage of these technologies has been growing ever since. Motion capture technologies' influence on video game storytelling is very noticeable and can play a significant role in immersing the player in the game universe. One of the best examples of using motion capture technology in a video game is a title called “The Last of Us.” The story is built around two characters, Joel and Ellie, who try to survive in a world of a significant catastrophe. The actors ' real-life chemistry dramatically influences how the story builds, and their relationship grows in-game (Blye, 2019).

These technologies are still evolving, as are virtual worlds and the technology behind creating them. As a result, it will be more and more challenging to separate the real world visually and computer-generated environments, effects, and characters in the future.

However, motion capture technologies are already an industry standard in the film-making and video game industries and growing in many fields as these technologies become more available to all.

2.2.1 Inertial Motion Capture

Inertial motion capture is a method to capture human motion through multiple sensors called inertial measurement units or IMU.

An Inertial Measurement Unit (IMU) is a standalone system that provides raw, calibrated sensor data. The sensor data is mainly linear and angular motion. This is usually achieved with a triad of gyroscopes and a triad of accelerometers. IMU´s are either strap-down or gimballed, inputting the integrated angular velocity and acceleration quantities in the sensor/body frame. IMUs are often used as building blocks in more complex systems. (Xsens, n.d.)

The IMU´s can be attached to the user differently depending on the product. The two main ways are that the sensors can either be strapped separately to the user, usually via a velcro band, or inserted into a specially designed motion capture suit, usually made from spandex or lycra. The Rokoko smart suit pro has specially designed slots for the sensors in the suit, but they are also secured in place via Velcro straps. The smart gloves have built-in sensors but do not have separate straps for each one.

2.2.2 Optical Motion Capture

Optical sensing as a term and category can mean a large and varying collection of technology. Image-based systems determine the user´s position with multiple cameras. The cameras track predetermined points, also called markers, on the user´s body, and they are aligned with a specific marker in the environment. The cameras take 2D images at the same time, and the position is estimated based on those. Stereometric techniques correlate tracking points on the tracked objects in each image and use this information and knowledge concerning the relationship between each image and camera parameters to calculate

position.

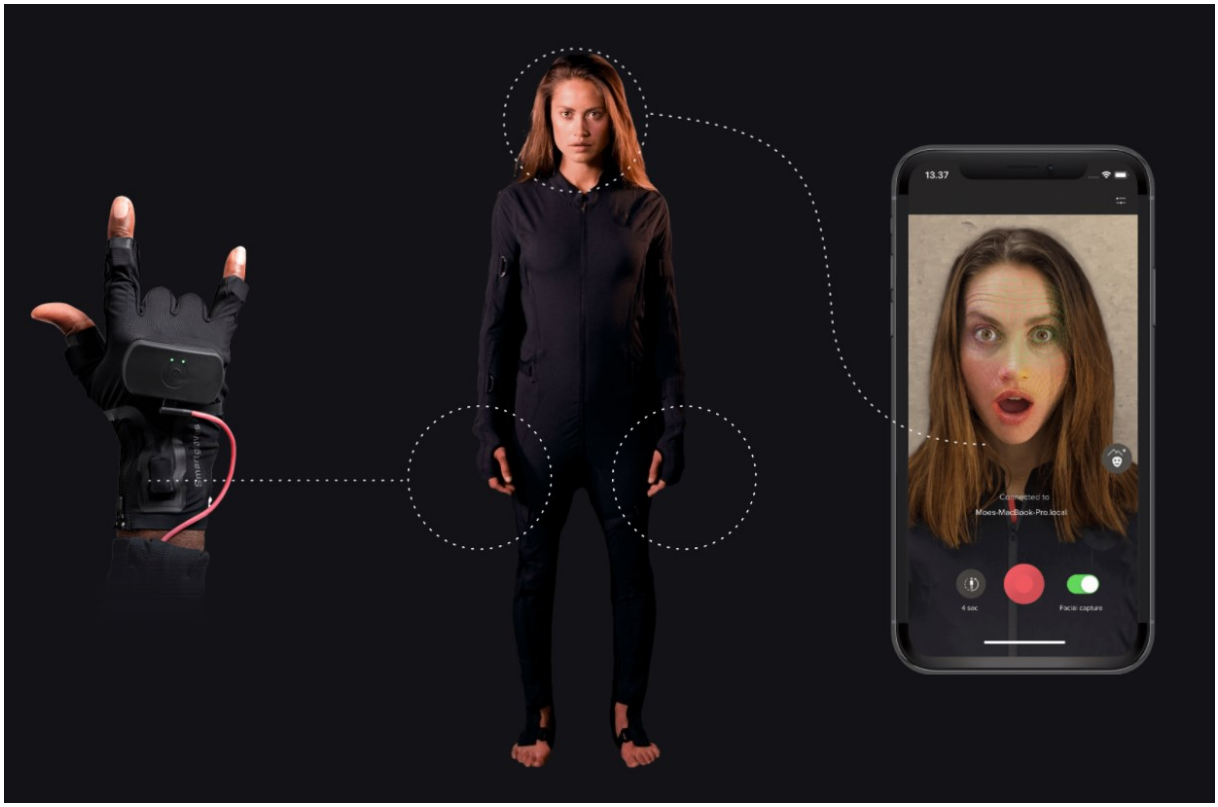
There are two kinds of markers. Passive markers are reflective and active markers that are light-emitting. Passive systems use infrared (IR) LEDs mounted around the camera lens and IR pass filters and measure the light reflected from the markers. Active systems use pulsed LEDs to measure the infrared light emitted by the LEDs placed on the body segments. Tracking objects without markers is also possible but usually less accurate. (Xsens, n.d.)

The Rokoko face capture is used to capture facial motions. It uses camera tracking for facial motions and heavily depends on computer vision and pattern recognition. As stated above, it needs higher computational resources, so there is a need for a specified mobile phone. The hardware needs to be iPhone X or newer (Rokoko, n.d.). It also needs Rokoko Remote application.

2.2.3 Rokoko

Rokoko is a company founded in 2014, and its headquarters are in Copenhagen in Denmark. They also have offices in San Francisco, Los Angeles, and Athens. Their vision is to give quick, non-intrusive, and intuitive animation tools for everyone through their products. (Rokoko,

2021) They offer three different solutions to make human motions digital.



Picture 1: Rokoko Products

Their first product was Smart suit Pro (which HAMK Smart research unit has), a newer version of Smart suit Pro II was released October 2021. They also offer Smartgloves and Face Capture solutions, as seen in Picture 1: Rokoko Products. Rokoko Smart gloves are physical gloves with embedded sensors of different sizes. The Rokoko Face Capture solution is purely a software addon, and a specific mobile phone needs to be acquired. The phone needs to be iPhone X or higher (no android support). The mobile phone also needs a different stand to be pointed towards the user's face. All three products need the use of Rokoko studio software to work. The Rokoko Studio supports real-time integrations with Unity, Unreal Engine, Blender, Cinema 4D, Maya, MotionBuilder, Houdini, iClone, CTA4, Isadora, and Siemens Jack, checked on November 2021.

Rokoko is a newer company that tries to bring these technologies to all at a fraction of the previous costs to acquire this kind of technology. Therefore, this thesis does not consider this or compare it to other available technologies or costs. Instead, it focuses on the

suitability of Rokoko products to create content for simulation training and different aspects of this.

2.3 Unreal Engine

Epic Games developed Unreal Engine, a powerful real-time 2D and 3D game creation software. It is a development framework like many others that consists of multiple tools and editors if looked closely enough. They are called game engines because they started as development frameworks to build games. Even today, they are mainly used for that purpose, but beneficial use of these has been growing each year. They offer the developer a lot of ready-made components and tools (like sound engine, physics engine, graphics engine, input, and the gameplay framework and online module) with the idea that the developer does not have to build them but instead focuses on using them. Recreating the tools Unreal Engine offers would take hundreds or thousands of developers and years of labor. Its most significant differences from other development frameworks (except game engines) are the real-time visualizations and functionalities to the end products. (Lee, 2016)

2.3.1 MetaHuman Creator

Digital humans, sometimes referred to as virtual avatars, have existed for decades. Nevertheless, creating believable high-fidelity real-time digital humans has been extremely difficult and time-consuming. However, epic Games believe that digital humans are a big part of the future, so they created a tool called MetaHuman Creator. It is a real-time digital human creation application that tremendously reduces creation time without compromising quality. It also supports straight workflow into Unreal Engine. (Epic Games, n.d.)

2.4 Conclusion

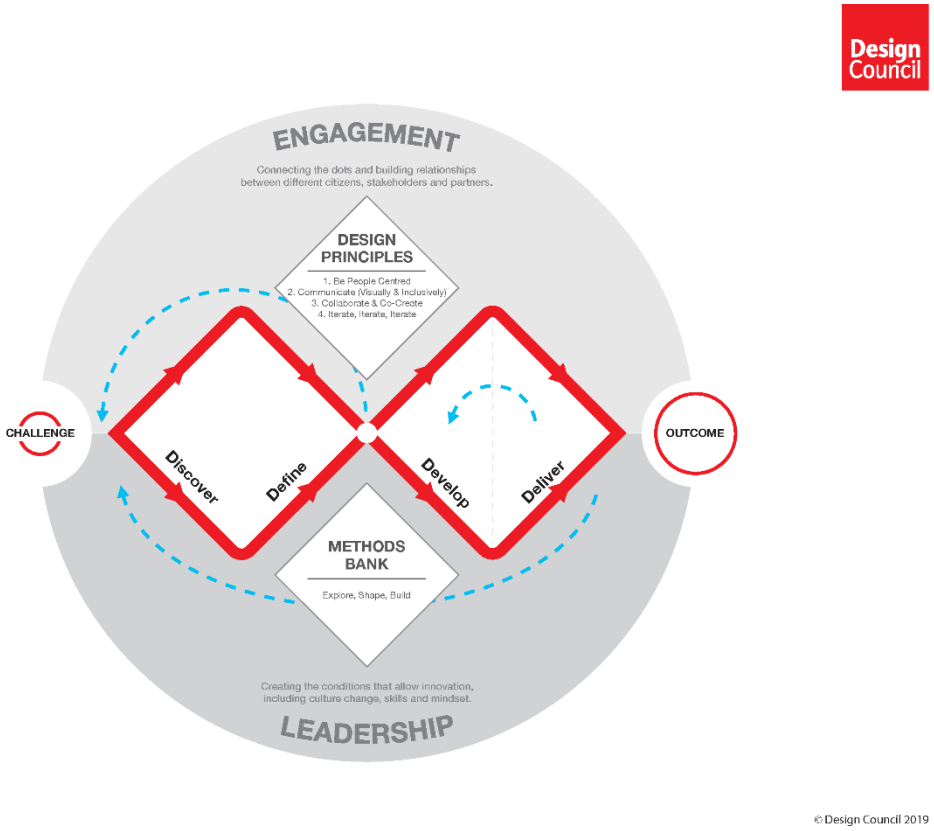
Information gathered through concept and knowledge base is very positive. Motion capture technologies have a strong history in the entertainment industry. The use cases are identical to content creation for simulation training. In theory, the Rokoko products should fulfill the needs.

The Rokoko Smart suit Pro and Smartgloves use inertial motion capture technology (IMU sensors) to gather locomotion. However, they only use IMU sensors and no other capture method or outside sensors, leading to possible problems. Furthermore, each sensor sends its data, but its position in the environment is not tracked. Therefore, inertial motion capture can lead to problems with body parts' relativity, other objects, or their absolute position in the tracked environment. Therefore, an assumption can be made that the initial calibration process is critical to achieving perfect tracking.

The short conclusion is that Rokoko products should suit the HAMK Smart research unit's needs. Furthermore, the concept and knowledge base confirmed that the focus is on the development work and how the Rokoko products work with the desired software and workflows.

3 The purpose and goal of development work

Design Council´s Double Diamond is a framework for innovation that can be used in different aspects. It conveys a design process to designers and non-designers alike, as seen in Picture 2: Double Diamond 2019 by Design Council. . The two diamonds represent a process of exploring an issue more widely or deeply (divergent thinking) and then taking focused action (convergent thinking). (Design Council, n.d.a) The Double Diamond suits this research project´s design, testing process, and needs well. Double Diamond will be a guiding framework for this project and to visualize the overall progress of the work also. The process of using the Double Diamond consists of four main steps, which are:



Picture 2: Double Diamond 2019 by Design Council. (Design Council, 2019)

• Discover.

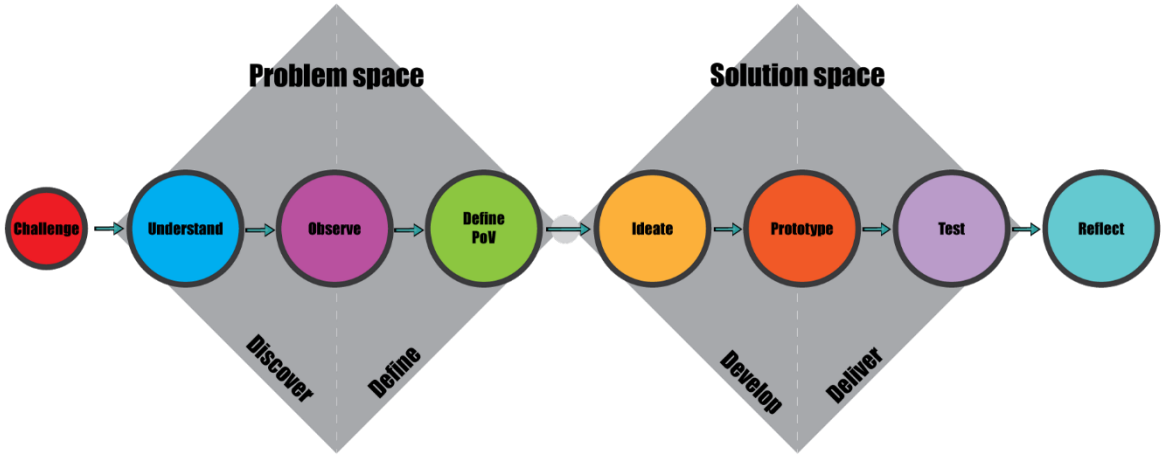
The first diamond helps people understand, rather than simply assume, what the problem is. It involves speaking to and spending time with people affected by the issues.

• Define. The insight gathered from the discovery phase can help to define the challenge differently.

• Develop. The second diamond encourages people to give different answers to the clearly defined problem, seeking inspiration from elsewhere and co-designing with a range of different people.

• Deliver. Delivery involves testing out solutions at a small scale, rejecting those that will not work, and improving those that will.

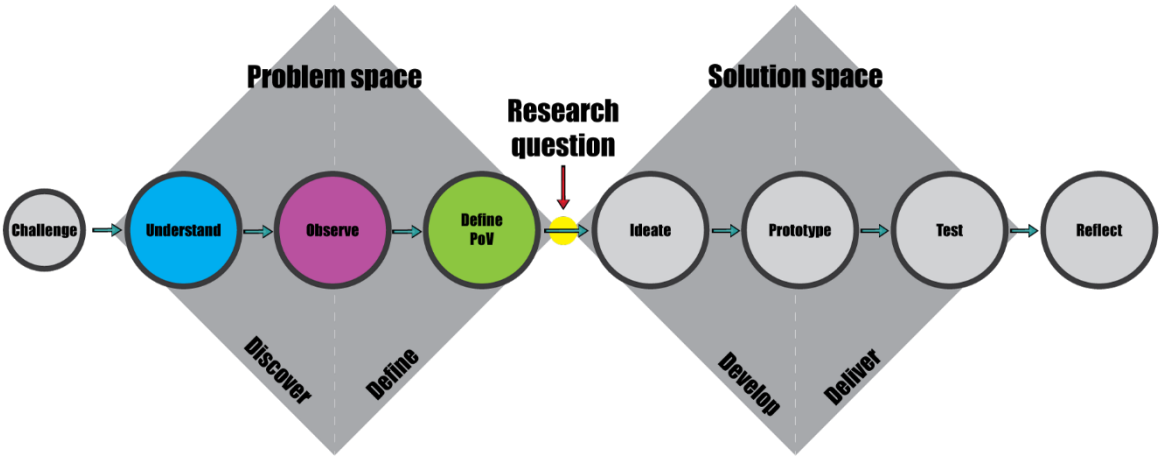
Double Diamond can be divided into smaller steps than the four main steps which can be seen in Picture 3: Double Diamond steps simplified. This is because the steps reflect more on the actual work done around the framework.



Picture 3: Double Diamond steps simplified

The purpose of the first diamond (including discovering & defining steps) is to define and understand the problem and the basics of the technologies behind it. When enough information and focus on what is to be done is achieved, the research question is emphasized between the first and second diamond.

In “Introduction” and “Concepts and knowledge base of development work,” topics understanding both the problem and the technologies were built. As a result, the research question was emphasized and became evident. Finally, in Picture 4: Current progress visualized in double diamond, the progress so far is visualized in the double diamond.



Picture 4: Current progress visualized in double diamond

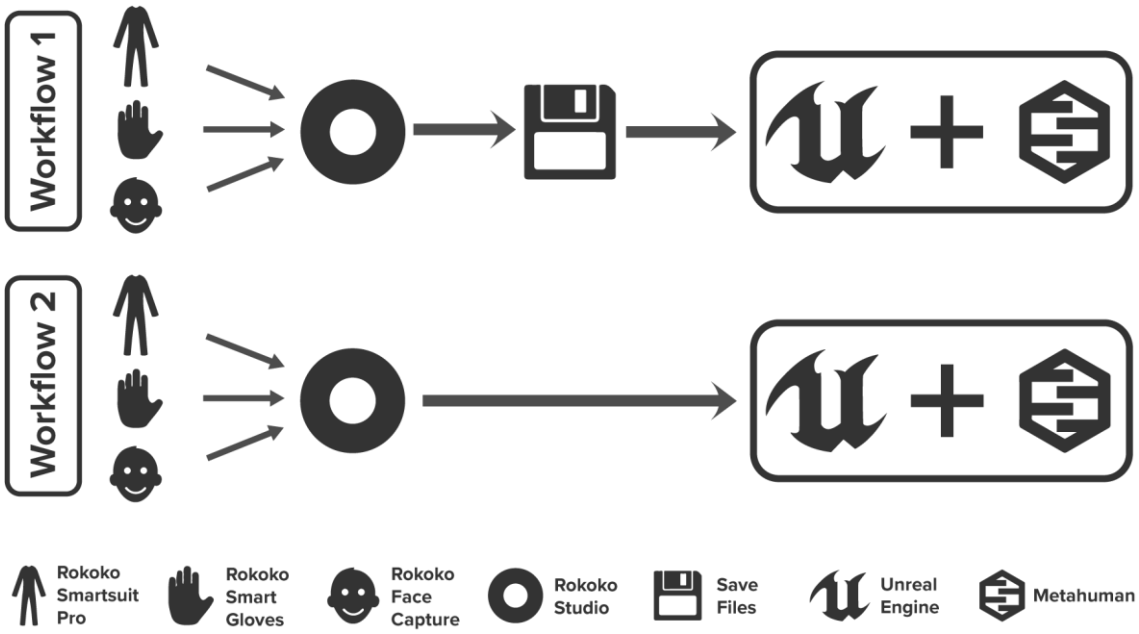
The next phase is to proceed to the second diamond. The purpose of the second diamond (including developing & delivering steps) is to create or find an actual solution and test it. It ends in conclusions, results, and answers to the research question. In this case, the products are already determined.

It is essential to understand that the second diamond is not purely just about the product or prototype at hand. It is also about the ways and methods of testing, evaluating, documenting. These are equally or even more important than the product's capabilities or prototype itself. These all define what is assessed, why, and how.

3.1 What

The goal is to increase knowledge of motion capture technologies possibilities in creating simulation training content for the HAMK Smart Research Unit and to find out how suitable the Rokoko product family is for this purpose. Furthermore, through the practical approach of using the Rokoko product family, the aim is to deepen the understanding of requirements, limits, best practices of using inertial motion capture systems to capture body movement and optical motion capture to capture facial expressions in use.

In the practical approach part, the goal is to research, understand and assess the two workflows shown in Picture 5: Visual presentation of the two desired workflows.



Picture 5: Visual presentation of the two desired workflows.

These two workflows look similar but differ a lot. They can be used for different purposes, and they both give the opportunity the create different things. For example, one can save the captured data in the first workflow and reuse it later. The captured data can be used later and still be adjusted or fine-tuned. The second workflow is projecting the captured data live to Unreal Engine. This workflow enables live shows or streams. From now on, we will call these workflows “Workflow 1 – saved” and “Workflow 2 – live”.

3.2 How

Not everything is known about the experimental testing phase or the possible findings. Therefore, it needs to be flexible enough to adjust to the findings constantly. Flexibility is the reason for splitting the experimental testing phase into more minor separate phases that should be small enough and approximately equal in the amount of work compared to each other. To guarantee that each phase was tested and documented in the same way, it was apparent that the testing phase needed a worksheet.

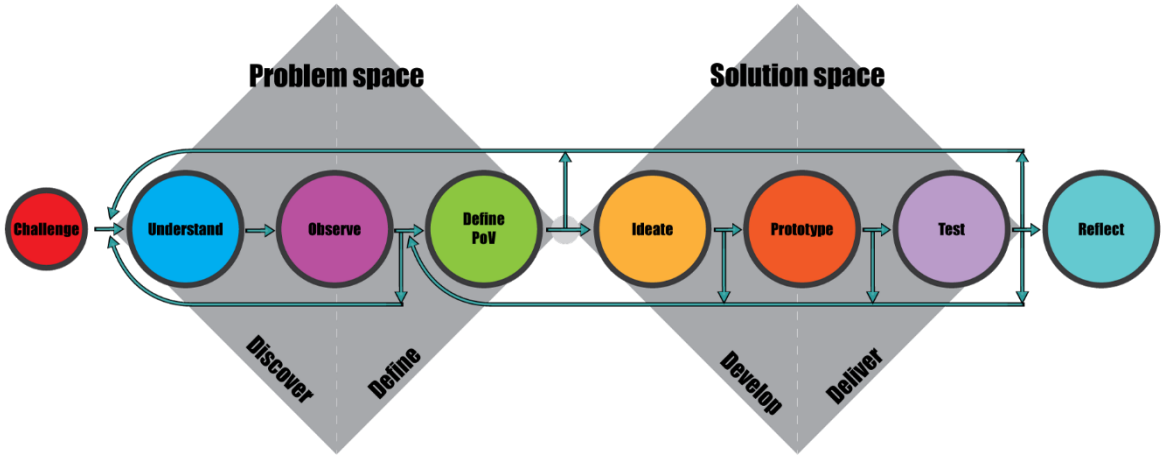
The Design Thinking Toolbox: A Guide to Mastering the most popular and valuable innovation methods book and its “Phase: Test” topic included a testing sheet and user guide (Attachment 1). (Lewrick, Link, & Leifer, 2020). The book has many different test sheets for different purposes, but this one suited this project´s needs.

The book also describes four main things one can do with the tool:

- Plan a test systematically and define roles.
- Document the test and the results, so it is easy to use them for subsequent activities.
- Consider in advance what are the test criteria, and in which cases the hypotheses are considered verified to validate the needs and check assumptions.
- Develop empathy for the user.

The book´s guide suggests having from two to three people for these tests and different roles accordingly. Suggestions were not achievable, so adjustments were made to follow the instructions as much as possible. The planning phase for the next test is a separate action, so this is possible to be done by one person entirely. According to the book´s guide for the testing phase itself, one person makes notes and documents the findings, one performs the test, and optionally one more person observes it. There is only one person available for the testing phase. That person needs to perform the test. To comprehend the other missing persons, it creates a need for a video camera to capture the test (comprehends the observer) and an easy-to-use microphone so the person doing the test can document the findings as they occur as efficiently as possible. The method and sheet will be used for each phase separately.

The sheet and method were chosen for flexibility, hands-on approach, and precise documentation. Also, the second diamond has assessment points throughout its process, as seen in Picture 6: Design thinking process with double diamond. If these indicate something meaningful, there is a possibility to take steps back or even start the whole process again with the learned knowledge. With this method, we can make sure they develop and deliver phases that will be flexible enough to consider the findings in each step.



Picture 6: Design thinking process with double diamond

3.2.1 The Demonstration

It was decided that it would be beneficial to reproduce a real-life event to support HAMK Smart Research Unit´s strategy and vision for future research. The reproduction will be done with one of the workflows stated in Picture 5: Visual presentation of the two desired workflows. Using the workflows will be a good valuation practice to determine the Rokoko products' suitability for creating simulation training context. The reproduction will be called “the demonstration.”

The demonstration use case itself was widely discussed among the HAMK Smart Research Unit professionals. What should it be, and what should it cover? The starting knowledge level of using these technologies is reasonably low. Therefore, it was decided for the demonstration not to be too complex or use senses or technologies that are not in the thesis's aim. A heart attack case was decided as a world event to be replicated into a virtual world. Technology-wise it also means capturing and using audio that is not the target of this thesis. However, it was agreed to be included in the project but not be evaluated or part of the thesis.

Heart attack possible symptoms and scenario (Kettunen, 2021):

- Discomfort in the chest (middle)
- Pain in the neck, spine, or maybe in one arm.
- Shortness of breath. Cold sweat. Heaviness
- Heavy pain in the chest.
- Collapse.

3.2.2 Testing phases

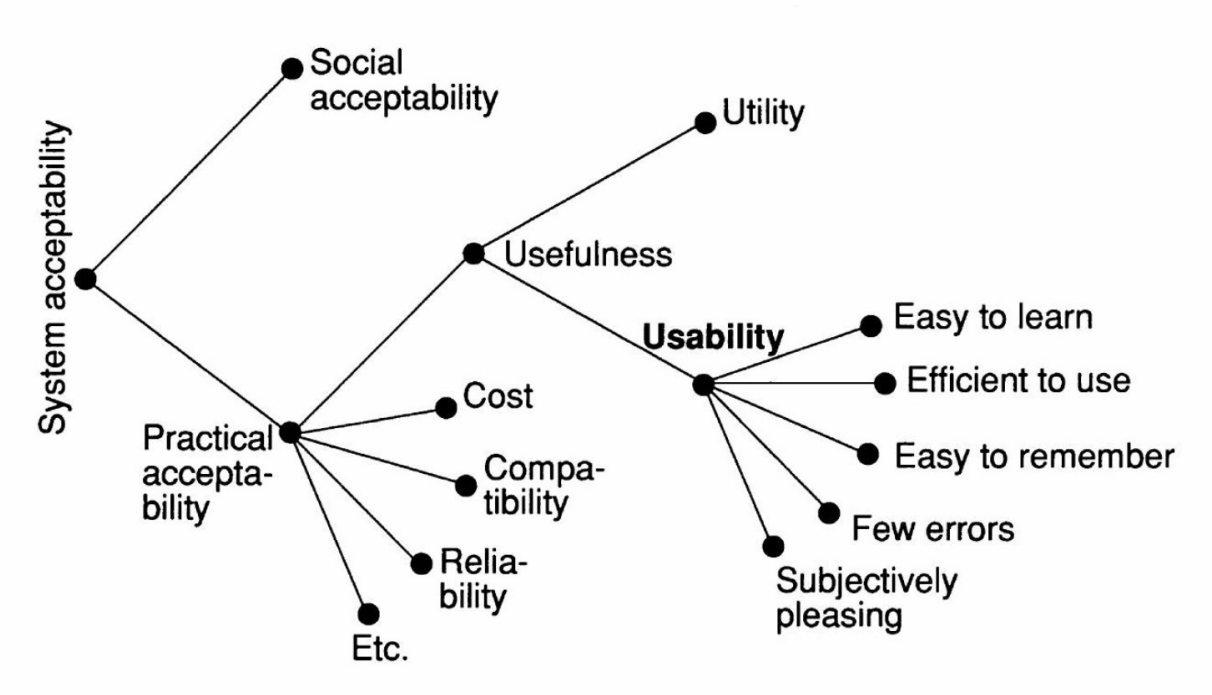
The experimental testing phase is separated into more minor phases to be more easily visualized and controlled. In case of problems during these phases, the problems can be more easily identified and isolated. As not all the information and knowledge are known on how everything works, the case study´s structure needs to be flexible. This is the reason for using a Testing Sheet from The Design Thinking Toolbox for every phase. It is based on double diamond and fits in perfectly. If valuable information was gathered during a phase, we could make changes to the case study before the next phase.

Phase 1: Research official and unofficial instructions and guides.
Phase 2: Setup the Rokoko products.
Phase 3: Trial the Rokoko products with Rokoko Studio.
Phase 4: Setup Unreal Engine project and MetaHumans.
Phase 5: Trial the workflow between Rokoko Studio and Unreal Engine using MetaHumans with the exported animations.
Phase 6: Trial the workflow between Rokoko Studio and Unreal Engine using MetaHumans with Live Link.
Phase 7: Record the demonstration with Rokoko products and playback in UE (workflow 1)
Phase 8: Record the demonstration in UE in real-time (workflow2)

3.2.3 How to assess overall usefulness

The research goal is to assess the overall usefulness of the Rokoko products for content creation for simulation training. According to Nielsen (Nielsen, 1993), this can be divided into two factors, utility, and usability. Both are part of system acceptability, as can be seen in Picture 7: A model of the attributes of system acceptability (Nielsen, 1993) and their role in this.

Utility answering is the product or service capable of fulfilling the customer or user's needs. Usability answering how easy and efficient using the product or service is. Both are assessed on all Rokoko products separately at the end of the case study. These are only assessed based on creating the demonstration, which mimics an actual use case as much as possible. The aim for assessment is the production phase meaning using the product at phases 7 and 8. Setup will be separately assessed as it differs from the production and has possibly different users.



Picture 7: A model of the attributes of system acceptability (Nielsen, 1993)

Nielsen splits usability into five different categories (Nielsen, 1993):

1. Learnability: How easy it is to learn the use of the product or service. How easily the user can get work done.

2. Efficiency: After learning, the product or service user can achieve high efficiency—the produced amount vs. time.

3. Memorability: Once the user has used the product or service can the user use it again at a later time.

4. Errors: What are the user error rate, and the user should be able to patch their errors. No groundbreaking errors should exist.

5. Satisfaction: The product or service provides everything the user needs pleasantly.

Nielsen´s framework does not include a matrix to assess utility as separate. No other existing matrix was found to assess the utility aspect of the motion capture products. The utility has a solid connection to usability, and partly these can overlap. In this case, to assess the overall usefulness of the products, it is also essential to understand the utility aspect. In the future, this can reveal something fundamental if the tested products do not fulfill the needs of the HAMK Smart research unit. Based on this information, a new utility matrix was created based on the most impactful technical aspects of motion capture technology, especially inertial motion capture suits. The most impactful technical aspects concerning motion capture technologies are:

- Initial Position Calibration precision: As inertial motion capture technology does not check its actual position in an environment after the initial calibration but instead calculates the expected position, the initial position and precision are very important.

- Captured movement precision: How accurately human movements are replicated in the virtual model.

- Captured movement limits: Is there a limit or restrictions that can not be captured or replicated on a virtual model?

- Long-term drifting: It is a known problem that the inertial motion capture suits tend to drift from their original position during long-term use. This is caused by not checking the actual position in an environment throughout the use. Does this exist, and how bad is it?

- Capture delay: Meaning the latency, how long it takes for the virtual model to raise its hand after the human raises his or hers. Delay mainly only affects the live link to other programs and streams.

- Capture smoothness: How smoothly is the movement replicated in the virtual model? Ranging from a few frames per second (aka slideshow) to a few hundred frames per second on which movement is replicated and updated (very smooth).

- Other affecting problems: There can be other affecting problems not listed here. These will be assessed by their impact.

Based on these, an adjusted grading system was created to support the research goal´s needs. Additionally, the most critical factors of these technologies regarding usability and utility were considered when creating the grading system. The usability and utility matrix will be used to assess the process of creating the demonstration. Only a usability matrix will be used to assess the setup process. Setting up part is mandatory to use these products, but both processes need to be assessed.

The assessed workflows aim not to include any re-adjusting or fine-tuning of the animations. They are meant to be raw data inputs and outputs as much as possible. Automated tools inside Rokoko Studio can be used as it does not require more than minor user work. However, this needs to be considered when assessing the overall outcome.

3.2.4 Created matrix to assess usability

1. Learnability:

    a. How easy is it to learn the use of the product or service?

i. It seems impossible or very hard

ii. It is complicated to learn

iii. Only basics are easy to learn

iv. Easy to learn thoroughly

v. Extremely easy to learn and master

b. The level of documentation or guides?

i. No documentation or guide

ii. Poor documentation or guide

iii. OK documentation or guide

iv. Good documentation or guide

v. Excellent documentation or guide

c. Previous user knowledge requirement?

i. Need to be an expert in this field

ii. Need previous significant knowledge or use

iii. Need previous medium knowledge or use

iv. Need only previous minor knowledge or use

v. No previous knowledge or use required

2. Efficiency

a. How many percent of work is actual production?

i. 0 – 20 %

ii. 20 – 40 %

iii. 40 – 60 %

iv. 60 – 80 %

v. 80 – 100 %

3. Memorability

a. To use it again, how much does one need to re-learn?

i. Nearly everything (80 – 100 %)

ii. Major part (60 – 80 %)

iii. Remember basics (40 – 60 %)

iv. Remember majority (20 – 40 %)

v. Only small things (0 – 20 %)

4. Errors

a. How often do system errors occur?

i. Less than every 30 mins

ii. Approx. every 30 – 60 mins

iii. Every hour or two

iv. Once a day

v. Once a week or less

b. Impact of system errors?

i. Start the whole process again (all work lost or unusable)

ii. Major part of work is lost or unusable

iii. Some parts of work are lost or unusable

iv. Minor parts of work are lost or unusable

v. No impact

c. Impact of user errors?

i. Start the whole process again (all work lost or unusable)

ii. Major part of work is lost or unusable

iii. Some parts of work are lost or unusable

iv. Minor parts of work are lost or unusable

v. No impact

5. Satisfaction

a. How does the product or service fulfill user needs?

i. Not at all

ii. Only partly

iii. It fulfills the basic needs, but not everything

iv. It fulfills every major need, but room for minor improvements

v. It fulfills all the needs or more

b. Does the user like to use the product or service?

i. Hate it, will not use it

ii. Will use it but only if mandatory

iii. It is okay

iv. Likes using it

v. Love it, want to use it more but have no real need

3.2.5 Created matrix to assess the utility

1. Initial Position Calibration precision

a. How precise is the initial position calibration?

i. Terrible, over 15 cm difference

ii. Bad, 10 – 15 cm difference

iii. Tolerable, 5 – 10 cm difference

iv. Good, 1 – 5 cm difference

v. Excellent, no noticeable difference

b. How significant an impact does it have?

i. It makes the products unusable

ii. Major impact, serious effect on the result

iii. Medium impact, some effect on the result

iv. Minor impact, no effect on the result

v. No impact

2. Captured movement precision

    a. How precise is the captured movement in relation to the actual movement?

        i. Terrible, over 15 cm difference

        ii. Bad, 10 – 15 cm difference

        iii. Tolerable, 5 – 10 cm difference

        iv. Good, 1 – 5 cm difference

        v. Excellent, no noticeable difference

3. Captured movement limits

    a. Do any movement limits exist? (If “No” skip rest)

        i. Yes.

        ii. No

    b. How big an impact does it have?

        i. It makes the products unusable

        ii. Major impact, serious effect on the result

        iii. Medium impact, some effect on the result

iv. Minor impact, no effect on the result

v. No impact

4. Long term drifting

a. Does long-term drifting occur? (If “No” skip rest)

i. Yes

ii. No

b. How big an impact does it have?

i. It makes the products unusable

ii. Major impact, serious effect on the result

iii. Medium impact, some effect on the result

iv. Minor impact, no effect on the result

v. No impact

c. How often does it occur?

i. Less than every 30 mins

ii. Approx. every 30 – 60 mins

iii. Every hour or two

iv. Once a day

v. Once a week or less

5. Capture delay
    a. How long does it take to replicate movement into a virtual character?
        i. Very long (more than 3s)
        ii. Long (1-3s)
        iii. Tolerable delay (0.5 – 1s)
        iv. Slightly noticeable delay
        v. No noticeable delay
6. Capture smoothness
    a. Does fast movement appear to look like a slide show instead of a smooth movie?
        i. None of the movement looks like a smooth movie
        ii. Slower movement looks like a smooth movie, but faster like a slide show
        iii. The fast movement has slide show effect partly
        iv. The fast movement has hardly noticeable slide show effect
        v. Even fast movements look like a smooth movie
7. Other affecting problems
    a. Do any other affecting problems exist? (If “No” skip rest)
        i. Yes

ii. No

b. How big an impact do they have?

i. It makes the products unusable

ii. Major impact, serious effect on the result

iii. Medium impact, some effect on the result

iv. Minor impact, no effect on the result

v. No impact

3.3 Where

Moving the motion capture setup and everything related is not optimal for many reasons. Firstly, it is time-consuming. Secondly, as we try to capture human movement in the world, changing the environment might cause variations in the results. Thou it might be necessary to change the environment at some point. However, this should still be guided by the test results, and otherwise, every variable factor should be taken out from the testing phase.

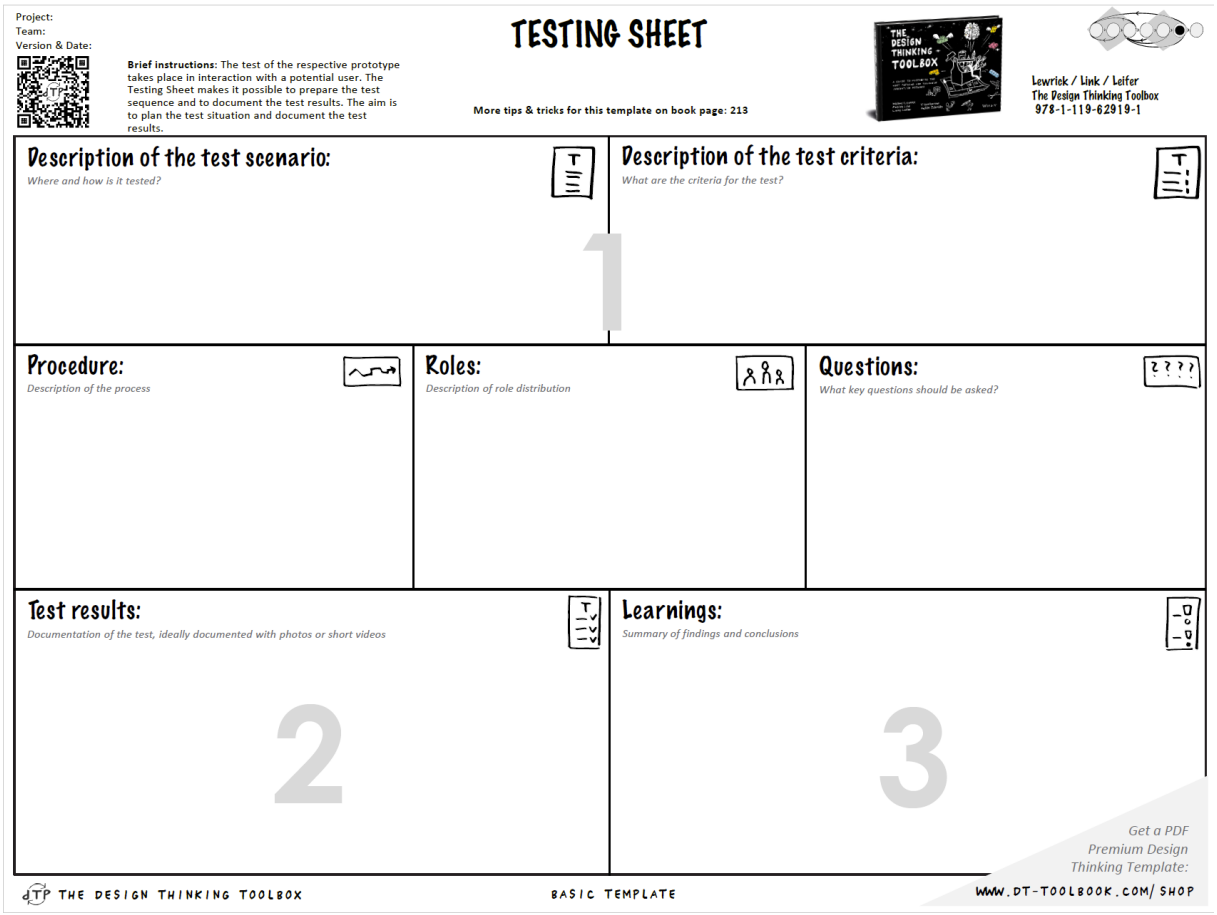
Due to Covid-19 restrictions and changing guidelines on space usage, it was seen best to set everything up and do the test in a place where these factors do not come into play. This place was home.

4 Execution of development project

The development project will consist of two parts. The first part will be a testing phase. Its aim is to test the products and workflows to assess them in practice. The first part is cut into smaller phases and each phase will be tested separately. To support the tests and documentation for each phase a testing sheet will be used. The second part will be about

recording a demonstration of possible content for simulation training with the Rokoko motion capture products. The second part will also include assessment of the suitability.

4.1 The testing phase



Attachment 1: The Design Thinking Toolbox´s Testing Sheet

The testing sheet makes it possible to prepare the test sequence and document the test results. It will be used separately in every phase. It has seven sections: Description of the test scenario, description of the test criteria, procedure, roles, questions, test results, and learning. Test results and learnings are filled after the actual test and others before it. The roles section will not be used since the answer will not change throughout the tests.

- Description of test scenario – should answer where and how it is tested.

- Description of the test criteria – should answer the criteria for the test.

- Procedure – should describe the whole process.
- Questions – should answer are the key questions that should be asked.
- Test results – should document test as precisely as possible.
- Learnings – should answer what the findings and conclusions of the test are.

4.1.1 Phase 1: Research official and unofficial instructions and guides.

Description of test scenario:

Find and gather official and unofficial instructions and guides for setup, workflows, and use. Information can be any format. Study the results and gather the best instructions for other phases. Find information on what was unknown.

Description of the test criteria:

Do they exist, how well they are documented, how detailed is the information is?

Procedure:

Find instructions of any format through the Rokoko website, google, youtube, and more. Examine findings. Assess and gather information to support the subsequent phases.

Questions:

What information do we not have (officially first, then unofficially)?

Test results:

The official Rokoko website has a separate guide section with filters with many video guides. Rokoko has a separate support site which also has many guides and instructions. The guides seem detailed enough and, in general, well explained, but especially in the video guides, it seems there can be multiple videos on the same subject. The text guides do not have separate good and bad practices, which could have been helpful. The guides are not

organized in a very user-friendly manner on the support page, so it might take time to find what one needs.

Rokoko also has a YouTube channel. There are many videos about workflows that are stated as not being official but what they are currently using. For example, there is no official workflow for using MetaHumans, but there are still instructional videos on achieving this.

The instructions on the Rokoko support website also state that the products need a power bank to operate and that they are not included with the purchase because of shipping legislation. The main requirement is to have one battery for the smart suit pro and one or two for the smart gloves. Each glove needs one USB-A output. Output requirements are 5V/2A and USB-A. The recommendation for the capacity of each battery is 5000mAh. (Rokoko, n.d.) The need for battery banks was not noticed upon initial purchase.

The Rokoko community has also made a decent number of videos about the products. The community provides solutions and help with the different workflows for Rokoko that they have implemented in their instructions. The best example is the UE MetaHuman control rig template asset created by Olly Balboa, which is mentioned in the Rokoko guide video (Rokoko, 2021). The community videos differ from reviews guides to end products. Youtuber named Moon lists many good points in his review about expectations, workflow, and results. (Moon, 2021) The main points are:

- To get the best results, one must clean up the capture with filters inside Rokoko Studio.

- They are confirmed that many Inertial motion capture suits like Rokoko need foot contact to the floor to work properly (one cannot jump).

- Virtual Production addition inside Rokoko Studio can provide help with this. Requirements are VR base stations and HTC Vive tracker (two) and using legacy filter inside Rokoko Studio.

- Hand precision is not good (common with Inertial motion-capture suits).

- The suit has a wi-fi hotspot to connect straight to the laptop, but the smart gloves do not. Therefore, one needs a portable wi-fi router for outside or portable capture.

- Handle expectations to a realistic level.

Learnings:

Rokoko has made decent instructions and videos on how to use their products. They should be enough to handle the setup and start using the products. As the processes and instructions can be updated over time, the ones used in this project might not be valid in the future, so mainly the findings like problems are documented and explained.

Concerning capturing quality, workflow, and use, the community videos showed that everything is not covered in the official guides. Therefore, everything is not as easy and good as the picture one might get from the Rokoko marketing videos.

The community is also helping Rokoko advance the workflows and ease of use. Rokoko developers have also noticed this and use their solutions. In case of problems or similar, the community is a strong candidate to look for help, solutions, and insight.

Based on the findings, three Insmat 10 000 mAh Power Banks that fulfill requirements were acquired as they are required.

The virtual production addition is the only way to capture motion without feet contact with the ground. HAMK Smart research unit has three HTC Vive trackers and one Valve Index VR set, including HTC 2.0 Base stations, which can be used for virtual production. They were loaned for this purpose as phases seven and eight might require this. One Tracker is attached to the suit, and the Rokoko website has a printable 3D model of a holder where it can be attached. The holder was downloaded and 3D-printed.

After this phase, we do not know at least how to get a precise hand location or set it up so that it is precise enough. Expectation levels should be checked with the technologies' capabilities.

4.1.2 Phase 2: Setup the Rokoko products.

Description of test scenario:

Setup everything necessary to start using the Rokoko products. During the first testing phase, additional equipment was acquired, and everything planned for future testing is shown in Picture 8: Equipment. In this phase, everything should be set up and ready to start motion capturing in the following phases.



Picture 8: Equipment

Description of the test criteria:

Is the setup doable while following the guides? Other assessments are based on own experience and feeling, with no specific criteria or assessment table.

Procedure:

Download and install Rokoko Studio. Login with the given username and password. Change the Studio settings according to the guide. Connect and set up Rokoko products. Download the Rokoko remote app for IOS. Setup video camera, connect to pc, setup capture software to record screen and camera feed.

Questions:

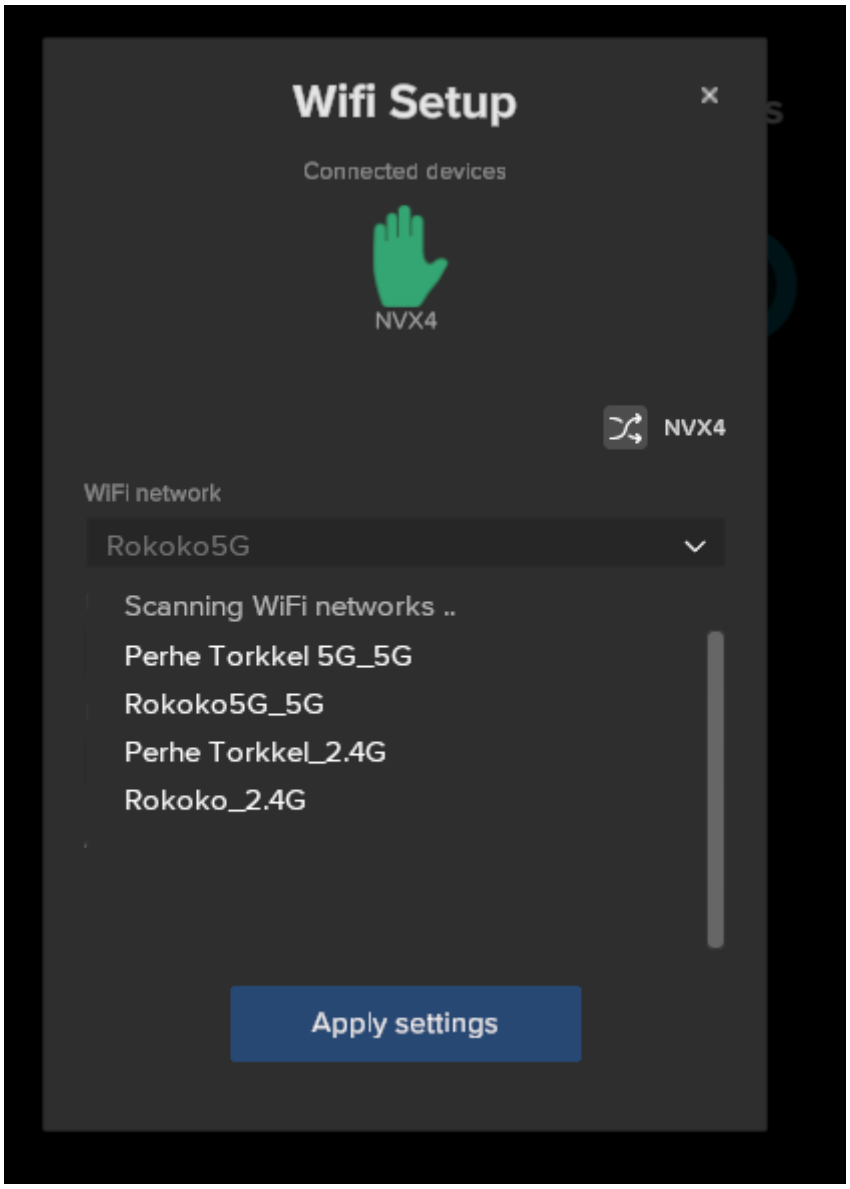
Are the guide and instructions detailed and simple enough to set up everything? How easy the process was to do it for the first time. Is there something the guides do not cover?

Test results:

Downloading the software and installation was straightforward. Login, setting the general settings for Rokoko Studio is simple if one follows the instructions on the Rokoko support website.

Connecting the USB cable to the Rokoko products needs surprising force and is easily mistaken to be pushed in even they are not. However, once connected, the physical connections are sturdy and will not disconnect by themselves, which is very positive in products like these, as USB connections can be untrustworthy sometimes.

When setting up the first smart glove, Rokoko Studio could not find the router´s 5Ghz Wi-Fi connection, but it did find the 2.4Ghz connection. Rokoko recommends using a 5Ghz connection when possible. Getting the 5Ghz connection to show up was not stated separately in the guide, but their support section had a solution for this. It stated that if one could find the 2.4Ghz Wi-fi connection but not the 5Ghz connection, one needs to switch the 5Ghz router channel to 36. (Rokoko, n.d.) Unfortunately, there was no instruction on how to do this. Instructions had to be googled and done separately. Changing the channel is done through router settings that one connects to via its IP address. From a user perspective, this is not optimal and not very simple if one has never done such a thing. A general instructional video would be recommended. After changing the 5Ghz channel to 36 and restarting the router, both connections were found through Rokoko Studio, as seen in Picture 9: Rokoko Studio Wi-Fi setup.



Picture 9: Rokoko Studio Wi-Fi setup

When starting player actor set up, it is recommended to only change the height setting. However, if problems appear, then changing the measurements to more reflect the user's body can be beneficial. Creating and changing the height of the actor profile is very simple and well documented. The actor profile created for this project is now named "Smartian." Its character color is blue, and its height is 176cm (which comes from the actual user´s height). No other measurement was adjusted or changed at this point.

OBS was chosen as the screen recording software as it is one of the best overall capture and streaming tools available for free. HAMK Smart research unit has a Panasonic HC-X1500 video camera and an Elgato 4K Cam Link (USB-A to HDMI) capture dongle for this project.

For proper voice recording, a wireless BOYA microphone was borrowed and used. All these were set up and tested to work with OBS. These are all used to capture the on-screen and real-world action, and combining these into one video feed seemed necessary.

Learnings:
The overall process of setting up everything is relatively easy, even for a beginner. The instructions and guides are well written and visualized through pictures, so one knows what should be done. Unfortunately, there are no separate guides for different versions of the Rokoko Studio (except for troubleshooting), so it is hard to assess if everything is up to date or not. However, as everything worked out fine, one can assume they are up to date.

Getting the 5Ghz Wi-Fi to show up was technically easy. However, it might be a different experience for a first-timer, especially since there is no official documentation about what and how this should be done. Also, as this project is done from the home office, it is easy to get access and change router settings, but that might not always be the case in a company or broader environment. In that kind of environment, purchasing and installing a separate router might not be allowed.

4.1.3 Phase 3: Trial the Rokoko products with Rokoko Studio.

Description of test scenario:
Use the Rokoko motion capture products for the first time. Record a small scene and try the filters inside Rokoko Studio to clean up the data as much as possible. Assess.

Description of the test criteria:
Work or not? Precision? Problems? Other assessments are based on own experience and feeling, with no specific criteria or assessment table.

Procedure:
Open Rokoko Studio. Dress the smart suit and smart gloves and connect the batteries. Open the Rokoko remote app and connect the phone to Rokoko Studio. Create a new scene inside Rokoko Studio and add a “Smartian” actor profile into it. Drag and drop the products onto the profile. Calibrate all products by performing a calibration pose. Try different poses and

movements. Identify possible inaccuracies and other problems. Record a test scene and try the filters.

Questions:

Do they work? How accurate are the products? Was there anything unexpected?

Test results:

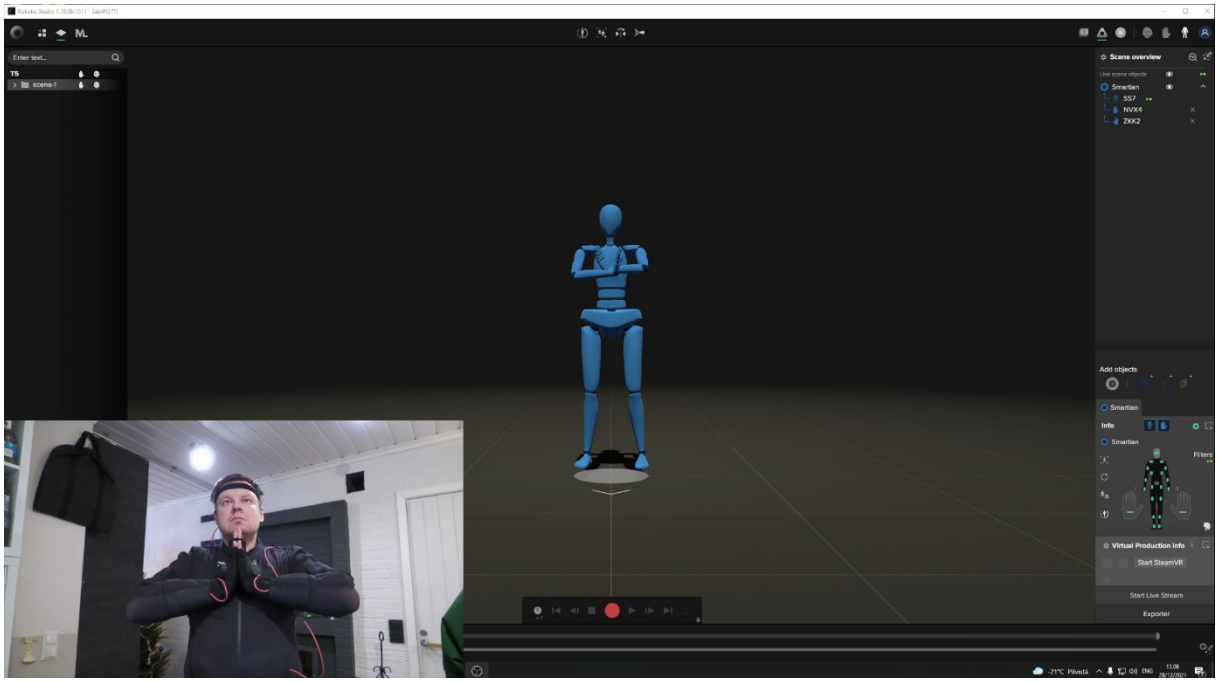
Dressing the suit is relatively easy and can be done by one person. However, there are no adequately designed pockets for three batteries. Either they are not available to the user (for example, pocket in the backside), or there are no proper places for the USB cords to pull through. As a result, one needs to think about the order of connecting the batteries and where to place them.

When the smart suit and both smart gloves were connected, the other smart glove´s movement would always lag in the Rokoko Studio. There was a statement that the products should be compatible with all routers during the initial setup. When it comes to connectivity, they most likely are, but it does not consider the number of used products simultaneously (amount of transferred data) and performance. Among further investigation, Rokoko recommends using a dedicated router for the motion capture, and lists recommended routers for different parts of the world (Rokoko, n.d.). The gloves were confirmed to work without lag when they were connected separately. The problem was related to the wi-fi connection and the amount of data transferred over it. The used router was Technicolor CGA2121, and other devices like mobile phones, tablets, and TVs are also connected to it. Therefore, there was no possibility to make it a dedicated router for Rokoko products. Due to the circumstances and future use, a new ASUS AC2900 Wi-Fi Gaming Router (RT-AC86U) that Rokoko recommends for the use of up to three smart suits was purchased. The lagging problem was fixed after setting up the new router and Wi-Fi and re-setting all the Rokoko products to use the new Wi-Fi.

The movement itself is well captured if the sensors in the suit are physically not pointing the wrong way. If they are pointing the wrong way, the movement is registered, but they are not moving in the right direction. Generally, one sensor controls one bone, so locating what is

not moving according to its physical one is easy. Rokoko provides a decent guide on where and how the sensors should be placed.

One of the most significant issues revealed during this phase was the distance of the hands to each other. The issue is apparent when doing a praying pose where the hands touch each other. As seen in Picture 10: Praying pose problem, the actual hands are touching each other, and in Rokoko Studio, the hands are clearly inside each other.



Picture 10: Praying pose problem

Changes to calibration poses and actor profile measurements were made to correct this problem. The profile measurements were also tried with the actual user measures. Unfortunately, these changes did not provide a wanted outcome or fix. Changing pelvis and shoulder width to more than what they are partly seemed to solve the problem but caused other significant problems, so it is not considered a solution.

While trying to solve this problem, Rokoko hosted a live stream on their YouTube channel. The host was Sam Lazarus, who works for Rokoko as a creative director. During the live stream, he answered some of the viewers' comments and questions, and during this, he introduced the existence of the Rokoko Discord channel. Discord is a communication platform with different text channels and VOIP (voice over internet protocol) (Discord, n.d.).

In the Rokoko channel, there are employees, users, and other interested people. It feels like a warm community with a genuine desire to help each other out. This problem was presented in the channel and Rokoko official support. Unfortunately, the Discord channel was discovered relatively late to this project's overall progress and deadline. The problem was not solved during this project, not by the community in the Discord channel nor by Rokoko's official support. Instead, it was instructed to use control rigs to get the precision that was needed manually.

In Rokoko Studio, one can choose which filters to use while recording or streaming the movement. If one is not streaming live, then there is the possibility to improve the data a bit by improving the filter data in the recording. There are no tools to adjust or configure one bone or sensor data specifically in the program, so the only option is to use and improve the filters. For example, in the hand distance problem, one could change the hand positions to be touching each other while doing the praying pose if such tools would exist. Usable filters are Locomotion, Locomotion Legacy, Treadmill, Drift Fix, Foot IK, Knee Pop smoothing, and Toe Bend, and they are explained on their support site (Rokoko, n.d.). While recording, the live filters seem to work decently, but while working on the filter data manually, it is clear that they can be improved a lot. Recommendation: go through the filter data manually, if not live-streaming, as it can significantly impact the result.

Learnings:

The movements are registered reasonably well, but there are apparent problems with body parts' position or relative position. These problems could not be fixed by adjusting the basic settings, measurements, or filters. Minor accuracy problems are common with inertial motion capture suits, but such apparent deviation and problems were not expected.

The filters are standard tools, and the software (version 1.19.0b) has no tools or control rig to fix or adjust the positioning errors. Accuracy problems would mean either wrong positioning of body parts in the live stream or manual labor with every animation or user's exports. In short, users have to fix the symptoms and not the cause because of the lack of tools in the Rokoko Studio. These problems could also be fixed by changing the initial calibration pose or its method. Identifying the most common positioning problems like the

“praying hands” and creating a series of different initial poses for these from where the sensors are calculated could be an answer in the future.

Positioning problems can be expected in future phases, and control rigs should be researched and considered to be used for better results. Using control rigs is not according to the initial plan to exclude as much manual labor as possible, but its importance overtakes it.

4.1.4 Phase 4: Setup Unreal Engine project and MetaHumans.

Description of test scenario:
Create an Unreal Engine project with MetaHuman and set up the workflow from Rokoko Studio to them.

Description of the test criteria:
Time consumption is estimated roughly in hours. Doable / not doable. Other assessments are based on own experience and feeling, with no specific criteria or assessment table.

Procedure:
Find official instructions or guides. Then, follow the guide step by step until the workflow between Rokoko Studio and the Unreal Engine and MetaHuman is ready to be tested.

Questions:
Is there an official guide, is it doable, how easy it is to follow, how much work there is to do the setup, what level of knowledge is needed.

Test results:
The phase started with finding a good guide to set up the workflow. “Updated Metahuman + Rokoko Mocap Workflow” YouTube video by Rokoko was chosen to be the guide for this phase (Rokoko, 2021). This guide is for Workflow 2 – live. No official guide was found to set up Workflow 1 – saved as a separate.
The first step was to install a Rokoko plugin from the Unreal Engine marketplace to the used Unreal Engine version, which was 4.27.2. While following the guide further, a surprise hit at 4:22 of the video. A node inside Unreal Engine named “Rokoko Body Pose” did not include a

“Bone Map override” function visible in the video and used part of the setup. After double-checking the video and the work so far, it was clear that this was not a user error. The problem pointed towards that the “Rokoko Body Pose” node had been changed or updated and the whole “Bone Map override” function had been removed. It was clear that not being able to follow the video instructions that the result would not work. The setup halted to a stall.

Researching the official guides, website, and support notes, there was no indication of anything related to this except that a newer version of the Rokoko plugin had been released after the guide video had been made and released.

The only option was to turn to the Discord channel and ask if anyone knew how to fix it. In the Rokoko Discord under the #Unreal text channel, there had already been discussion and questions about the workflow and that the new plugin does not have the Bone Map override -function. There were no answers to these problems, but a user named “Ilias_Stent,” a member of a user group called Rokoko Team, announced that he/she was working on new documentation for the newer version of the plugin. Ilias_Stent also confirmed that there were changes to the plugin and that the Bone Map override function had been removed. There was no answer to whether this change was made because of Rokoko or something Epic changed that forced them to update the plugin. Rokoko updated the plugin without announcing that the old workflow or guide did not work. There was no guide on using the new plugin, which can not be identified as a user-centered operations design. There is no accurate indication or proof that this person works for Rokoko, or is this person just a helpful community member.

The plugin update was during the Christmas holidays in 2022, and it was evident that this had a clear impact on other users. After waiting for a couple of days, the new guide was released in the Rokoko Discord. When the guide (Attachment 2: Rokoko_Plugin_Setup_for_Metahuman_Mocap) was released, it had a few errors that prevented the workflow from working. These were pointed out quickly by the community and fixed to the documentation. After that, it was time to continue the setup with the new guide.

Compared to the old workflow, the new workflow added many steps, especially changing the orientation of metahuman bones, and renaming them takes time. Therefore, this guide and process are not for entry-level users. The guide assumes one knows how to do basic things in Unreal Engine and does not go over them. Also, misspelling a letter of a bit over sixty bones that one has to rename will cause capturing problems. Assets can be made and shared in the future for a more straightforward setup, but at the time, everything had to be changed by hand.

This phase took more than two weeks because of the Rokoko plugin and workflow changes. The timing for this was very unlucky, but other users were affected by these changes and their impact. This impact is not in the scope of this thesis, but Rokoko should evaluate it.

Follow-up update: A new instructional video for the workflow was released within a month after the initial update. The new instructional video also links a download folder with assets where all the bone corrections are done. The video and assets save time and make the process much simpler and more accessible. Rokoko employees also confirmed a new version of Rokoko Studio in the making, and its Beta testing phase should start at the end of January 2022. The new Studio version should improve tracking and support the new Smart suit II with its capabilities. Also, there was a hint of new upcoming tools inside the studio, but no factual information on what they are. The changes and impact should be checked later.

Learnings:

Rokoko Studio supports many programs and workflows and keeping them all up to date, and working takes time and effort. In addition, all programs and third-party solutions like MetaHuman (currently in beta) keep constantly updating their products and software that might directly affect the usage of Rokoko products and related workflows. From the customer perspective, it is about handling these changes and challenges and communicating about them. In this case, this was not fulfilling our expectations as a customer or user.

The Workflow 2 – live should now be set up to be assessed. Unfortunately, for Workflow 1 – saved during this test, no official guide was found.

4.1.5 Phase 5: Trial the workflow between Rokoko Studio and Unreal Engine using MetaHumans with exported animations.

Description of test scenario:

Trial how to export recorded animations from Rokoko Studio to Unreal Engine and retarget them onto MetaHumans work.

Description of the test criteria:

Doable / Not doable. Other assessments are based on own experience and feeling, with no specific criteria or assessment table.

Procedure:

Find an official guide. Follow the guide to trial the workflow.

Questions:

Is it doable? Is there an official guide? Is there anything unexpected in the workflow? How easy is the overall workflow to use? How time-consuming is the workflow?

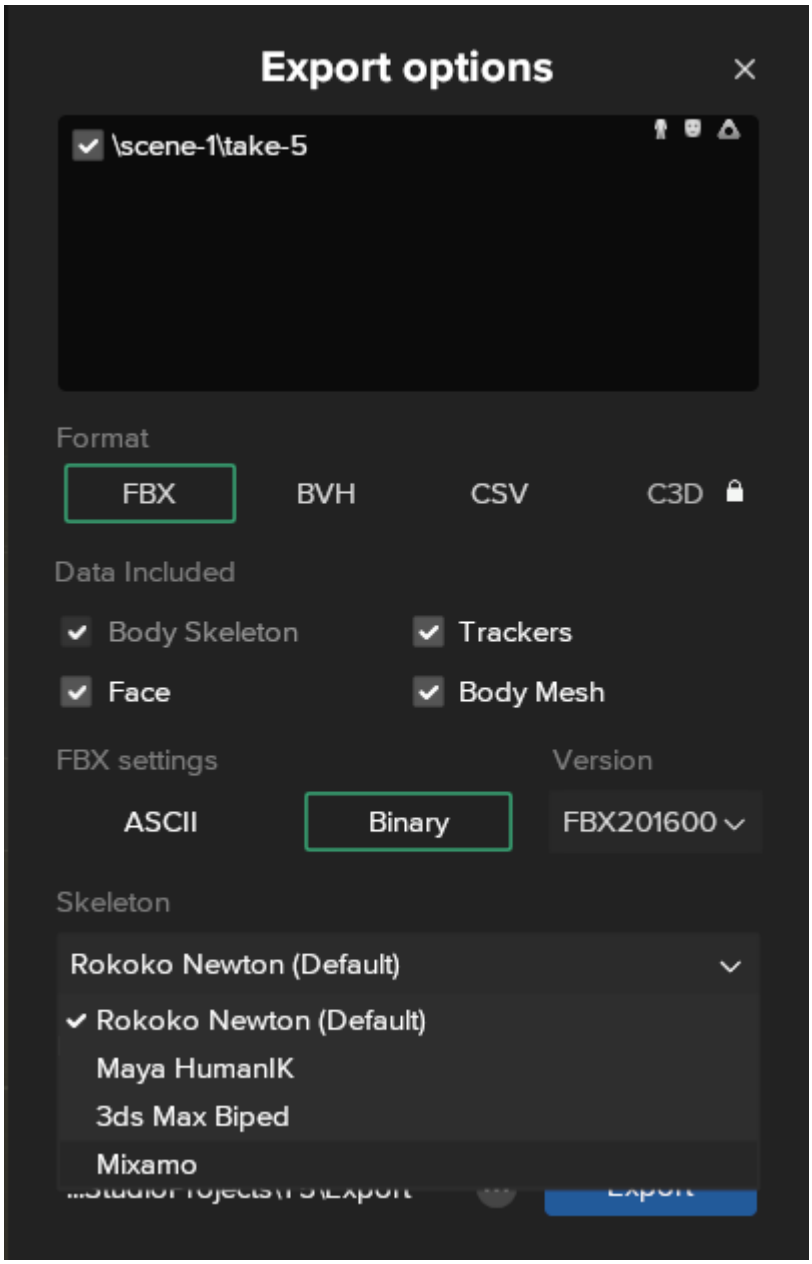
Test results:

There was no official guide on achieving this, or one could not be found. Not finding guides does not mean that it is not doable, but clear instructions were not found. The support site is missing instructions to set up workflows altogether, but some can be found on their YouTube channel.

There was a discussion on the Rokoko Discord server about not being able to retarget the facial expressions to MetaHuman inside Unreal Engine if using this workflow. Retargeting was not tested or researched.

Learnings:

There is no official guide to set up and use this workflow. It does not mean it cannot be done, but it needs a deeper understanding of export options, as shown in Picture 11: Rokoko studio animation export options.



Picture 11: Rokoko studio animation export options

In the exported skeleton option, there is no straight support for Unreal Engine´s used Mannequin or MetaHuman, which means one has to retarget the bones to get the animation to work correctly. To achieve this, one would need a guide or a more profound understanding of the process and the used skeletons.

This outcome changes the point of view in the diamond process, which can be seen in Picture 6: Design thinking process with double diamond. Workflow 1 – saved is no more seen as a valid option for the initial purposes. The main reason behind this is the lack of official

guiding for this workflow. No guides mean that any changes and occurring problems one would have to solve independently. In past experiences, most of the changes and adjustments inside the Rokoko plugin were unavailable or told to customers. In an unsupported workflow, one might end up with a broken workflow without knowing what is causing it. Time consumption on these cannot be estimated.

As a result, Phase 7: Record the demonstration (workflow 1) will be skipped. Picture 6: Design thinking process with double diamond

4.1.6 Phase 5: Trial the workflow between Rokoko Studio and Unreal Engine using MetaHumans with a live link.

Description of test scenario:

Trial how to live linking the Rokoko Studio and Unreal Engine works, how the live linked data can be retargeted to a MetaHuman inside Unreal Engine.

Description of the test criteria:

Doable / Not doable. Other assessments are based on own experience and feeling, with no specific criteria or assessment table.

Procedure:

Prepare equipment. Open Rokoko Studio and Unreal Engine (the project created). Equip every piece of equipment. Connect the equipment to Rokoko Studio. Turn on the live link from Rokoko Studio and Unreal Engine. Trial the live motion capture products – Rokoko studio – Unreal Engine, and MetaHuman. Record a test recording.

Questions:

Does it work? Is there visually anything noticeable that needs to be pointed out? Is there a noticeable capture lag or delay? How easy or hard is this workflow getting running? Is there anything unexpected positive or negative? Can this workflow be used to record the demonstration?

Test results:

After everything is set up, the overall process to start the live link and use it is fairly quick and easy. The biggest hassle is to equip the suit, gloves, face capture device, and batteries.

The smart gloves seemed like they did not fit with the smart suit or were not designed together. There are no proper battery pockets on the sleeves, so one has to purchase separate ones, or one can choose to insert the longer USB-c cables inside the suit and place the other end to the front pockets in the suit. The suit´s wrist sensors are disabled if the smart gloves are connected. When using the smart gloves, these sensors are in the way of the glove so one can equip both simultaneously. The best way is to move these sensors from their original place and place them somewhere upwards the suit where they are not in the way anymore. The suit's sleeves have to be turned over and rolled back up on top of the suit. The edge of the sleeve is tight and might cause issues. This is uncomfortable. The suit and the gloves seem like they do not belong together.

The workflow works well, and the movement is being replicated. However, there are still issues and new issues also. For example, some sensors, especially the feet, start to drift when working for a more extended period. Drifting can be a real problem if one has to do long sessions without breaks. The result is that the hands are still going into each other approximately 20 centimeters. Researching user videos proves that it can be seen that this problem is almost affecting everyone. It also seems that this is a known issue for Rokoko since they are avoiding putting their hands together in the front. The videos indicate that the workflow works as intended, but the Rokoko algorithm keeps repeating the same mathematical error, and so far, no solution to correct this has been found. One can try adjusting the MetaHuman bones to compensate for this error, but it mainly ends up causing new errors and needs more profound knowledge or trial and error. Researching ways to fix this, the best way to get the results one wants is to manipulate the animations after recording them.

Inside Unreal Engine, after recording the animation, one can open it up with a level sequencer tool. It is similar to video editing tools but not as extensive. Inside, one can attach a control rig onto the MetaHuman in the animation. The control rig on a MetaHuman can be seen in Picture 12: Control rig on MetaHuman.



Picture 12: Control rig on MetaHuman

With this tool and a bit of know-how, one can adjust the bone positions and rotations in the animation. One can fine-tune and adjust every bone in every frame, but this is very time-consuming, even for the most experienced animators. Control rigs seem to be the only way to get accurate results if needed at the current time. Using control rigs will not be part of the assessment as they can be used on every animation, and with them, the animations can also be created from scratch. The end assessment should reflect the Rokoko product's accuracy without the manual work to fix possible problems.

More extended testing showed that one could not jump nor lay down without causing severe problems to the recording. The problems are caused because some inertial motion capture systems expect one foot to be on the floor all the time. In Rokoko studio, this was

the case with the original setup. The program was forcing one foot to always be on the floor, so this would cause different kinds of problems, for example, the person clipping through the floor in cases neither foot was on the ground. Researching this problem and ways to fix it, the virtual production workflow for Rokoko Studio would allow the person being recorded to jump, lay down, and do other movements that have no feet on the ground.

Learnings:

The information gathered during this phase proved that using the virtual production tools in Rokoko studio is mandatory to record the demonstration in Phase 8. Gathered information also impacts the point of view in the double diamond.

As a result of Phase 5, doing Phase 7: Record the demonstration (workflow 1) was to be skipped. However, using a virtual production tool is mandatory, and it needs to be set up and tested before the demonstration can be recorded.
As a result, Phase 7 will be done, but the topic will be changed to “Setup and trial virtual production in Rokoko Studio.”

4.1.7 Phase 7: Setup and trial virtual production in Rokoko Studio

Description of test scenario:

Setup and trial virtual production tools inside the Rokoko Studio. Focus on being able to record animations where feet are not touching the ground.

Description of the test criteria:

Doable / Not doable. Other assessments are based on own experience and feeling, with no specific criteria or assessment table.

Procedure:

Find an official guide and information about virtual production and how to set it up. Create a list of needed things. Acquire and install them. Setup up the virtual production tools and trial them.

Questions:

Doable / Not doable? Is the virtual production affecting anything other than enabling up and down movement? Is the up and down movement correct?

Test results:

The setup and trial were based on Rokoko Tutorial: Virtual Production Setup - YouTube video (Rokoko, 2019). It requires some equipment usually associated with virtual reality (VR) glasses. Two base stations and at least two HTC Vive Trackers. The basic idea is that the two base stations track the position of the two Trackers in a room. The first tracker determines the floor level, and the second is attached to the suit to track its position in the room. The Rokoko Studio detects the equipment well, and the process to determine the floor level from the tracker and attaching the other tracker to the suit is simple and works well. After this, the person jumping and laying down works, and the movement is translated into the Rokoko Studio. The overall capture quality is slightly affected because the trackers determine the vertical position. Quality loss is not huge but noticeable and should be checked if precision is needed.

One can only attach the trackers to the smart suit inside the Rokoko Studio and also physically. Smart gloves and feet could be thought of as possibilities to expand this to get more precision. Further development on this could solve the hand tracking problem if nothing else can solve it.

Learnings:

The virtual production tool was reasonably easy to set up and start using. It solved our problem of laying down for the demonstration. Finally, everything is set for our last testing phase.

4.1.8 Phase 8: Record the demonstration (workflow2)

Description of test scenario:

Plan and practice the act. Equip all equipment, open and prepare all software. Record the demonstration.

Description of the test criteria:

All assessments are based on own experience and feelings, with no specific criteria or assessment table.

Procedure:

Watch and gather heart attack information. Plan the scene on how to act a heart attack. Act it through a few times. Equip all gear. Open and prepare all software. Test try everything. Record a test sequence. Record the demonstration.

Questions:

How straightforward is the whole process to record after everything is set up? Was there anything that was not expected?

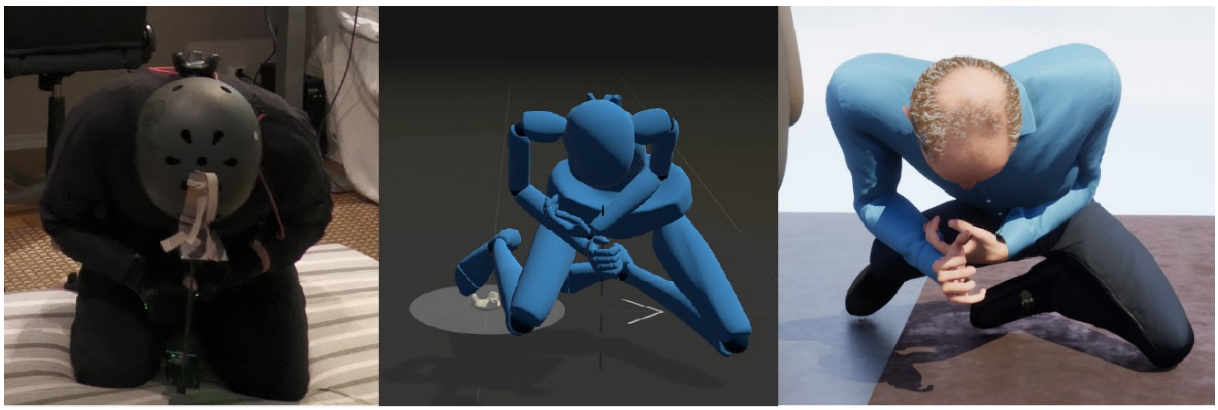
Test results:

After everything is set up, recording new animations are simple and straightforward. Setting everything up is a significantly more challenging and lengthy process than starting the recording process and recording. During recordings, everything worked as planned. The same problems pointed out during earlier phases still exist. Screenshots from the recorded videos of real-world, inside Rokoko Studio and MetaHuman inside Unreal Engine were combined to next to each other to get a better comparison point. The recordings were not time-stamped, so all three screenshots inside Pictures 13 – 15 can have been taken at a bit different time, and also, the point of view can alter.

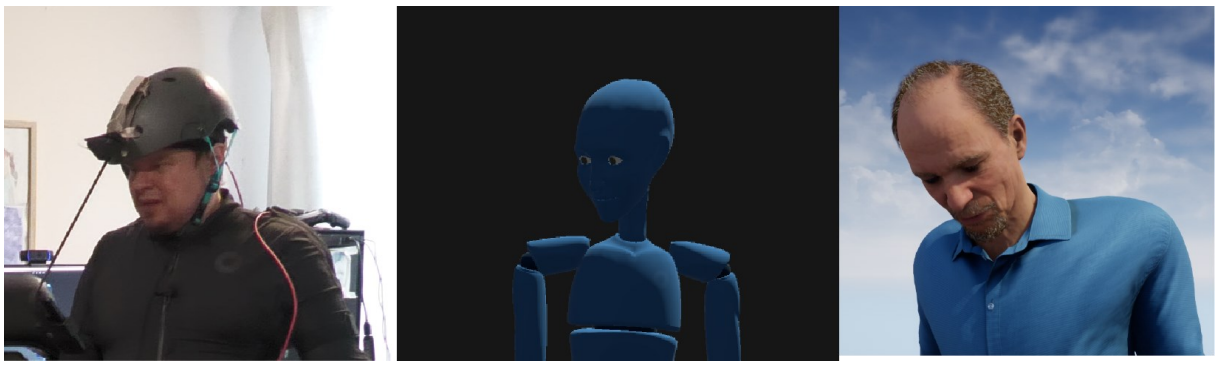
There are visible differences in positional tracking between each step; actual position – Rokoko Studio – MetaHuman inside Unreal Engine. It has to be noted that, basically, Rokoko products' capture precision only affects the differences between the screenshots from the actual position and Rokoko Studio. The differences between the screenshots from Rokoko Studio and MetaHumans inside Unreal Engine are mainly affected by how the bones of the MetaHuman are set up or adjusted. Some MetaHuman bodies (for example, Ada and normal-weight woman body skeleton) seem to look more realistic than the one seen in Pictures 13 - 15. The shoulders especially look unnatural in Picture 13: Demonstration comparison number 1.



Picture 13: Demonstration comparison number 1



Picture 14: Demonstration comparison number 2



Picture 15: Demonstration comparison number 3

Acting and actor´s natural movement were not assessed in this phase as the original plan of using a professional actor to do this phase was canceled due to Covid-19 restrictions.

Learnings:

Starting the recording is pretty easy after everything is set up. It does not take much time. However, the accuracy is as shown in Rokoko Studio, and not all problems could be fixed in this workflow. There are differences between the MetaHuman´s body skeleton and how they look in the result. Rokoko Studio does not support outputting an A-pose which Unreal Engine and all MetaHumans use as a starting pose. Enabling the A-pose output would likely correct most of the issues of using different body type skeletons.

4.2 Assessing the demonstration

In this topic, creating the demonstration and the Rokoko products will be assessed based on the matrixes created earlier. The assessment will be done based on the experience gathered during the testing phases. Only one answer is chosen for every question, and there will be a comment about the reasons behind it. The usability and utility matrix will be used to assess creating the demonstration, meaning recording it. Only a usability matrix will be used to assess the setup phase as its own. This will give an indication of both processes, as the setting up part is mandatory to be able to use these products.

4.2.1 Assess usability of the setup process

1. Learnability:

    a. How easy is it to learn the use of the product or service? In this case, how easy is it to set up the workflow?

    It is complicated to learn.
    To set up everything, one needs to understand the basics of the chosen target software. Many basics are not covered in the guides. Setting up the workflow takes quite a lot of knowledge and understanding in different areas (for example, router settings, configuring two routers, knowledge of export targets, setting up live workflows, and more).

    b. The level of documentation or guides?

OK documentation and/or guides.
The guides cover most parts, and there is plenty of them. However, the outdated guides are kept and not removed for some reason, which can confuse.

c. Previous user knowledge requirement?

Need previous major knowledge or use.
This applies especially to the other software than Rokoko. The guides assume the user knows the basics of the chosen software. For example, some Rokoko guides or troubleshooting tell one to configure the router wi-fi 5G channel to be 36, but no instructions or hints on how to do this. One has to figure it out on its own. Rokoko not being able to give instructions on all brands and models is understandable.

2. Efficiency

a. How many percent of work is actual production?

20 – 40 %.
The majority of the time goes into watching and reading guides instead of setup. Also, troubleshooting with mainly google services can be time-consuming, and not all methods work.

3. Memorability

a. To use it again, how much does one need to re-learn?

Remember basics (40 – 60 %).
The basics are easy to remember, but at least 25% are in such detail that they have to be rehearsed almost every time. Repeating this process often can help, but having to do a setup process often points to different problems.

4. Errors

a. How often do system errors occur?

   Approximately every 30 – 60 mins.
   In the setup process, the most significant system errors occurred while connecting the products to the Rokoko studio via Wi-Fi. Also, updating products firmware created some problems.

b. Impact of system errors?

   Minor parts of work are lost or unusable.
   The system errors did not lose anything in the setup process, but steps had to be repeated, which is equivalent to a loss of work. Time consumption was impacted the most.

c. Impact of user errors?

   Minor parts of work are lost or unusable.
   User errors mainly occurred of not knowing what to do or choose. Some parts had a more trial-and-error type of proceeding than anything else. User errors mainly increased time consumption.

5. Satisfaction

a. How does the product or service fulfill one´s needs?

   It fulfills the basic needs, but not everything.
   The whole setup process is not for people unfamiliar with at least the target software. It is time-consuming, and all steps are not fully guided.

b. Does one like to use the product or service?

   Will use it, but only if mandatory.
   The first setup takes time and effort. The complete setup means configuring or installing: a router, Rokoko Studio, Rokoko products, iPhone, and in this case also Unreal Engine, Quixel Bridge, MetaHumans, and the Unreal Engine

project itself. This setup is not easily changed to another pc, and because of the time consumption, it should be regarded as mandatory only.

Overall, the setup process is relatively time-consuming and requires more knowledge than the official guides. In this project, setting up the target software, project and configuring it was part of the workflow. This should be noted that it can be separated from the Rokoko Studio setup if wished-for valuation purposes. Numerical assessment of the usability of the setup process is two out of five (2/5).

4.2.2 Assess usability of recording and using

1. Learnability:

    a. How easy is it to learn the use of the product or service?

    Only basics are easy to learn.
    After everything is set up, learning to record is easy. Learning how to prepare all equipment and equip it is relatively easy. Learning to use Rokoko Studio filters properly is a bit more complicated task. Learning to use or record the animations in Unreal Engine is not easy. In the end, to use the whole workflow, one needs to learn the whole process.

    b. The level of documentation or guides?

    OK, documentation or guide.
    The YouTube video guides are visual and informationally ok, but they do not cover all aspects of learning and using these workflows. Guides for the Workflow 1 – saved was not found. The guides for Rokoko Studio are decent.

    c. Previous user knowledge requirement?

    Need previous medium knowledge or use.
    One needs previous knowledge and use to record and play an animation inside Unreal Engine. To switch MetaHuman characters to another or play

new animations, one has to know the basics of the process and how to cope with the visual scripting inside Unreal Engine. Rokoko Studio filters, for example, are not intuitive, and one has to learn what they do and how they work to get the best out of them.

2. Efficiency

    a. How many percent of work is actual production?

    40 – 60 %.
    The recording and use are mainly straightforward after having all the equipment, software, and live link set up and ready. To set everything up takes time and recording length has a significant impact on efficiency. To be ready to start recording, it takes approximately fifteen to thirty minutes to get ready from not experienced user.

3. Memorability

    a. To use it again, how much does one need to re-learn?

    Remember majority (20 – 40 %).
    The whole process is easy to remember when talking about recording. If one must switch to a new MetaHuman character, it is different. Other adjustments are estimated to be around 20% of all usage.

4. Errors

    a. How often do system errors occur?

    Approximately every 30 – 60 mins.
    The main problems are drifting problems meaning positional precision. The inaccuracy of the hands is constant and does not change. However, the drifting problem is not constant and can happen anytime. Its cause is in the inertial motion capture system, but the sensors and the algorithm driving

everything have a significant factor. Drifting can happen inside a few minutes while recording, but it is almost guaranteed to happen at least every 30 minutes if doing a single recording or more often.

b. Impact of system errors?

Minor parts of work are lost or unusable.
Usually, a system error only ruins the current recording at hand. However, the recording length has a significant effect on the impact of the system error. For example, when trying to record longer animations, these can become a significant problem ruining most work. In addition, the problem can impact the artistic freedom of doing uncut scenes and more.

c. Impact of user errors?

Some parts of work are lost or unusable.
Usually, user errors affect a single recording. They can have more extensive effects, but it is not easy to accidentally lose all work or something similar. No accidental user errors happened during the testing phases.

5. Satisfaction

a. How does the product or service fulfill one´s needs?

It fulfills the basic needs, but not everything.
The overall assessment is that the product and workflows are harder to set up than expected. However, experienced Unreal Engine developers are working in the HAMK Smart research unit, so this should not be that big of a factor. The biggest issue with the whole product range was mainly the algorithm

calculating the position of the hands inaccurately. One purpose of use in the HAMK Smart research unit for these technologies is to teach hand skills, and for that, the linear algorithm is not accurate enough. As mentioned earlier in the testing phases, the hands were over twenty centimeters inside each other. The problem can not be changed or fixed inside Rokoko Studio, so the same problem exists in every animation created. They can be manually fixed inside Unreal Engine through control rigs, but this can never be efficient enough for professional or production level use.

b. Does one like to use the product or service?

It is okay.
The products are pretty fun and comfortable to use. The Studio is not the most intuitive software but handles the basics well. It is missing some critical tools or better calibration options to support better accuracy that the algorithm cannot handle. However, suiting up and starting everything is on an okay level.

After setup, using the products and software is relatively easy, and one gets familiar with the process. The Unreal Engine and changes inside it need previous use and knowledge. However, the simulation training assumably will be done in the target software, and one would need previous use and knowledge for that. Here, the whole workflow 2 – live was assessed, not just the Rokoko Studio part. It is good to understand that previous use and knowledge from the target software is required, but not so much from the Rokoko Studio. The lack of guides led to skipping the workflow 1 -saved even though it does not necessarily mean that it cannot be done, but this would have needed a lot deeper knowledge of used skeletons, bone structures, and retargeting. Numerical assessment is three out of five (3/5).

4.2.3 Assess the utility of recording and using

1. Initial Position Calibration precision

a. How precise is the initial position calibration?

Good, 1 – 5 cm difference.
The initial pose does not seem to differ much from the actual position.

b. How big an impact does it have?

Medium impact, some effect on the result.

The initial pose can still have a medium impact on the animation. In addition, the position of the sensors compared to one´s body is also somewhat crucial for further movement to be adequately replicated.

2. Captured movement precision

a. How precise is the captured movement in relation to the actual movement?

Terrible, over 15 cm difference.
After the initial pose calibration, some poses like the praying pose indicates wrongly calculated precision. The hands go in each other over twenty centimeters, and the shoulders are not at the correct angle. One can not clap, for example. As there is no way or tools to change, fix, or do anything about this issue, the products currently can not be regarded as accurate.

3. Captured movement limits

a. Do any movement limits exist? (If “No” skip rest)

No.

b. How big an impact does it have?

No impact.

4. Long term drifting

a. Does long-term drifting occur? (If “No” skip rest)

Yes.
Long-term drifting occurs approximately between fifteen to thirty minutes of use. It can happen more often but does not affect the shorter recordings.

b. How big an impact does it have?

Medium impact, some effect on the result.
It can only ruin the animation currently being recorded. The project did not have an effect, but the impact was visible when testing a more extended recording.

c. How often does it occur?

Less than every 30 mins.
It can occur any time, but the estimation is that this has an almost definite effect when recording animations up to fifteen to thirty minutes long.

5. Capture delay

a. How long does it take to replicate movement into a virtual character?

Slightly noticeable delay.
The delay is slightly noticeable if visible at all. However, it does not affect this project's workflows.

6. Capture smoothness

a. Does fast movement appear to look like a slide show instead of a smooth movie?

The fast movement has a slide show effect partly.
The captured animation can be recorded as 100 frames per second. There is mainly no slide show effect, and the movement appears smooth. Results are not being compared to other products like Xsens. Some fast movement capture can be affected by this, but no absolute consistency could be

reproduced. Magnetic interference or something else can also be affecting this.

7. Other affecting problems

    a. Do any other affecting problems exist? (If “No” skip rest)

    No

    b. How big an impact do they have?

    No impact

Assessing the utility of recording and using is complicated. Many things are done well, and they work as expected. Then a few issues have a significant impact on overall performance, and for the user to have no ways to affect these issues, they can become a groundbreaking obstacle for use. Rokoko has no known issues listing or a technical road map for customers to know what issues are being worked on and what is not. The roadmap of planned functions like Facebook account login is not the same. For customers, conducting business like this makes it harder to know what error is caused by a faulty product and what is caused by the software or algorithm and is affecting everyone. For customers, there was no way of knowing are the issues caused by the software even worked on, for example, hand precision. As a result, this puts users planning or trying to use the products in production or at any professional level in a not ideal place. For example, new customers did not know that one would have to manually fix every animation one does with the products if hand precision is wished. Those who were customers already knew that, but at the same time, they did not know if Rokoko was even considering addressing and fixing these issues. Addressing these issues is not in this project's scope, but Rokoko should carefully assess should they add communication, openness, and transparency. While conducting the testing phases and research, the honest assessment is that Rokoko´s customer expectation management, communications, and not being open and transparent on technical issues and roadmaps had a more significant impact on customers and users than the actual technical issues. This as a

whole has a clear impact on the actual suitability of these products for the HAMK Smart research unit for content creation for simulation training. However, this is not being assessed or noted in the matrix. The overall numerical assessment is two and a half out of a maximum of five (2.5/5). The assessment will be rounded down due to the importance of captured movement precision and other reasons stated above when using a scale of whole numbers.

4.3 Guides

The initial plan was to create a handbook/guide to reproduce the process done in the testing phases. However, as the workflows and methods are prone to change, a decision was made not to create guides. So instead, the suggestion is to check Rokoko`s website, Discord, YouTube channel as the first option to get the latest information and up-to-date guides.

5 Conclusions and reflecting

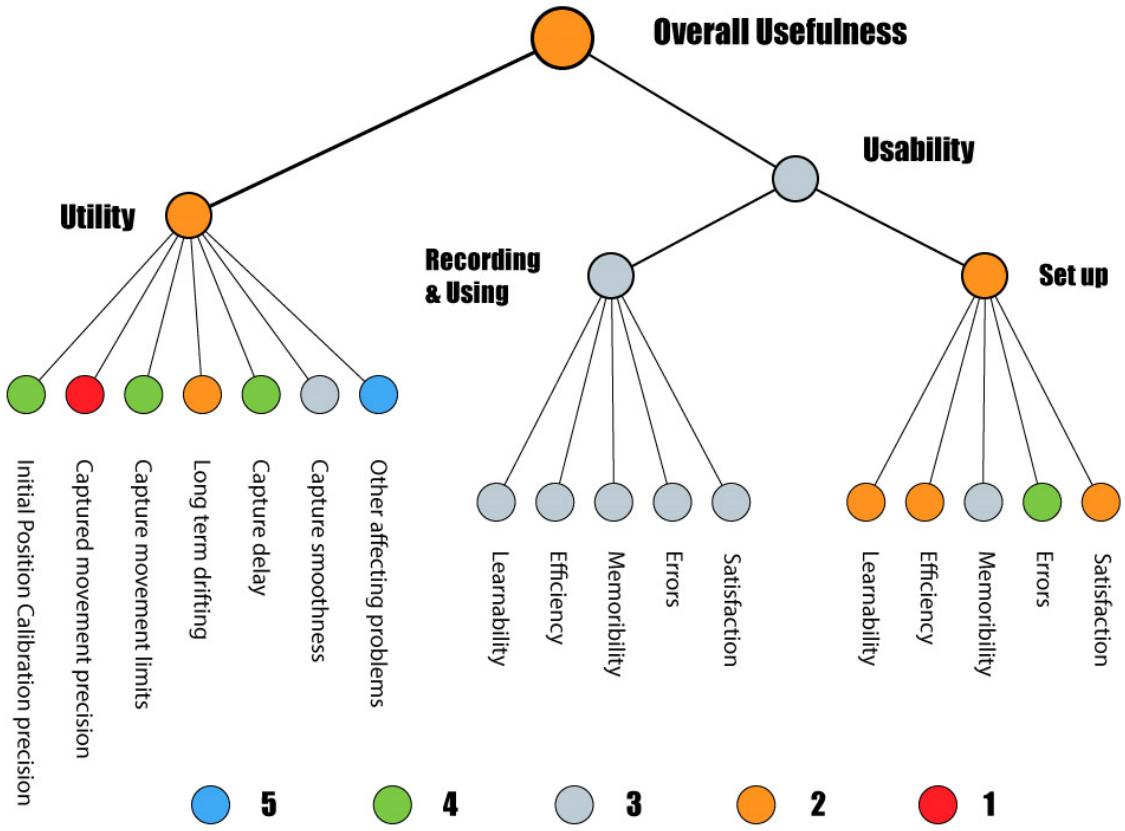
One of the research findings was that no existing framework to assess motion capture technologies or products was found. As a result, a matrix to assess the overall usefulness was created. It consists of two parts, usability, and utility. The matrix can be used in the future by anyone or HAMK Smart to assess different products or future updates released by Rokoko. The matrix can be future developed to support the overall assessment better. For more, it would benefit from an integrated points system, with the possibility to adjust the importance of a chosen section to reflect one´s needs better. Based on its use, more precise definitions are also needed. For example, what is the difference between OK and Good documentation? Everything should be defined so that different users would come to the same conclusion with the same product. The utility results give decent information to set expectation levels or a comparison point. However, the usability results seemed they are not precise enough to give a clear indication of what the possible problems are. Without additional written text, the usability results are an indication that the matrix needs improvement. For customers, it is tough to assess how accurate and precise motion capture products are (except by using them), and this could be standardized. An independent agency should evaluate the level of accuracy and precision.



Picture 16: Screenshots from YouTube videos released by a user named CitizenMetaOne

Motion capture products combined with tools such as Unreal Engine and MetaHumans can significantly impact how we learn in the future. If one is interested in seeing the possibilities of these technologies, a solid recommendation is to study YouTube content created by the user named CitizenMetaOne. Picture 16: Screenshots from YouTube videos released by a user named CitizenMetaOne show examples of polished results; however, the videos with movement, speech, and sounds bring the MetaHumans alive, showcasing the true potential.

Assessing the overall suitability of Rokoko motion capture products for content creation purposes for simulation training in the HAMK Smart research unit as a task was more demanding and more complex than it seemed at first. The assumption was that it was mainly about the utility and usability of the software, workflow, and motion capture products. However, if costs or community do not matter, the conclusion is clear; at the moment, better and more accurate products and solutions exist.



Picture 17: Overall usefulness of Rokoko products

The assessment in topic 4.2 Assessing the demonstration was compiled into one visual outcome as seen in Picture 17: Overall usefulness of Rokoko products. The compiled result can help users understand if the products are worth further examining. As a result, this should be mandatory when using the matrix. However, the visualization revealed that assessing all the products in the same matrix and visualization is not recommended. As one product´s fault will affect everything, the result is that the matrix and visualization show the worst results of all products. Therefore, the recommendation is to assess each product first as a separate, then assess all used products as a whole.

Opinion created during the whole process on why people acquire Rokoko products in the first place is its affordability, level of expectation of quality created by marketing content, interest in the indie developer scene, and non-monthly payment system. Most of the users know that they will not receive 100% precision when it comes to motion capture, but they

expect maybe 80 - 90% precision, and the rest they are acceptable to tolerate or are prepared to fix them manually. Unfortunately, the products did not deliver even 80 - 90% accuracy in our tests. The hand's distance to each other and elbow and shoulder angles were wrong, and other problems existed also. Fixing these problems manually for every animation in the target software because of the lack of tools to fix this in the source program impacts efficiency. If the plan is for daily or weekly use, the assessment from the tests is that the Rokoko products cannot be recommended unless the inaccuracies can be easily fixed in the target software. In the assessed workflows using the control rigs inside Unreal Engine was not part of the assessment, but they are still seen as a way to fix the problems to get a decent result, but the process is very time-consuming. This is dependent on where precision is needed and how precise, as some movement is captured accurately enough. Examples: For capturing position and movement seen in Picture 18: Suitable movement for capturing. Photographer Alexy Almond from service Pexels, the products suit better than position and movement seen in Picture 19: Unsuitable movement for capturing. Photographer Valeria Ushakova from service Pexels.



Picture 18: Suitable movement for capturing. Photographer Alexy Almond from service Pexels (Almond).



Picture 19: Unsuitable movement for capturing. Photographer Valeria Ushakova from service Pexels (Ushakova).

The costs to acquire Rokoko products are significantly lower than many other solutions available. Especially for indie developers, they are tempting as they usually are on a very tight budget.

From the experiences gathered during the project, research, testing, and contacting Rokoko´s customer service and their community discord, conclusions can be drawn where Rokoko could improve.

Managing customer expectation levels is the first that could be revised. Having a closed technical development road map and not having openly known errors or bug listing, the expectation level is mainly based on the marketing content. The products or software is not living up to this expectation level. Making a “Before you purchase” - video would, for example, help with this. The video could also include the possible issues that might prevent one from using the products altogether.

Another example of this is not truly understanding that a dedicated router is required for proper use of the products, and one might have to change its settings to find the wi-fi network to connect the products. Separate routers or changing settings might not be allowed or possible in environments like schools and companies with carefully planned LAN and Wi-Fi connections that a specialized department controls. Precision and possible inaccuracies are also highly recommended to be covered if this suggestion is taken into action.

The second to be revised would be openness and communications. Rokoko is branding itself to be the most customer and community-driven solution out there. It can still be so in the future, but the actions at the moment speak partly against this: Known issues/bugs listing is not visible for new or existing customers. The technical roadmap is not available for new or existing customers. One can input ideas in the function's roadmap, but all are filtered (approved/declined) by a Rokoko personnel. During this project, no suggestion that was not in line with Rokoko´s plans has been put up to be voted. None of the suggestions personally made during this project were replied to or put up to be upvoted. The community is mainly being built in their discord channel, and Rokoko´s "SoMe and Community" team is in charge of this. However, they announced that they are not in direct contact with the "customer success" department or "development teams," so their hands are tied with forwarding suggestions and feedback. One could have thought it to be the primary communication platform between users and employees, but it was told not to be so.

The Rokoko Studio supports exporting and live linking motion capture data and animations to many target software. The community appreciates many target software, but it is ambitious, and the amount of work involved to upkeep all these is significant. At points (usually after updates) getting the workflows to work again, the community had to step up and help each other out. The community is a massive asset to Rokoko, but the experience is that Rokoko is not tapping into this potential, partly at most. During the project, a software update was released, its notes or effects were not communicated to users at all at the time of release, and it broke a working workflow. The update made the products unusable and useless for two weeks for the intended workflow. From the customer, user, and developer's point of view, this was not acceptable on any level. Afterward, nothing was officially communicated about how the update was released and communicated.

There are different ways to approach the problem to fix the hand's inaccuracy. These are based on personal experiences and might not be accurate as more knowledge might be required. The first would be to look to the algorithm and try to fix this as it appears to be the source of the problem. However, fixing the algorithm is not easy and might take a long time and possibly machine learning to fix it. For the time being, alternative solutions could be to check in to the initial calibration process to have multiple poses. From which the initial readings are measured (normal, T-pose, praying pose, for example), one could choose which one to use to get the accuracy where needed. The third solution would be to create a control rig for the initial calibration pose, so one can manipulate the location and rotations of bones to get accuracy where needed in real-time.

Creating more output poses like an A-pose, which some software like Unreal Engine use as default, would be beneficial. A-pose could improve the accuracy of bone configurations with models like MetaHuman. Therefore, it would also help make the workflows easier for users.

The Rokoko product family still offers equipment and tools to create decent or ok motion-capture animations. Problems and inaccuracies exist, and some animations need more manual labor afterward than others to look decent. When comparing creating animations (body, hand, feet, face) manually from nothing with control rigs, using the Rokoko product family is a lot more efficient and quicker method even if they need manual fixing. Because of the product's low initial purchase price, they can pay back fairly quickly if hourly payments are calculated against purely manual animating. If the need is for daily or weekly motion capture or high live precision, it is recommended to look for other solutions and products, even if it means higher initial and monthly payments. At least now, it pays off in the long run, but if the accuracy of the products in Rokoko Studio is improved, this could change quickly. For random use as HAMK Smart research unit has, this is a better solution than nothing, but manual work inside target software and know-how should be planned and taken into account to achieve a decent animation. The Rokoko motion capture products will be moved into HAMK Smart research unit facilities and set up there for use.

Rokoko has announced the release of the new Smart suit 2, and they will start shipping in Q1 2022. A new version of the Rokoko Studio was unofficially announced also. There has not

been any official announcement on what this means for developing the V1 version of the products or the current Rokoko Studio. Time will tell. Rokoko has found a market gap and a need they are tapping into. Now it is up to them to make their journey a long-lasting success story that it can be, but there are also warning signs that it might end differently. From the user's point of view, all their efforts should focus on fixing the inaccuracy problems or tools to correct them; they are, after all, motion capture products.

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Attachment 1: The Design Thinking Toolbox´s Testing Sheet

Project:
Team:
Version & Date:

Brief instructions: The test of the respective prototype takes place in interaction with a potential user. The Testing Sheet makes it possible to prepare the test sequence and to document the test results. The aim is to plan the test situation and document the test results.

TESTING SHEET

More tips & tricks for this template on book page: 213



Lewrick / Link / Leifer
The Design Thinking Toolbox
978-1-119-62919-1

Description of the test scenario:
Where and how is it tested?

1

Description of the test criteria:
What are the criteria for the test?

Procedure:
Description of the process

Roles:
Description of role distribution

Questions:
What key questions should be asked?

Test results:
Documentation of the test, ideally documented with photos or short videos

2

Learnings:
Summary of findings and conclusions

3

Get a PDF Premium Design Thinking Template:
WWW.DT-TOOLBOOK.COM/SHOP

Attachment 2: Rokoko_Plugin_Setup_for_Metahuman_Mocap

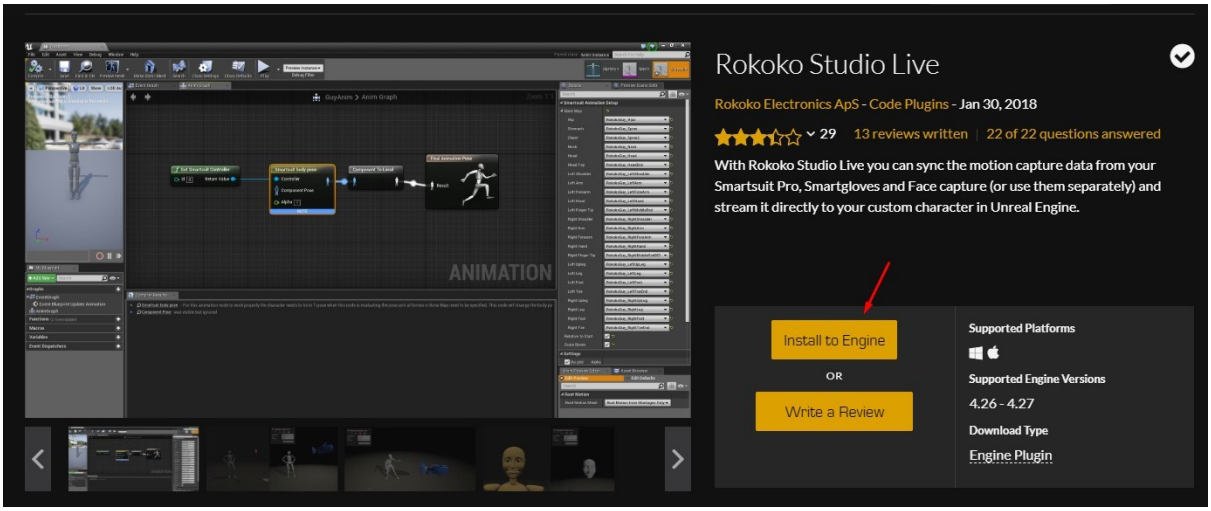
Rokoko Plugin Setup for Livestreaming to Metahumans (4.26-4.27)

Note: There might be changes for better workflow. For any issue reach us at support@rokoko.com.

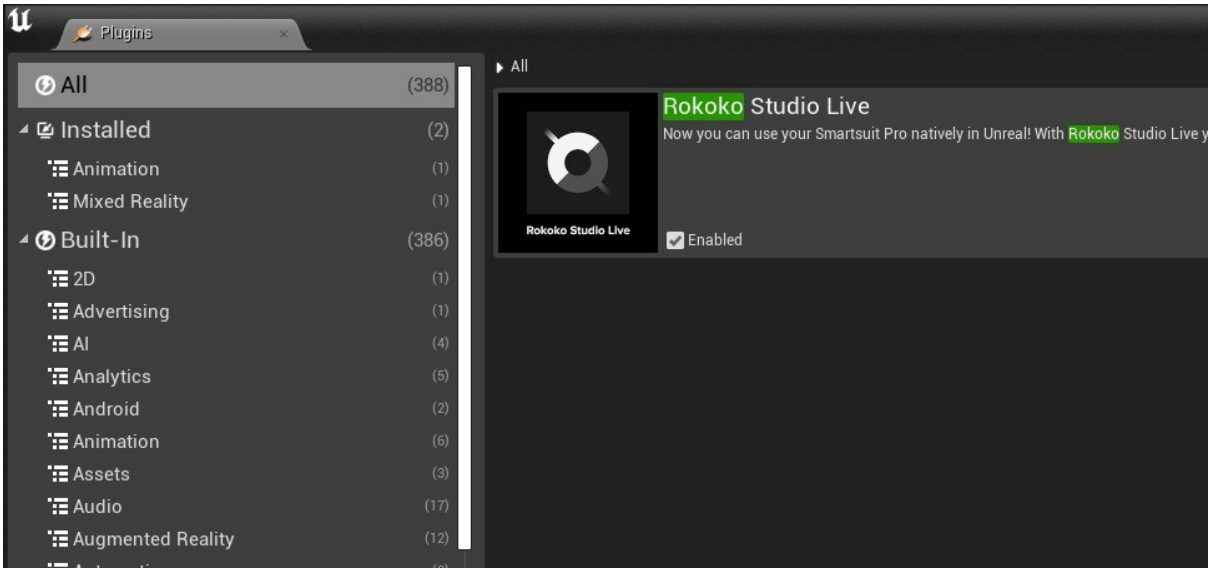
For this documentation, I downloaded and imported, in Unreal 4.27.2, the metahuman "Ada" from Quixel Bridge.

6 Setting up the Plugin

1. Uninstall ANY previous Rokoko plugin that you may have installed manually.
   (It should be in *C:\Program Files\Epic Games\UE_4.27\Engine\Plugins* as "Smartsuit" folder, delete the file)
2. Install to your current engine version(4.26-4.27) the Rokoko Plugin from Marketplace.



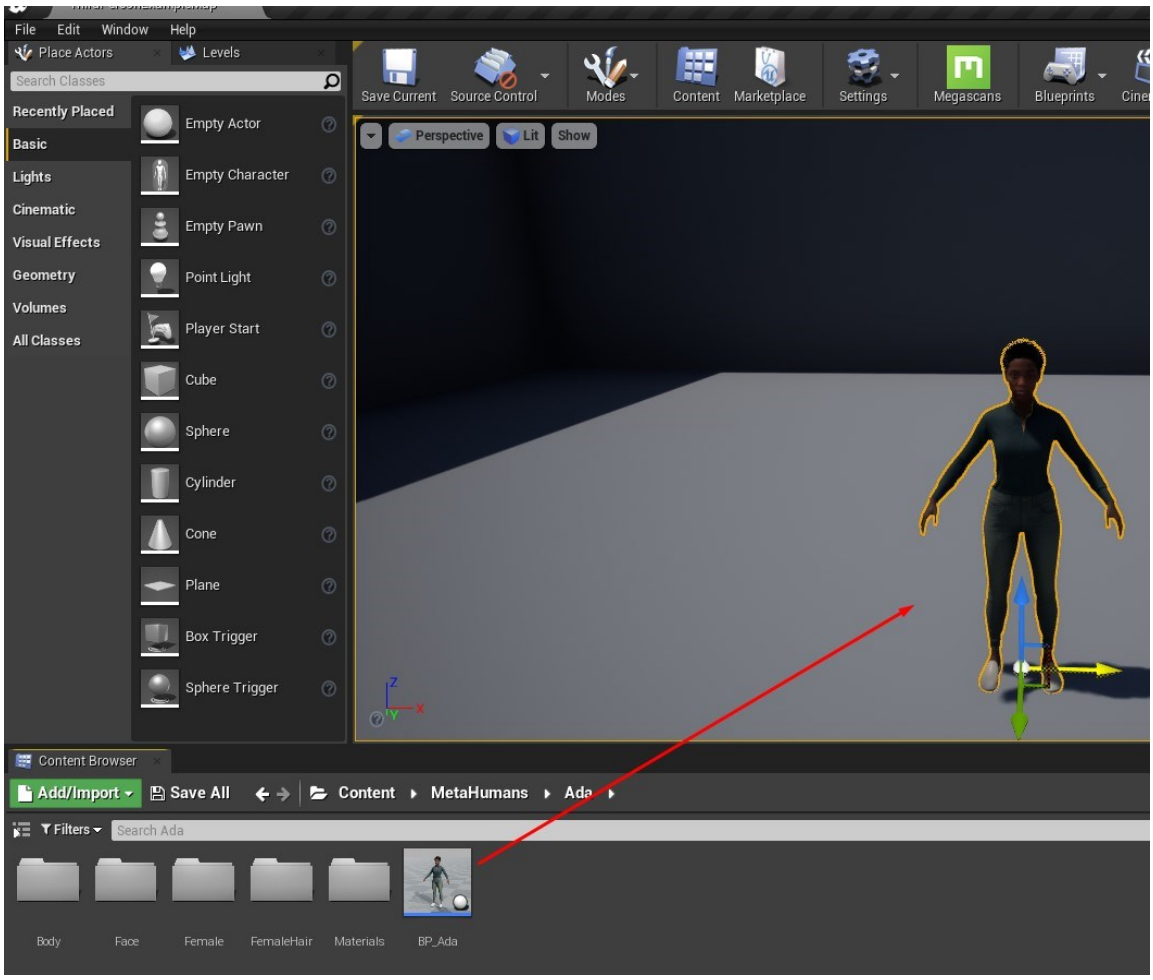
3. Launch a project. Go to Edit>Plugins and search for “Rokoko Studio Live'' and in that section make sure the “Enabled” checkbox is checked. Then, restart your project.



7 Metahuman Setup - Create T-Pose Assets

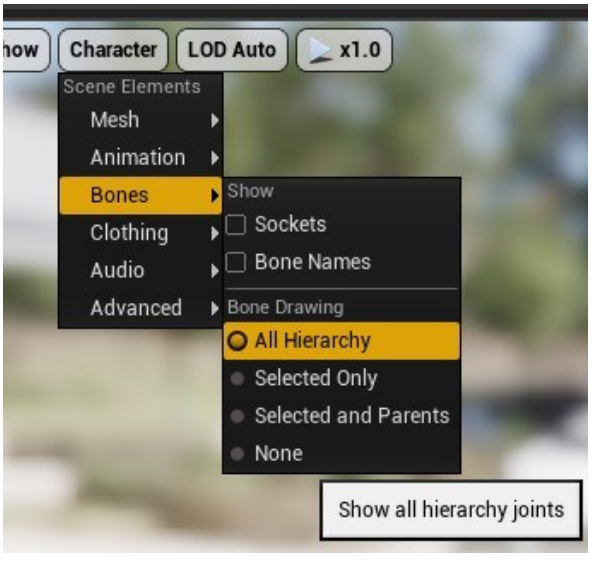
Note: This section can be found in Sam’s tutorial. (2:31-7:08)

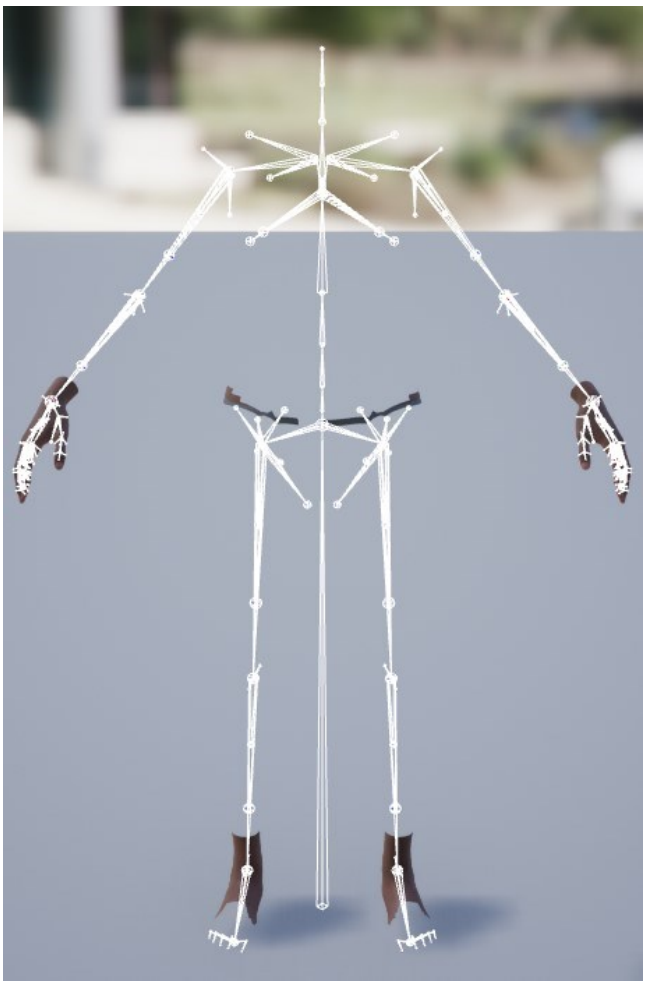
Drag and drop “BP_Ada” into the scene.(It should be in Content>MetaHumans>Ada)



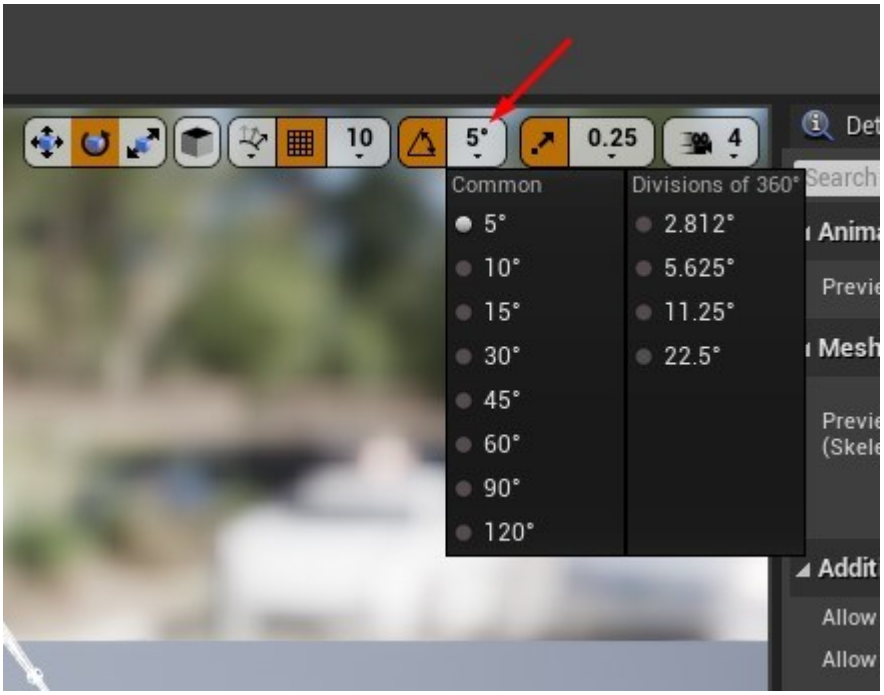
Body T-Pose Asset

1. Navigate to: Content>MetaHumans>Common>Female>Medium>NormalWeight>Body)and open the “metahuman_base_skel” Skeleton.
2. Navigate to Character>Bones>All Hierarchy to show all the bones.

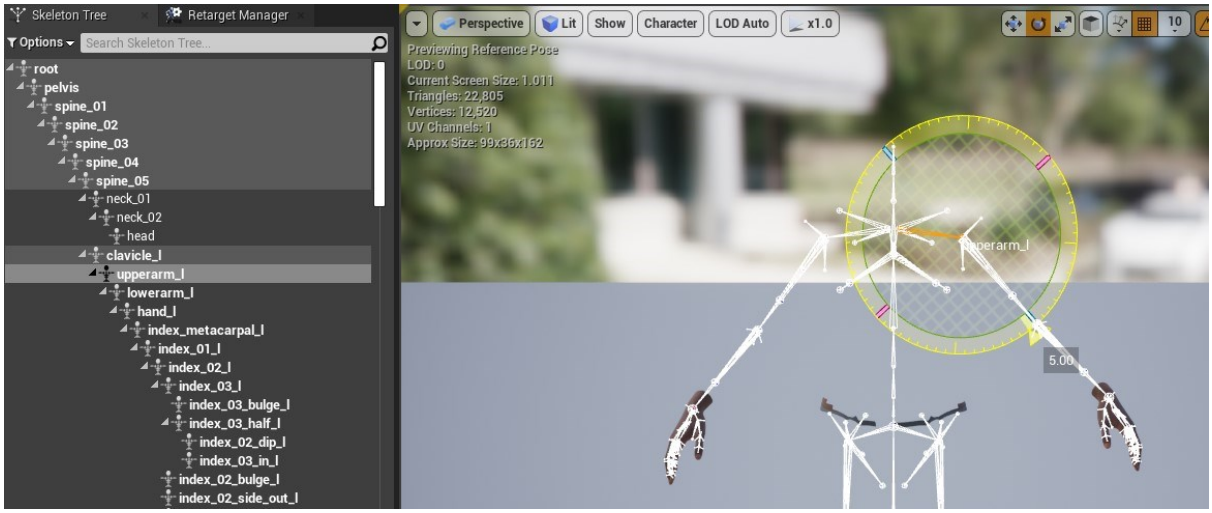




3. Set the Rotation Grid Snap value as 5°.



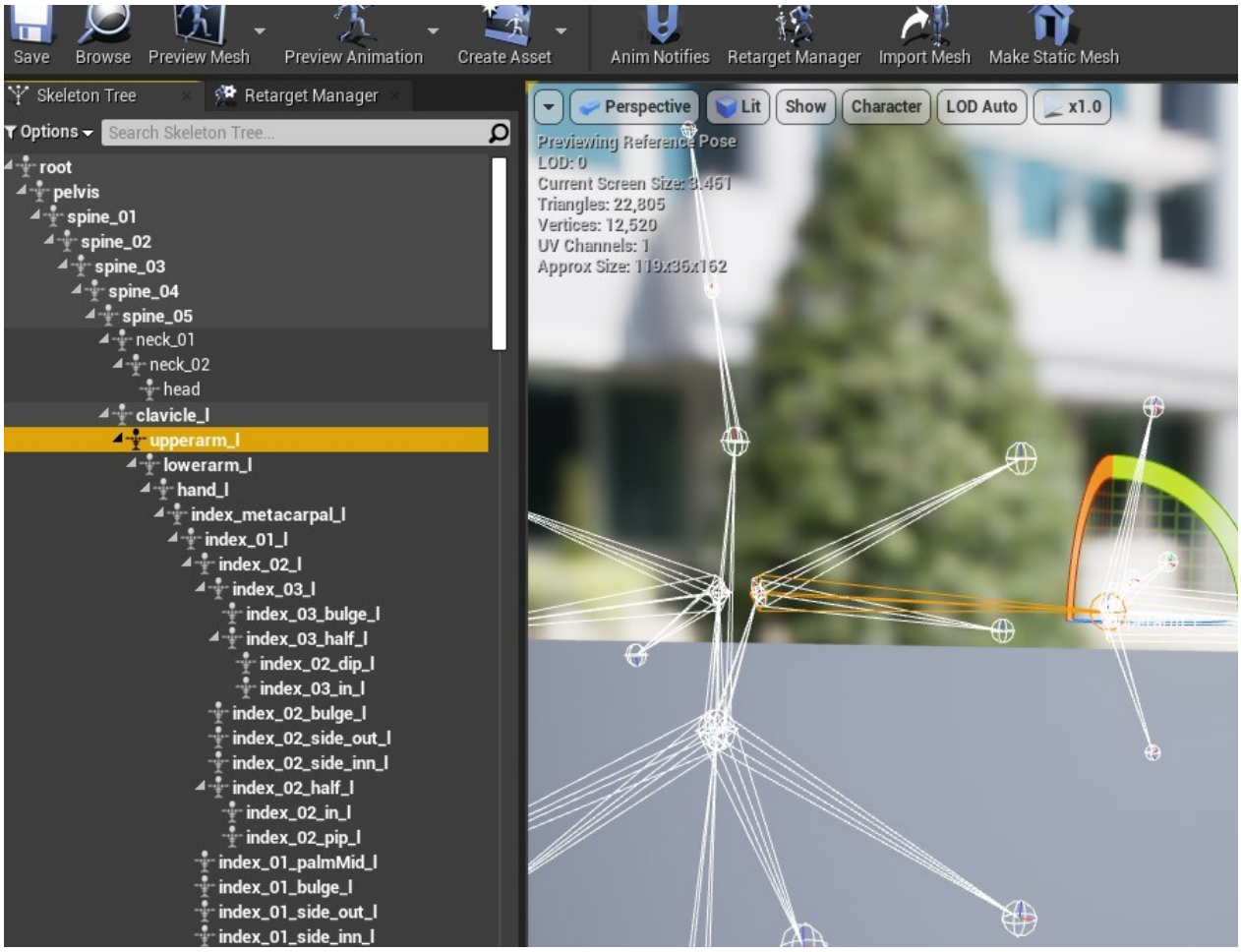
4. Select the “clavicle_l” bone from the Skeleton Tree and rotate it +5° in Y axis.

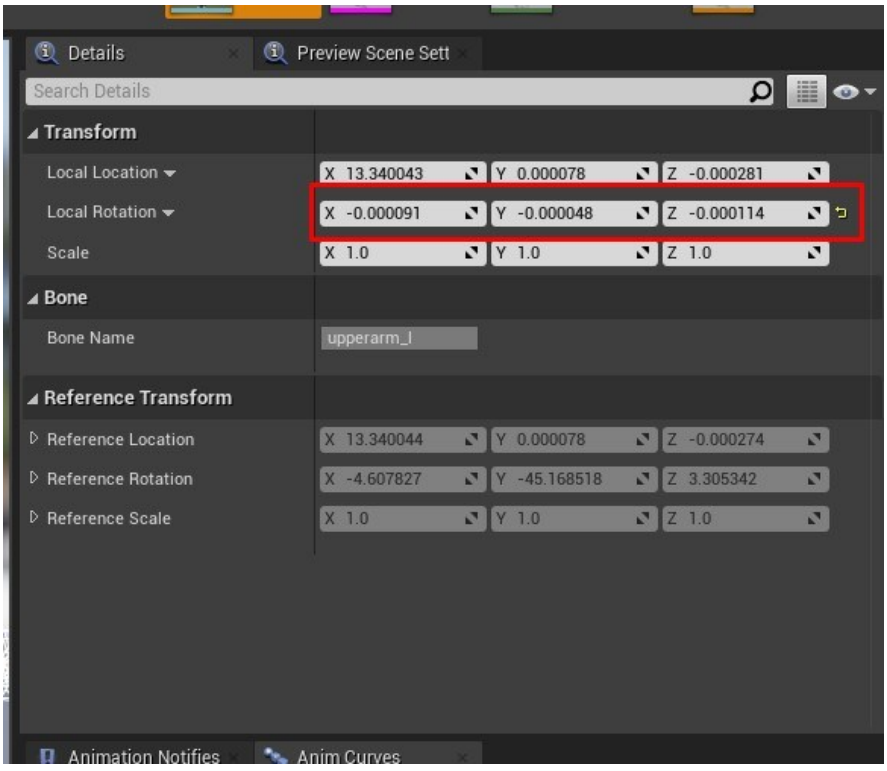


5. Select the “upperarm_l”, “loweraram_l” and “hand_l” bones and set their Local Rotation as 0. Local Rotation can be found in the top-right details panel. (see the picture below)

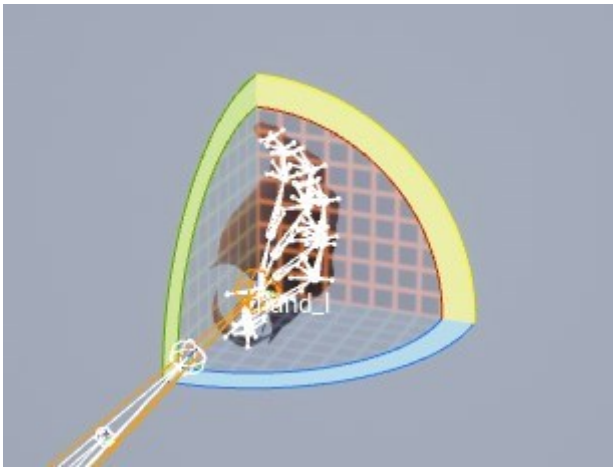
   Note: Apply this procedure for each bone, do not select all of them!

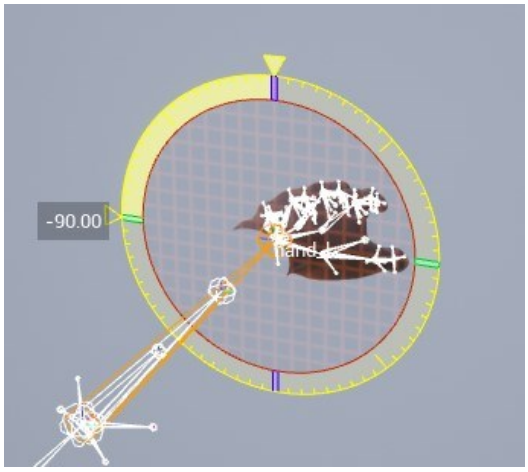
Do not worry about long integers. Eg 0.000057.

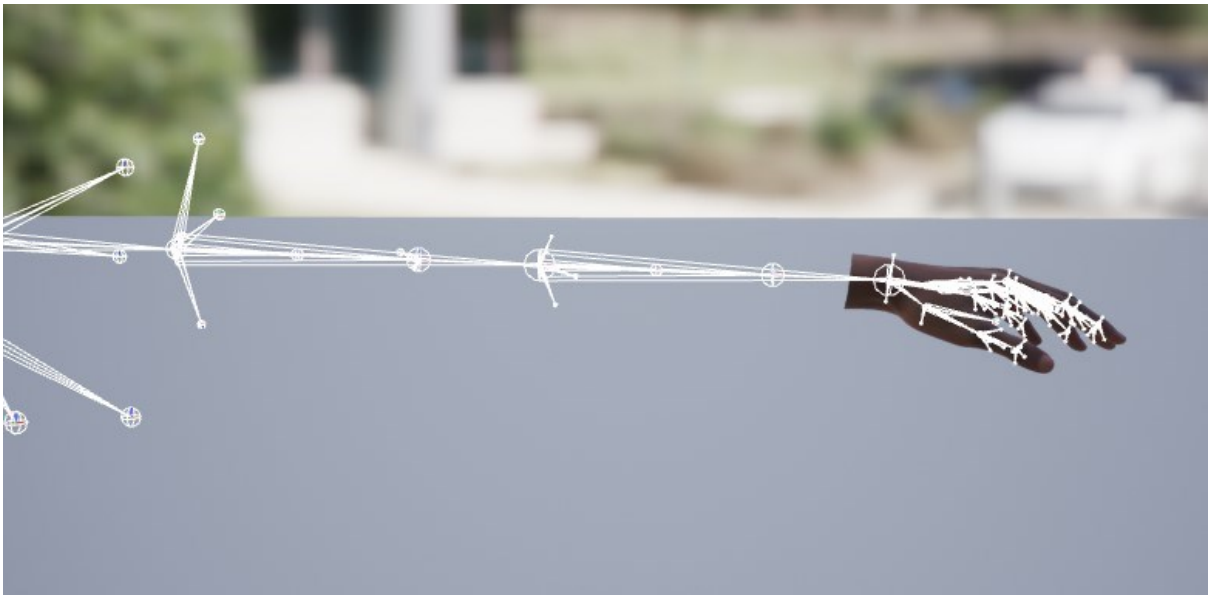




6. Rotate “hand_l” bone -90° in X axis.



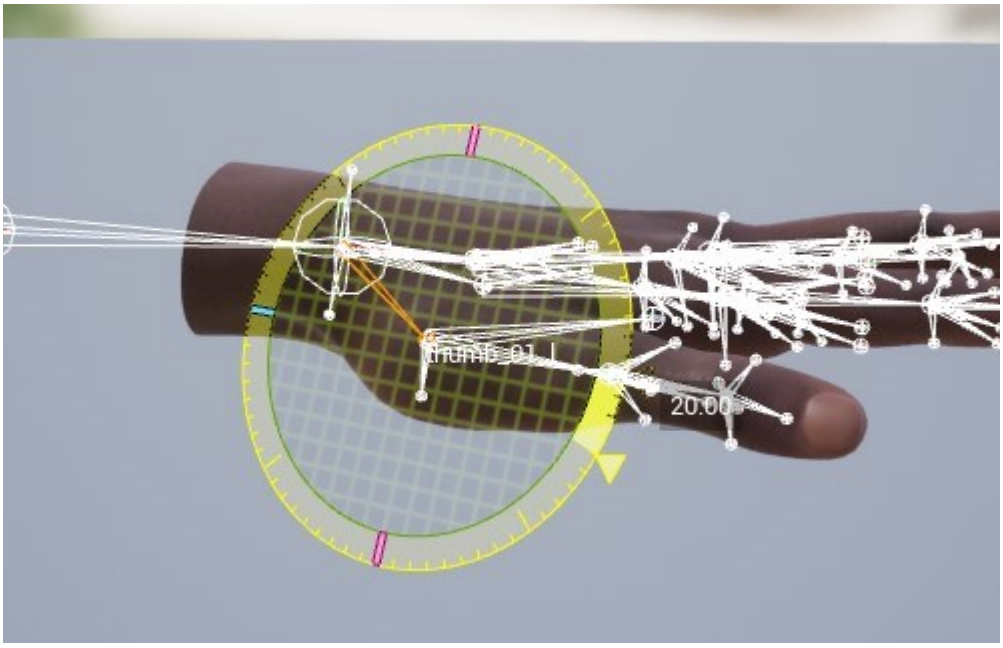




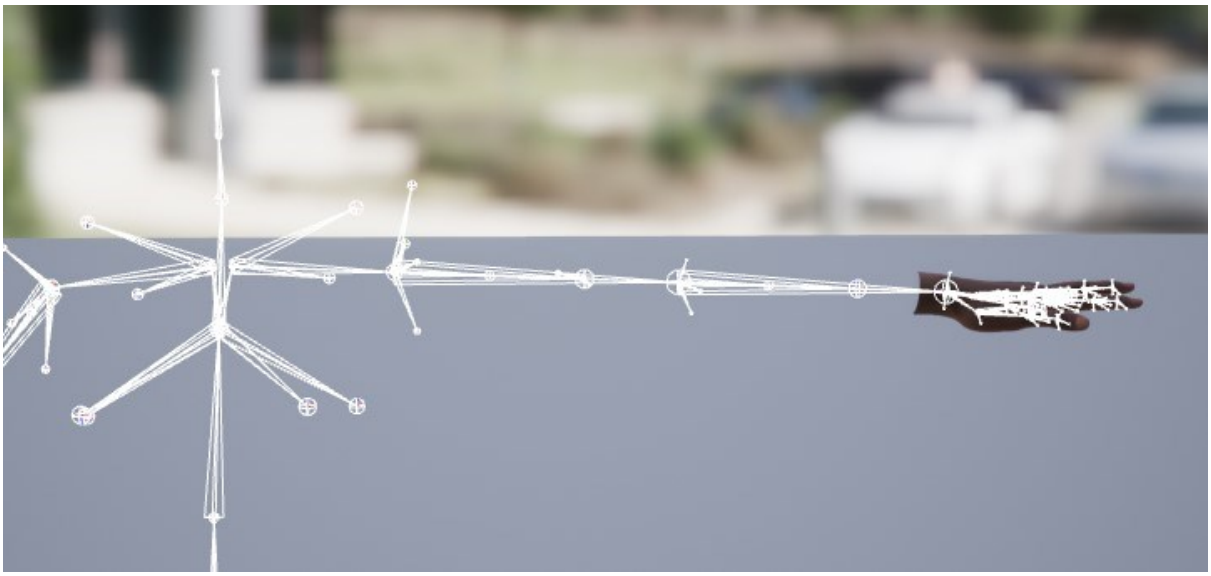
7. Now that the arm is flat, fingers need to be flat, too. Set the Local Rotation as 0°, like before, in these bones:

index_01_l	index_02_l
middle_01_l	middle_02_l
pinky_02_l	pinky_02_l
ring_01_l	ring_01_l
thumb_02_l	thumb_03_l

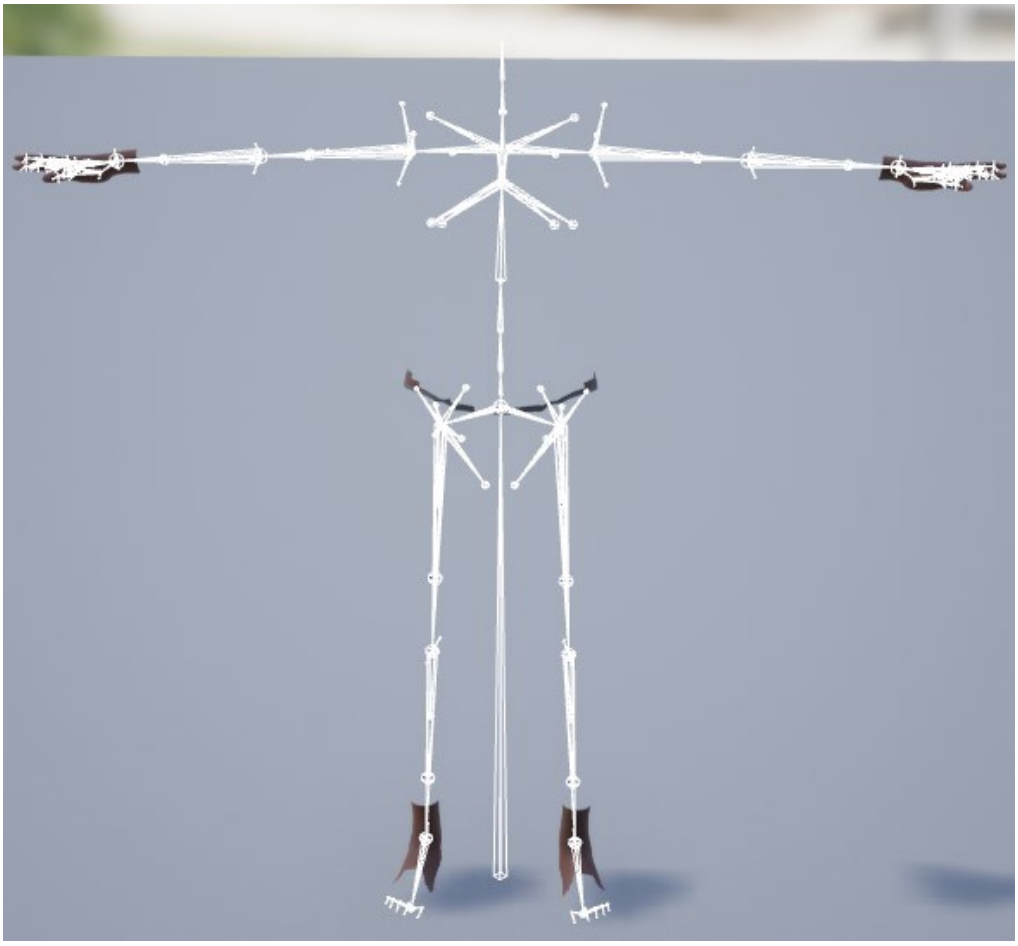
For the “thumb_01_l”, rotate it by +20° in the Y axis.



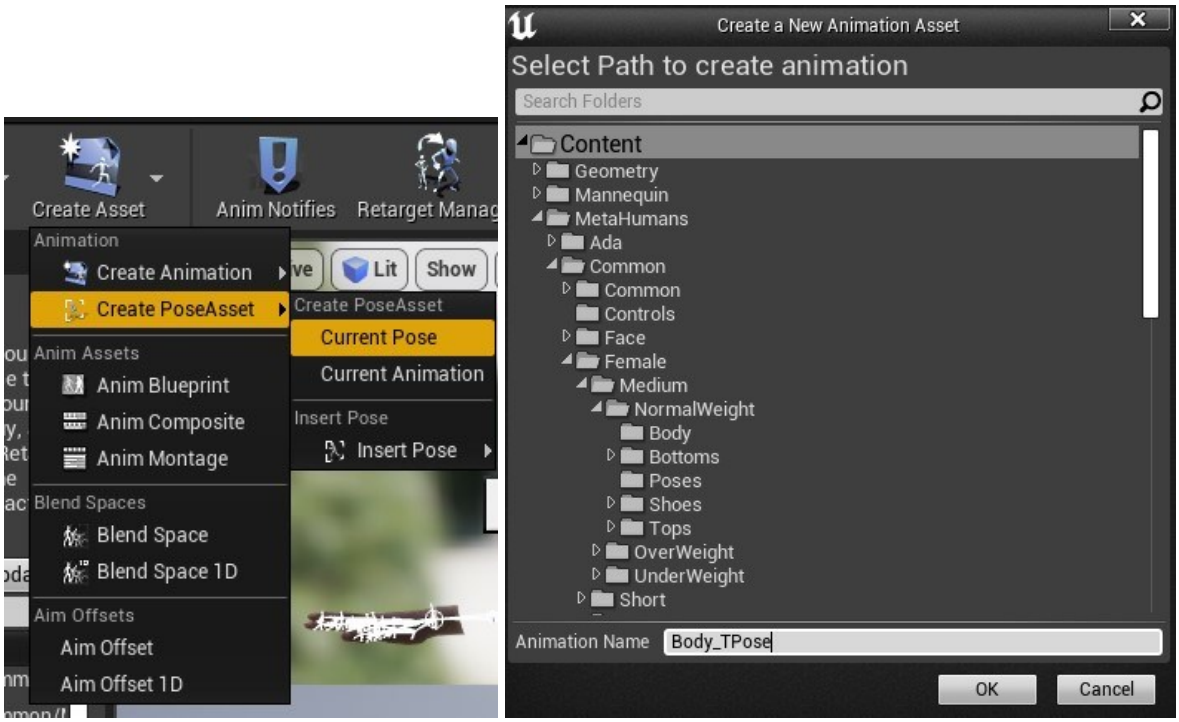
Finally, the Metahuman's left arm will look like this:



Repeat the same procedure for the Right-Hand, so your Skeleton will appear such as:



8. On the top bar, select Create Asset>Create PoseAsset>CurrentPose, name it something like “Body_TPose” and press “OK”. (I ‘ll save it in the content folder, for easy access)



Face T-Pose Asset

1. Navigate to Content>MetaHumans>Common>Face and open the “Face_Archetype_Skeleton” Skeleton.
2. In this skeleton only 4 bones need to be processed:

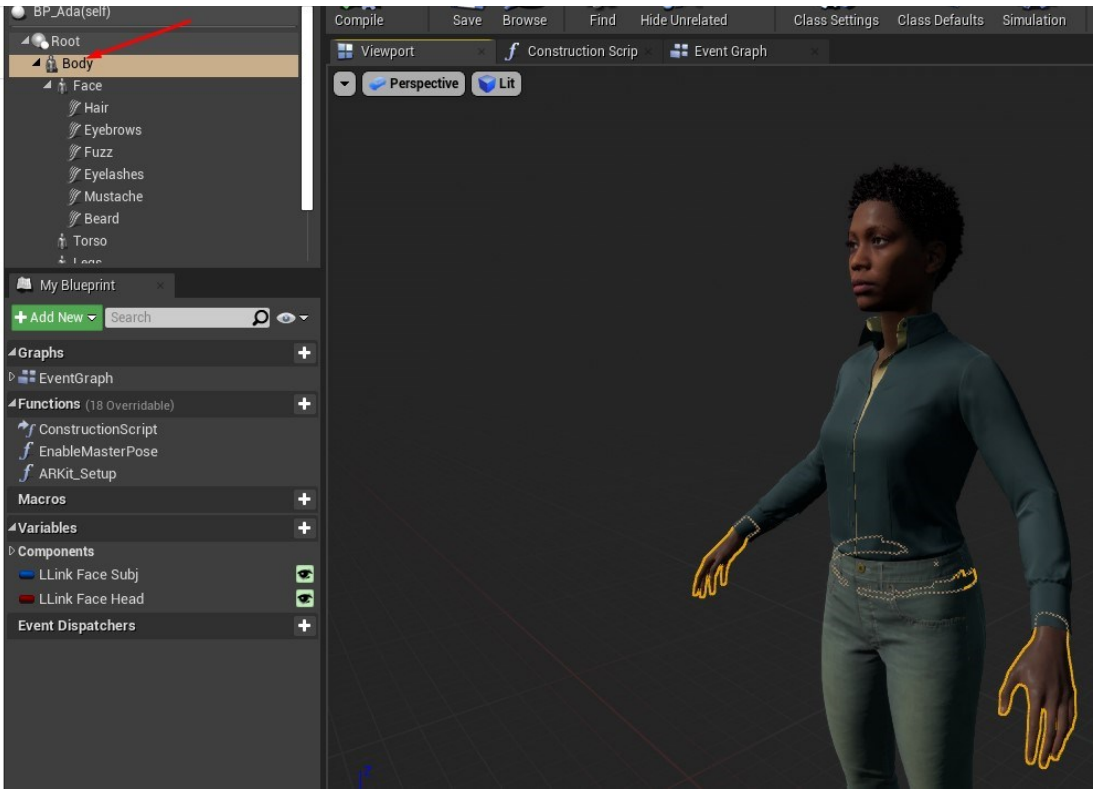
clavicle_l	Rotate by +5° in Y axis
upperarm_l	Set the Local Rotation as 0° in X-Y-Z axis
clavicle_r	Rotate by +5° in Y axis
upperarm_r	Set the Local Rotation as 0° in X-Y-Z axis

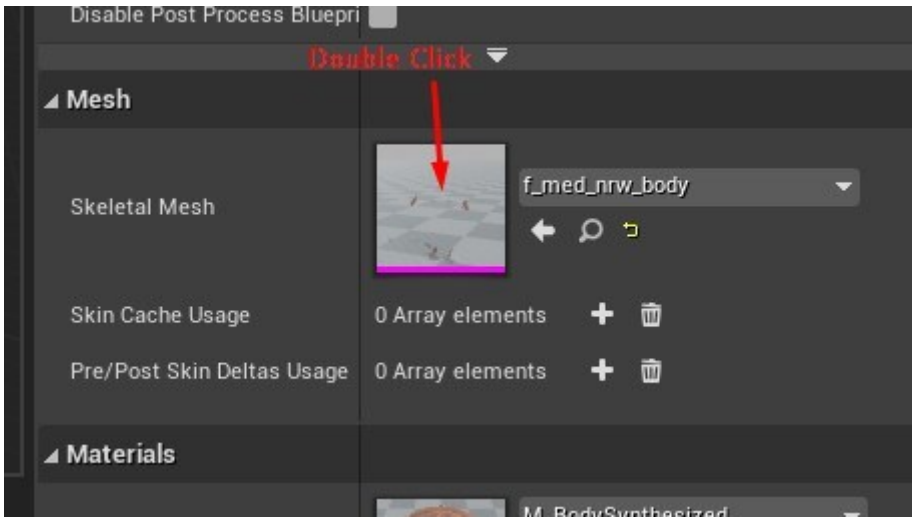
Then, Create Asset>Create PoseAsset>Current Pose, name it something like “Face_TPose '' and press ''OK”.

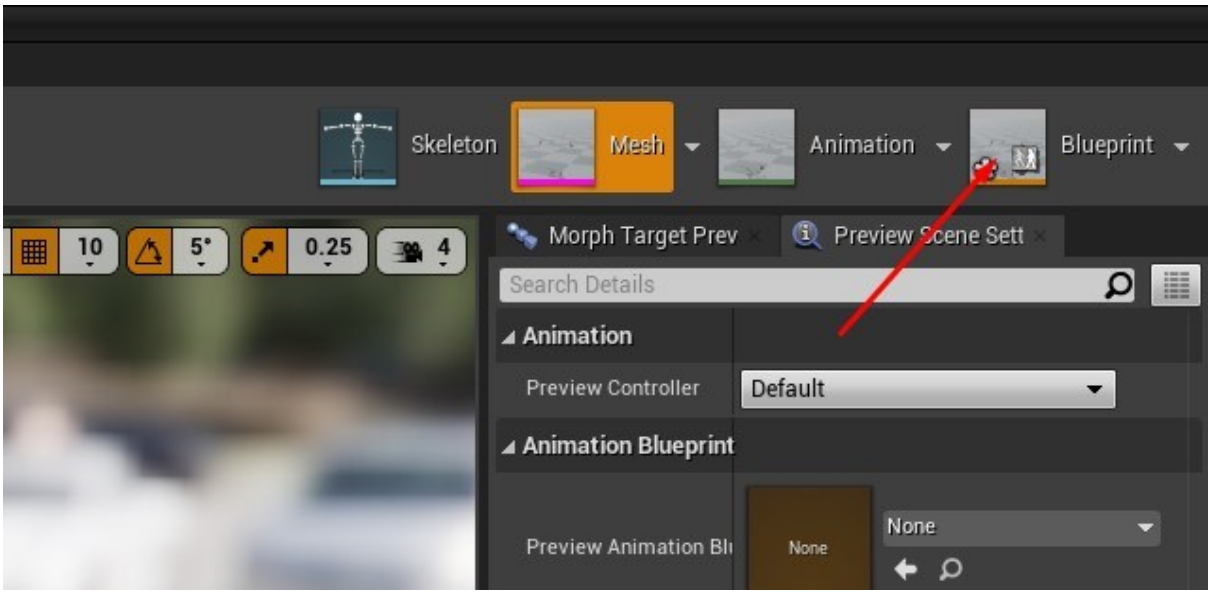
(I ‘ll save it in the content folder, for easy access)

8 Metahuman Setup for Body Capture

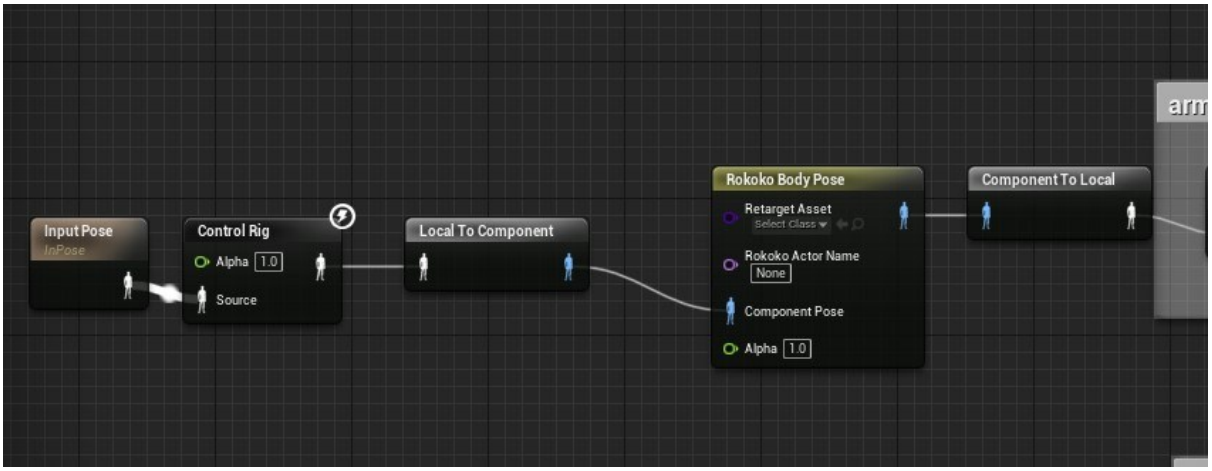
1. On the “BP_Ada”, select on top-left the “Body” and double click on the skeletal mesh(middle-right), to open the Skeleton. Then, go to the Animation Blueprint, on top-right.



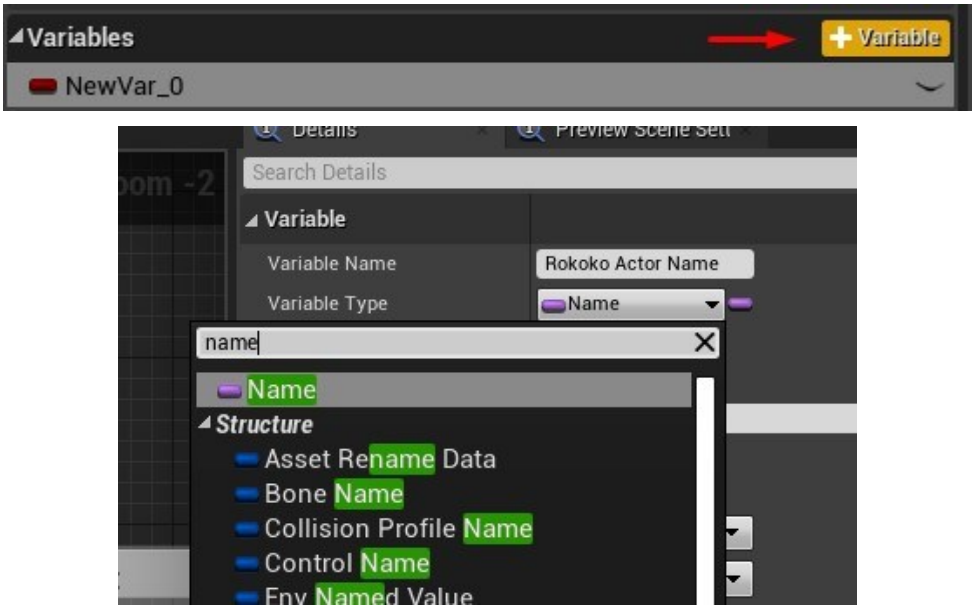




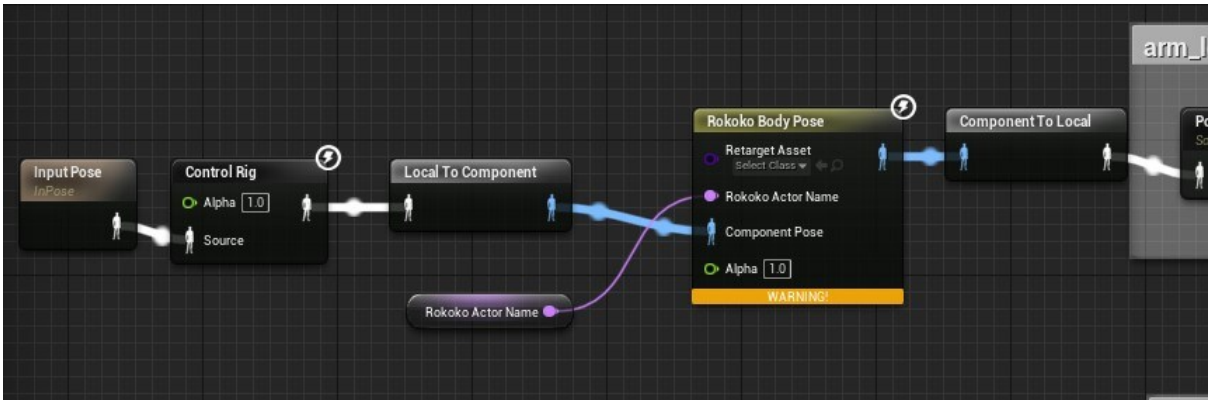
2. In the AnimGraph create a “Rokoko Body Pose” node and connect the pins as shown below (The “Local to Component” and “Component to Local” will appear automatically. You can manually create them, too)



3. Create a variable, set it as Name and name it something like Rokoko Actor Name.

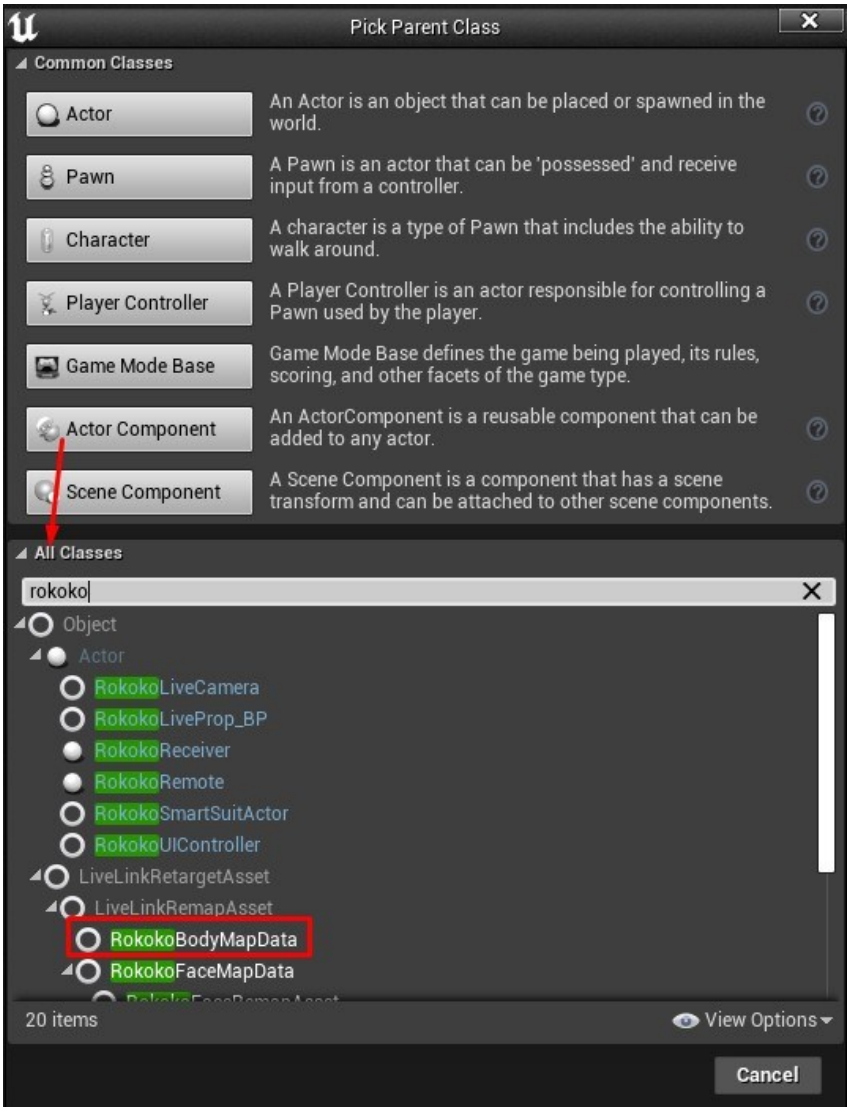


4. Drag “Rokoko Actor Name” into the graph, select “get Rokoko Actor Name” and connect it to the “Rokoko Body Pose” input.



5. In the Content folder, right-click, select Blueprint Class, expand the “All Classes” tab, type Rokoko and select “RokokoBodyMapData”.

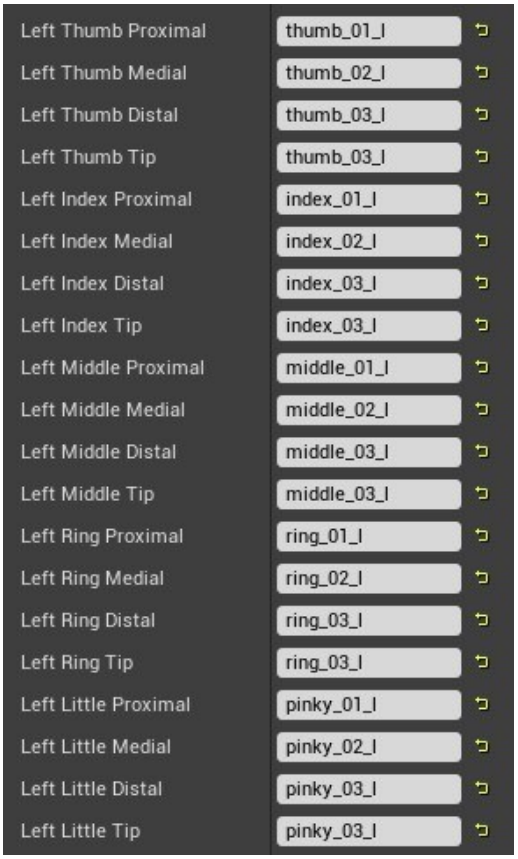
   Name it something like “character_boneMap”.

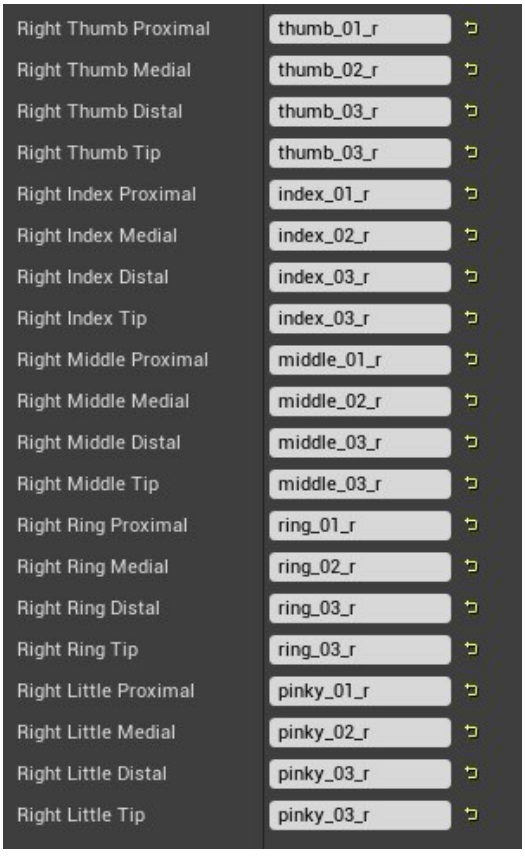


6. Open the “character_boneMap” blueprint and write the names of the corresponding joints in the hierarchy.

   “Ada” bone map setup(“metahuman_base_skel” Skeleton):

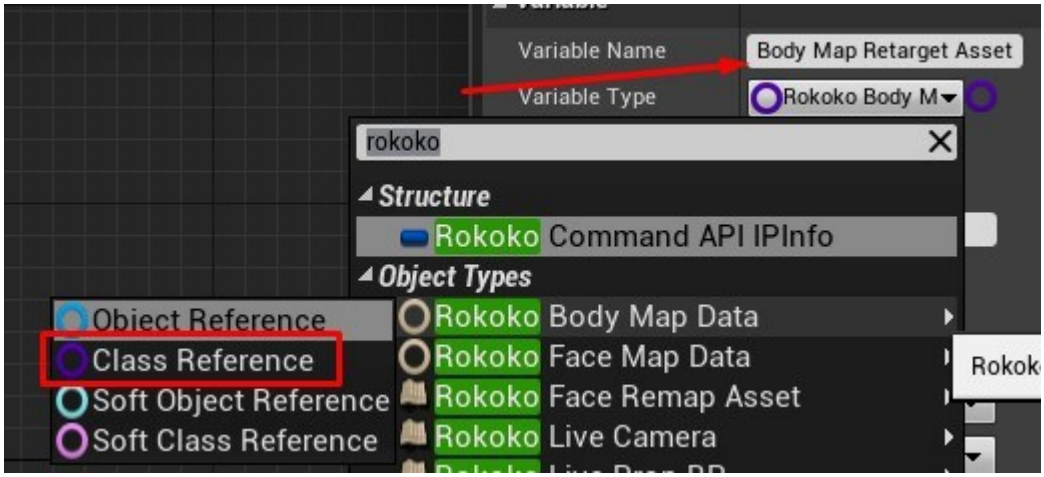




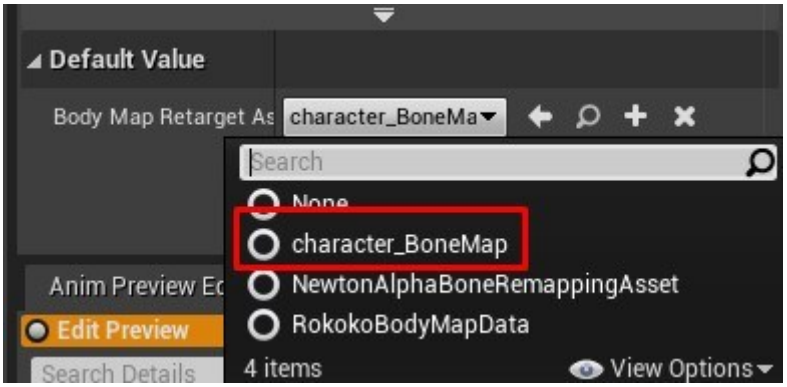


Then, hit compile and save.

7. Back on the “f_med_nrw_animbp” animation Blueprint, create a variable, set it at “Rokoko Body Map Data” **class reference** and name it something like “BodyMapRetargetAsset”.

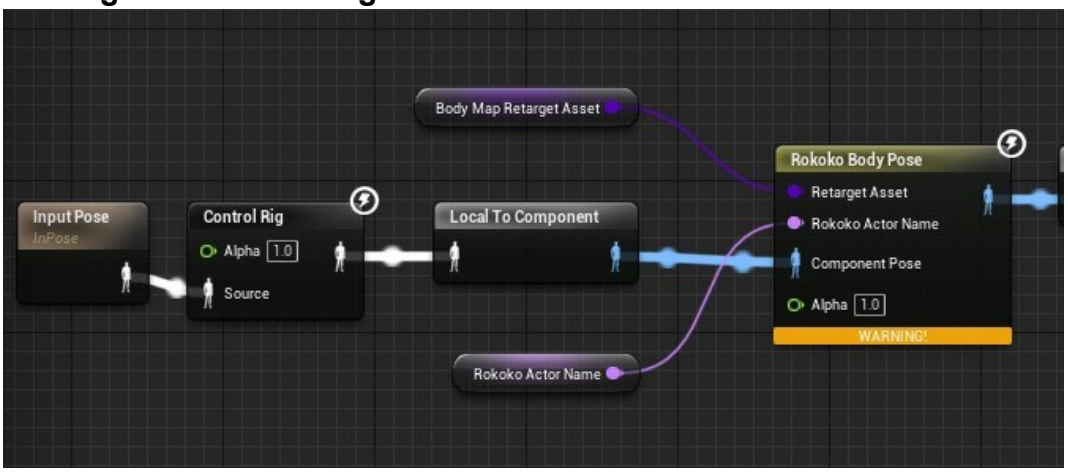


Compile and set its default value to the bone map you just created.

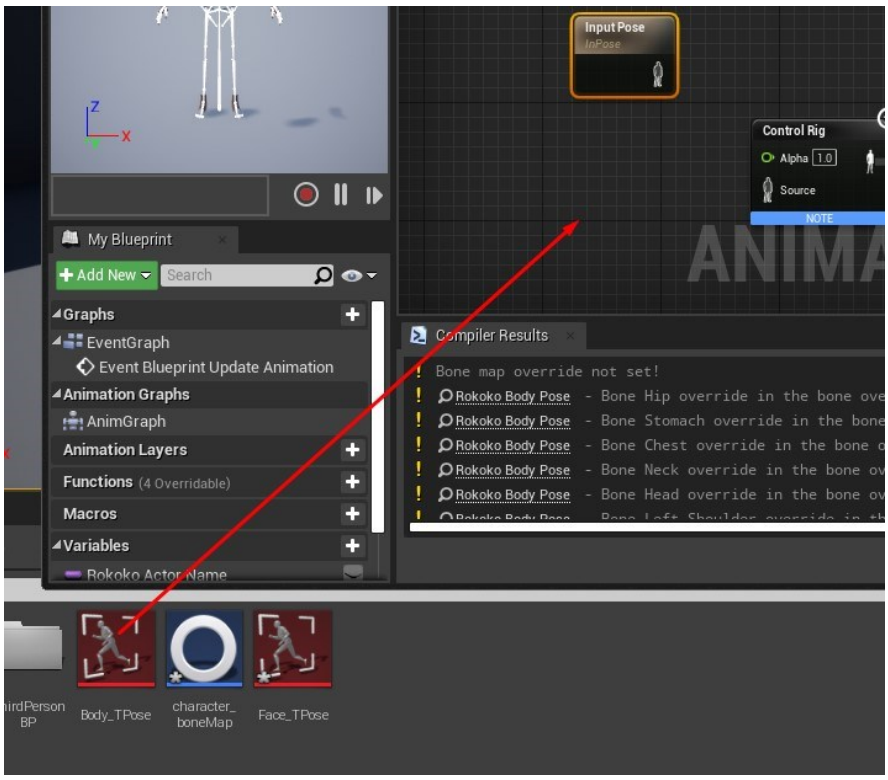


Drag it into the AnimGraph, select “get “BodyMapRetargetAsset” and connect it to the “Rokoko Body Pose” input as shown:

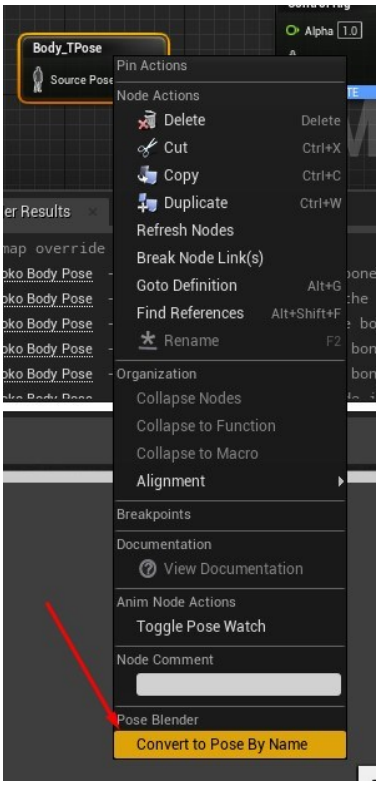
Note: Ignore the warnings!



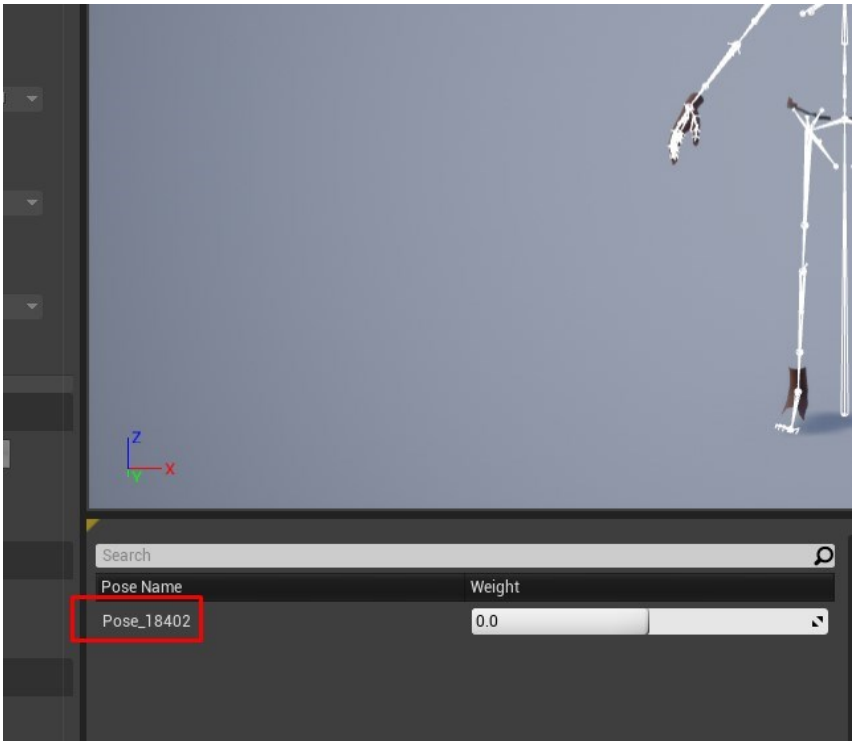
8. Drag and drop the “Body_TPose”, you created some steps before, into the AnimGraph.



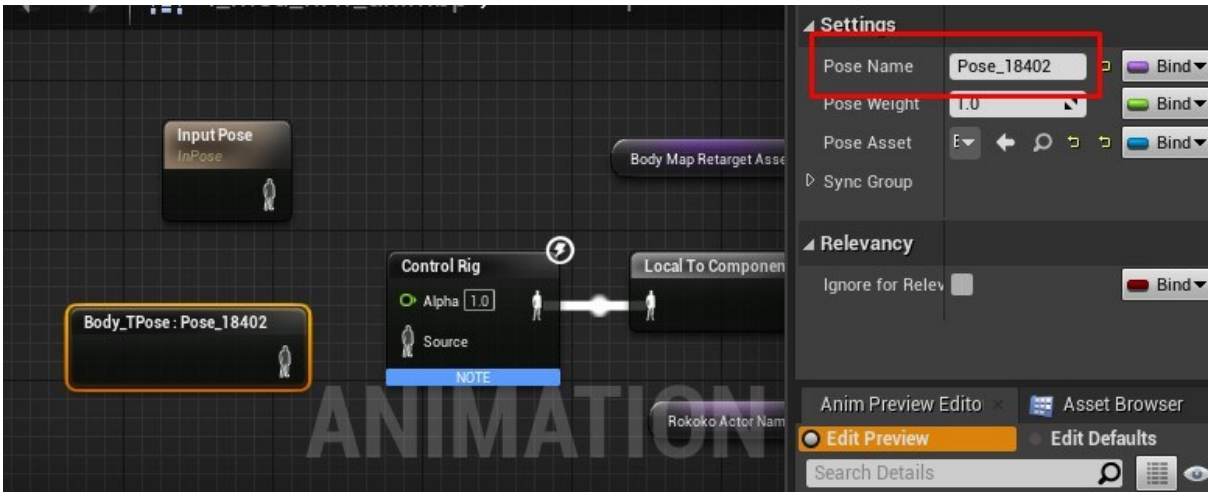
9. Right click on the Body_TPose, inside AnimGraph, and select on the bottom of the window “Convert to Pose By Name”.



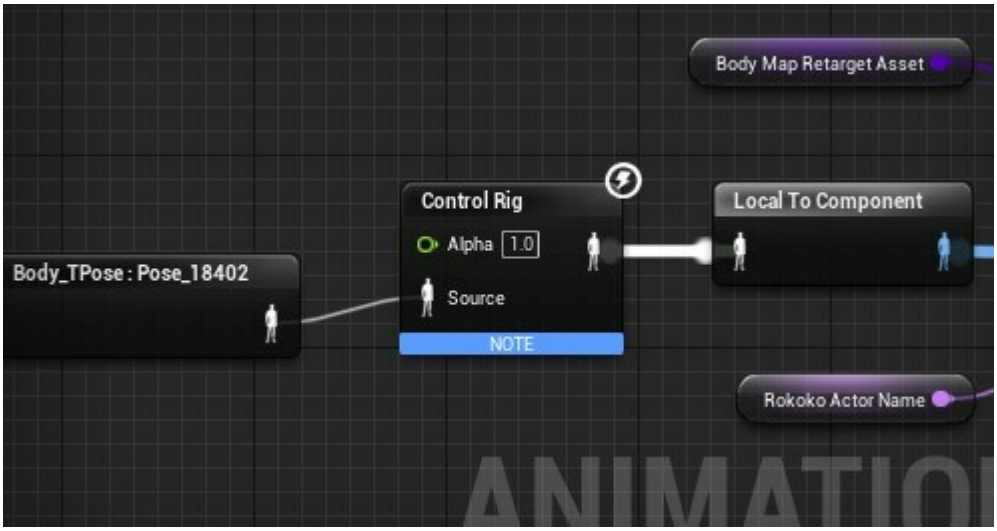
If you open the “Body_TPose” in the content browser, you will notice the “Pose Name” with a number. **Most of the time, it's different in your case**.



10.Back on the AnimGraph select the “Body_TPose” and in the Details panel(top-right), set the Pose Name as in the “Body_TPose”.



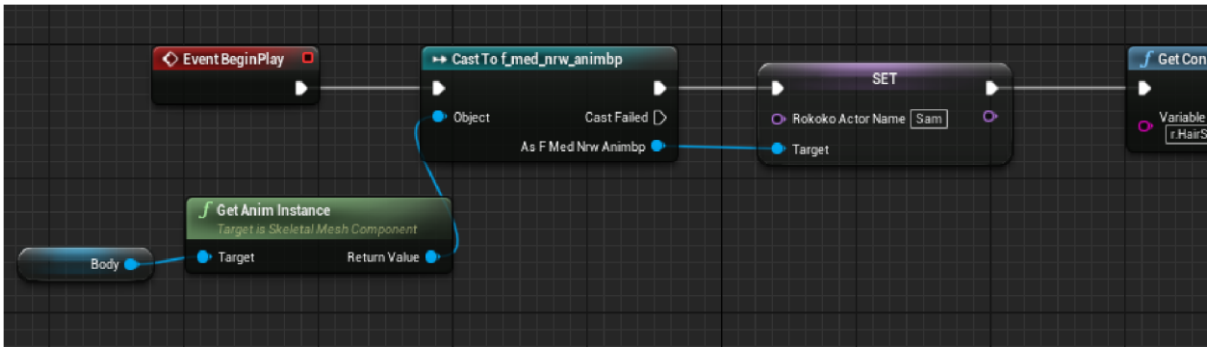
11.Connect the “Body_TPose” in “Control Rig” node and delete the “Input Pose”.



You will notice that in the Animation Blueprint live preview, the mesh is set as T-Pose.

Note: Ignore the warnings!

12. Open the “BP_Ada” blueprint. Go to the event graph and on top-left drag the ‘Body’ mesh to the graph. From its pin, drag and create a “Get Anim Instance” node. From its pin,drag and create a “Cast to f_med_nrw_animbp” node. From “Cast to f_med_nrw_animbp” blue pin drag and create a “Set Rokoko Actor Name”. Set the

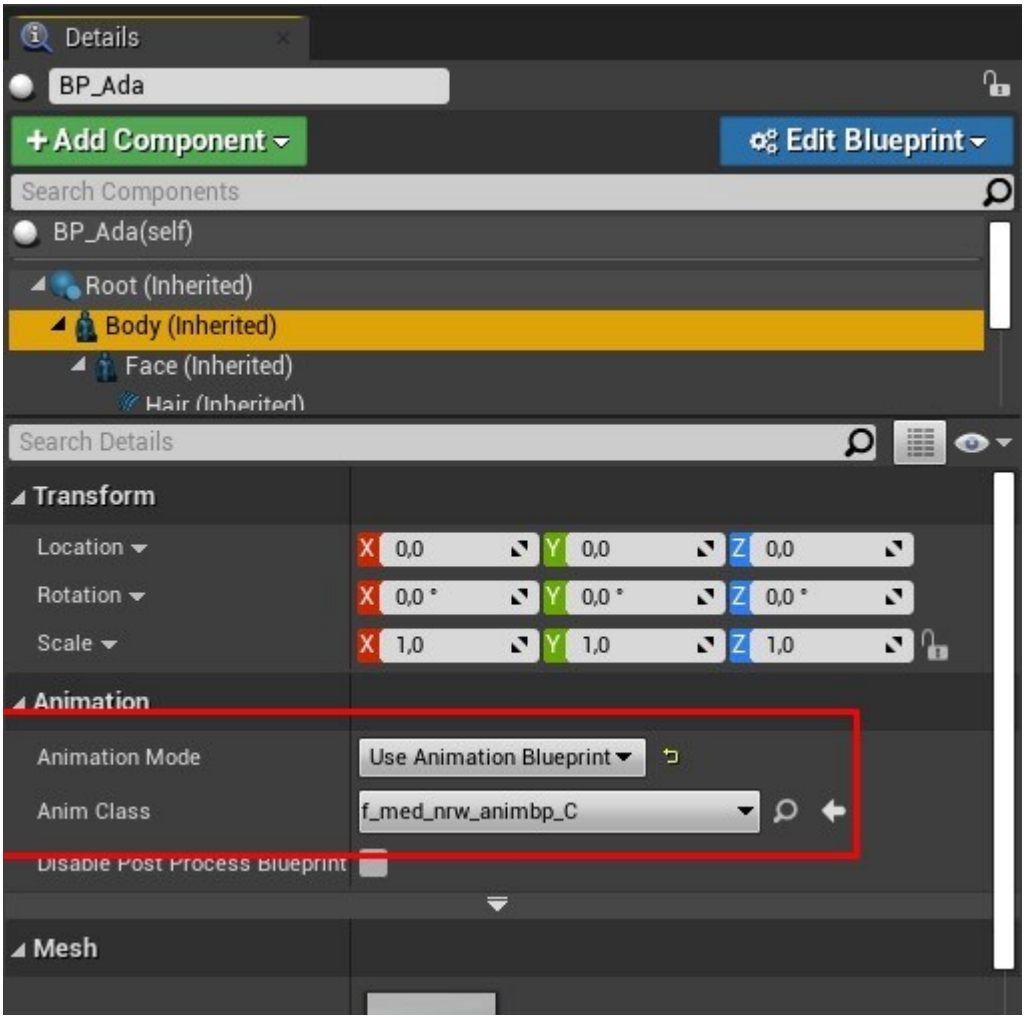


name as it is on your Actor Profile in Rokoko Studio. Connect the rest pins.

Compile and Save the Blueprint.

13. Finally, in Unreal’s viewport, select the “BP_Ada”, select ‘Body’ mesh ,and in the Details panel, go to the Animation section(above the Mesh section). Select the

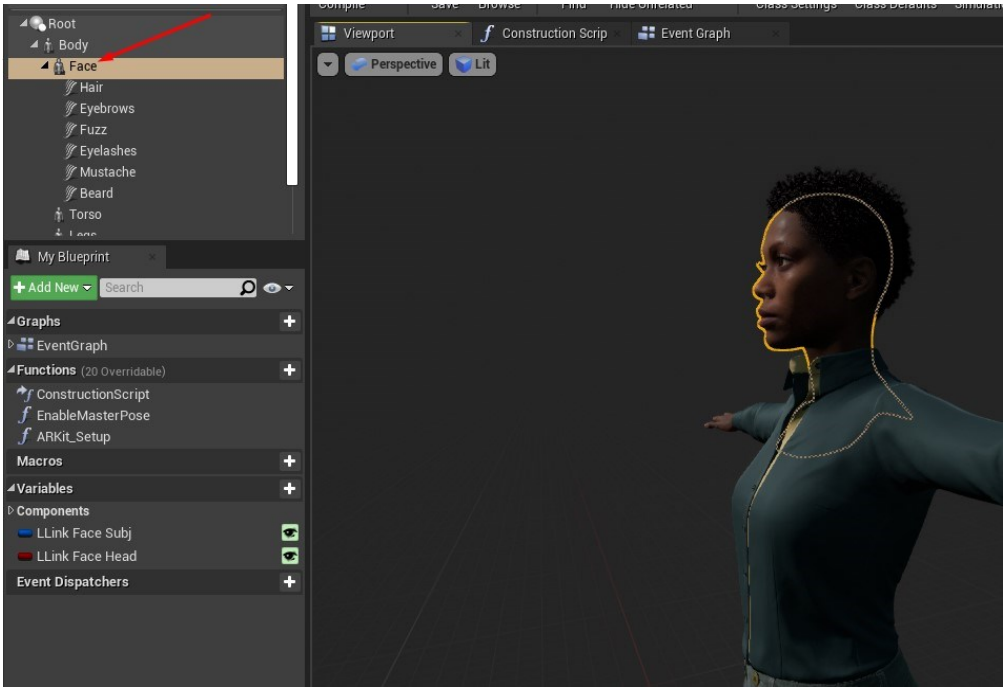
Animation Mode as “Use Animation Blueprint”, and the Anim Class as “f_med_nrw_animbp”.

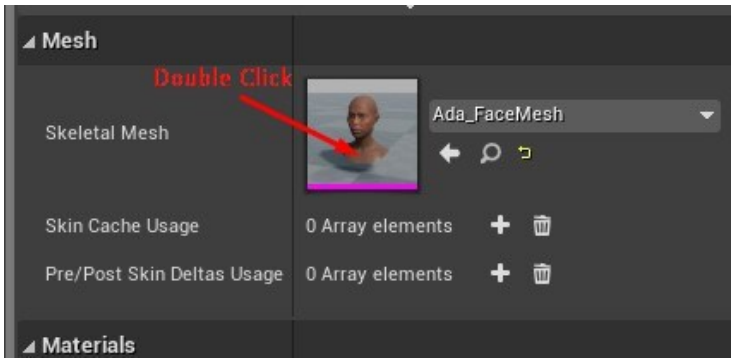


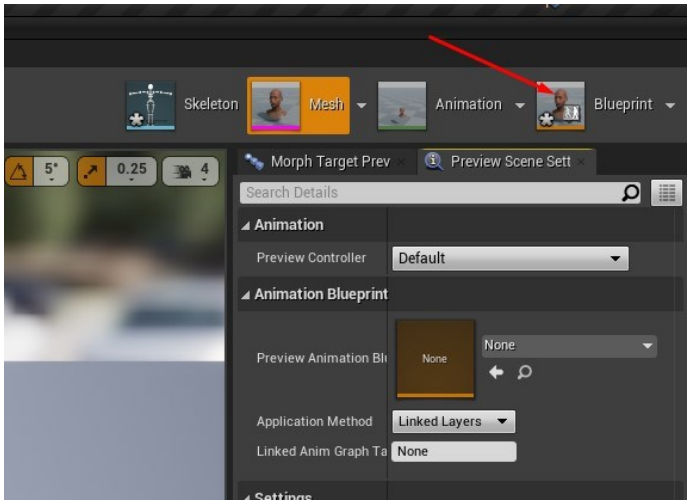
Note: If you delete your metahuman from viewport and re-drag it again, you may need to re-set Animation Mode and Anim Class.

9 Metahuman Setup for Face Capture

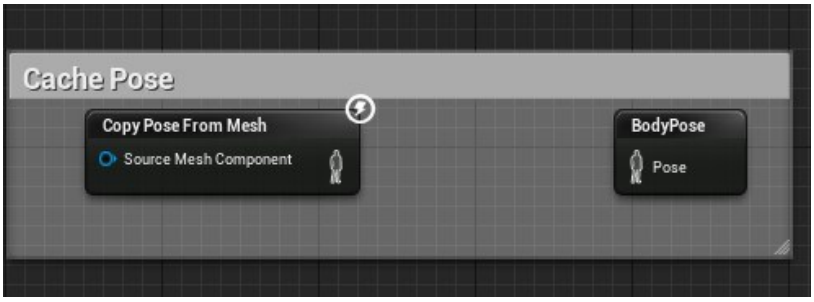
1. On the “BP_Ada”, select on top-left the “Face” and double click on the skeletal mesh(middle-right), to open the Skeleton. Then, go to the Animation Blueprint, on top-right.





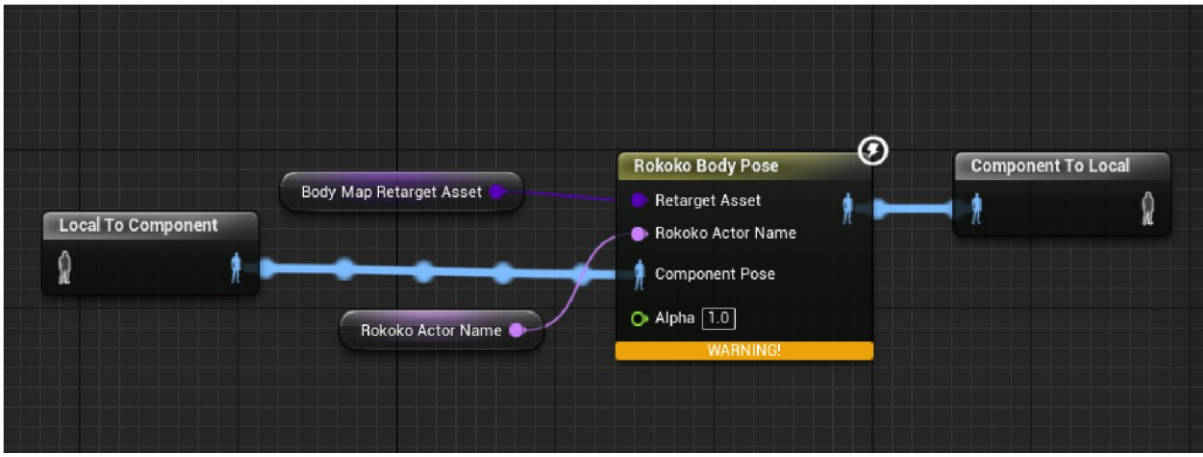


2. Remove the connection from these nodes as shown:

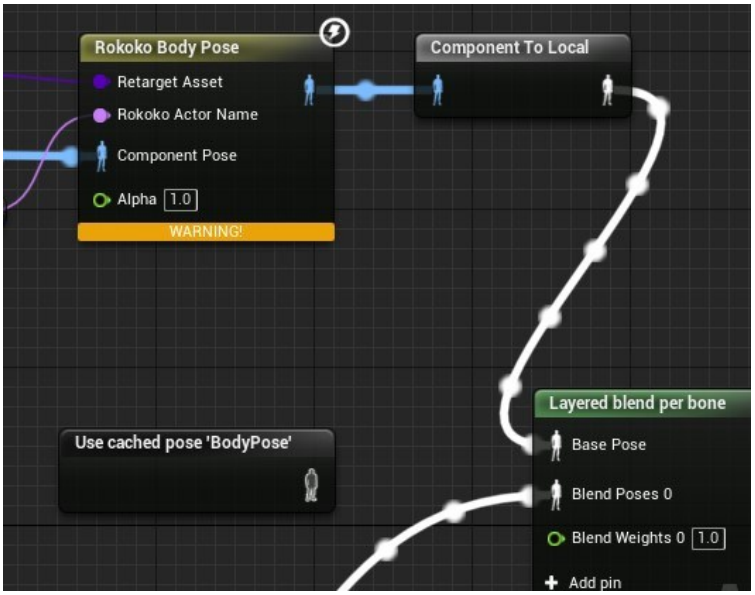


3. Then, do the exact same thing as for “f_med_nrw_animbp”.

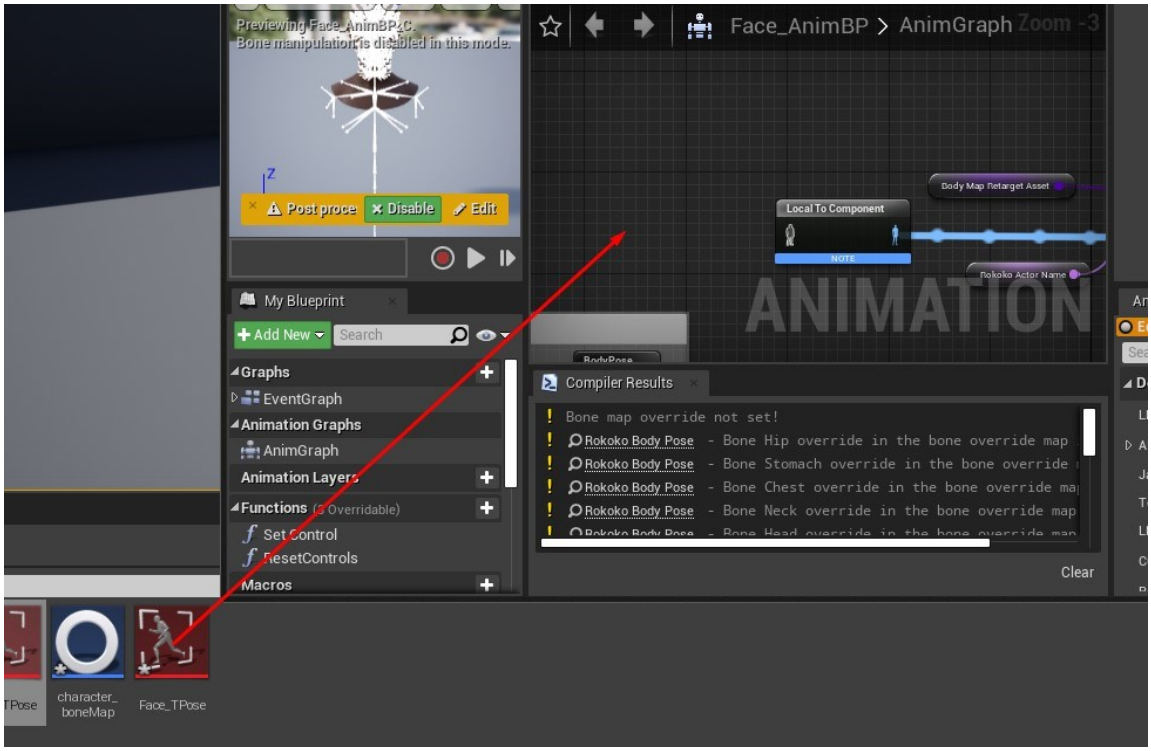
   Create a Rokoko Body Pose, a “Name” variable, a “Rokoko Body Map Data” **as class reference** variable, compile and set its default value to the bone map you just created and connect them.



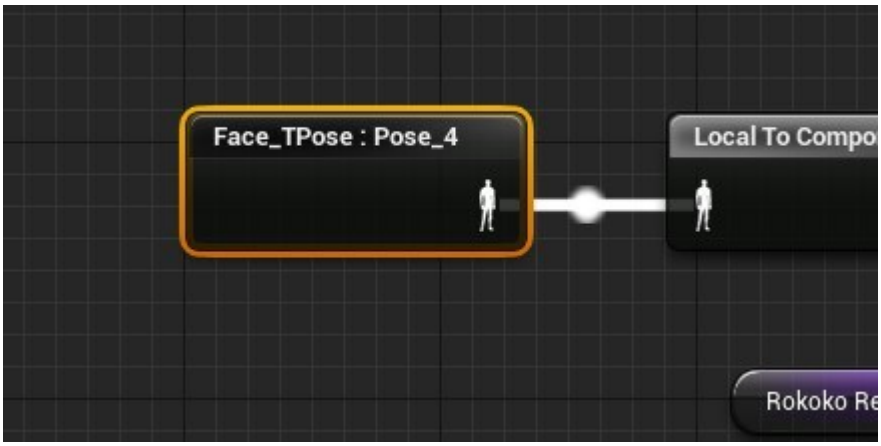
4. Connect the “Component to Local” output to “Layered blend per bone”input:



5. Drag the “Face_TPose” from the content browser to the Face_AnimBP.

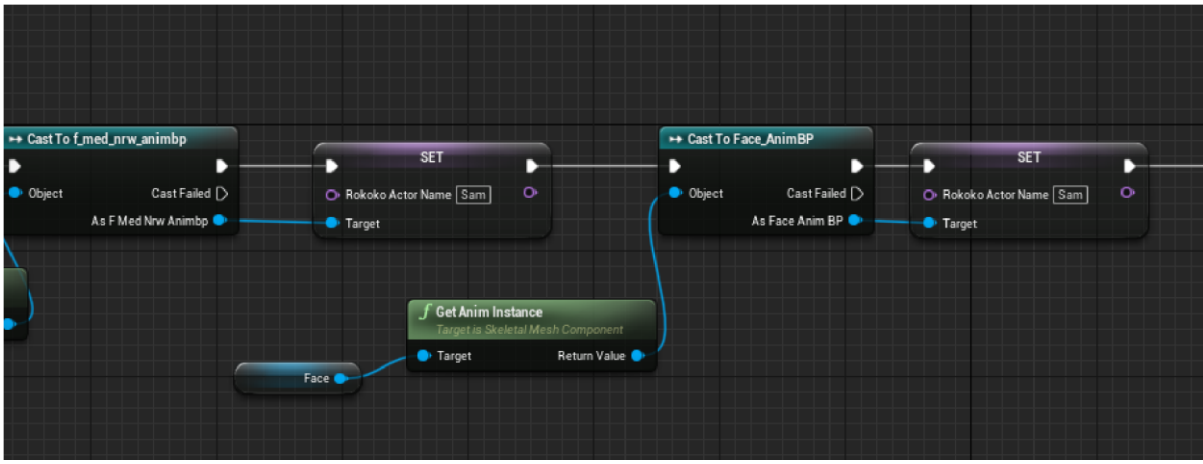


6. Right click on the “Face_TPose”, inside AnimGraph, and select “Corvent to Pose By Name”.
7. Open the “Face_TPose”, check the “Pose Name”(as you did for Body_TP, select “Face_TPose” on the AnimGraph and insert the “Pose Name” to the Details panel on top-right of the “Pose Name” node. Connect it to the “Local to Component” node.

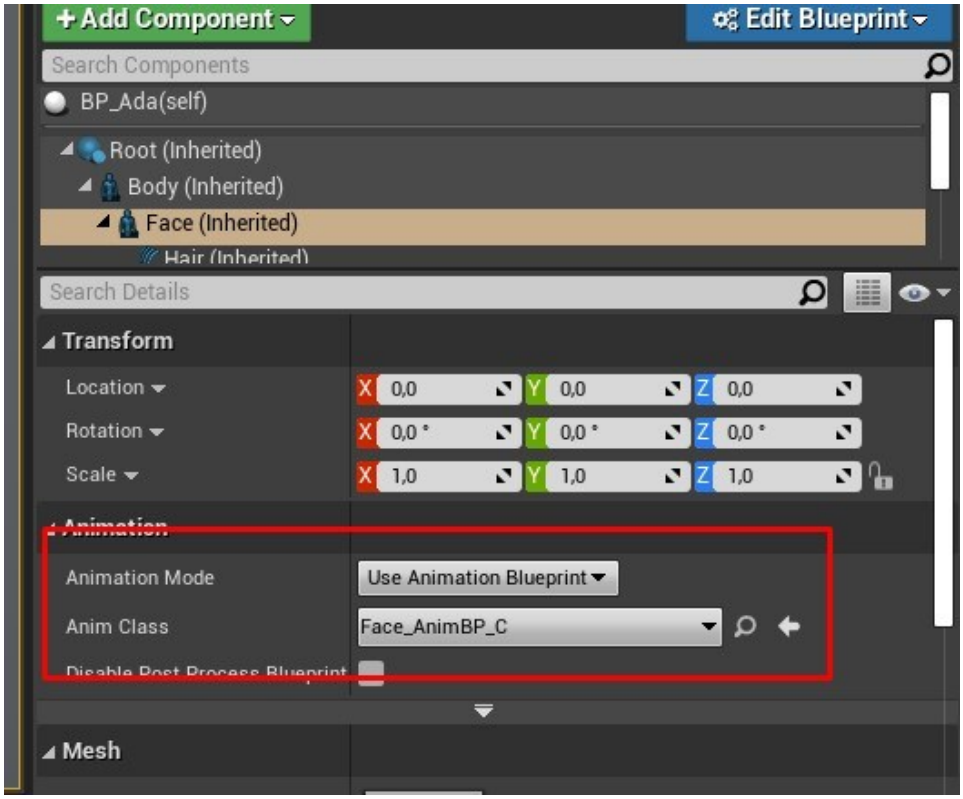


Compile and save.

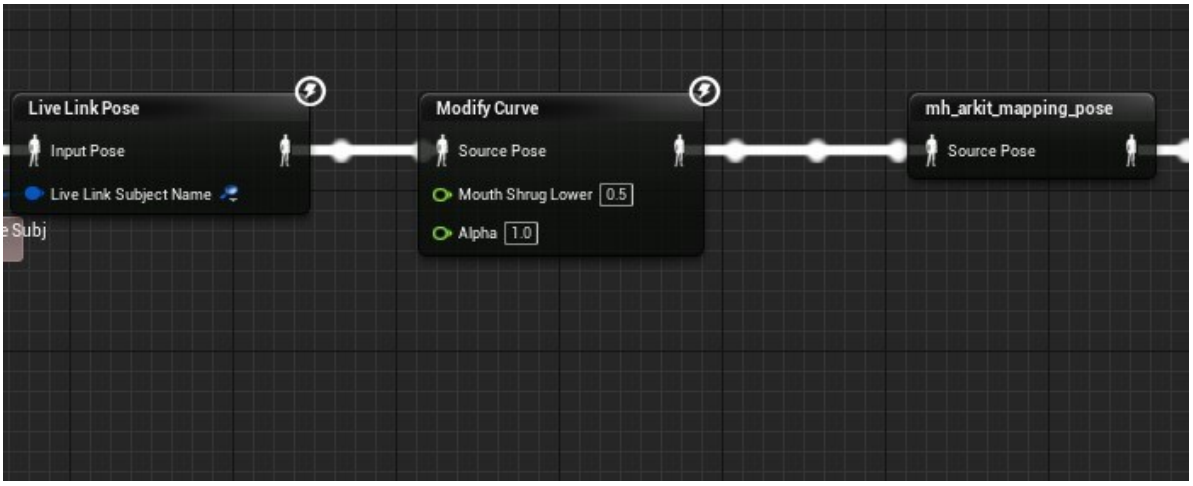
14. On “BP_Ada” blueprint, drag into the event graph the ‘Face’ mesh on top-left, get “get Anim Instance”, get “Cast to Face_AnimBP” and set “Rokoko Actor Name” as your profile in Rokoko Studio.



8. Finally, in Unreal's viewport, select the "BP_Ada", select 'Body' mesh ,and in the Details panel, go to the Animation section(above the Mesh section). Select the Animation Mode as "Use Animation Blueprint", and the Anim Class as "Face_AnimBP_C".

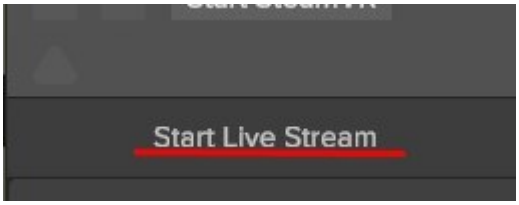


Note: In case, lower lips in metahuman are slightly open,on "Face_AnimBP" add a "Modify Curve" node between "Live Link Pose" node and "mh_arkit_mapping_pose". Right click on the "Modify Curve" node output>Add Curve Pin and select "MouthShrug Lower. Seti its value to something like 0.5.

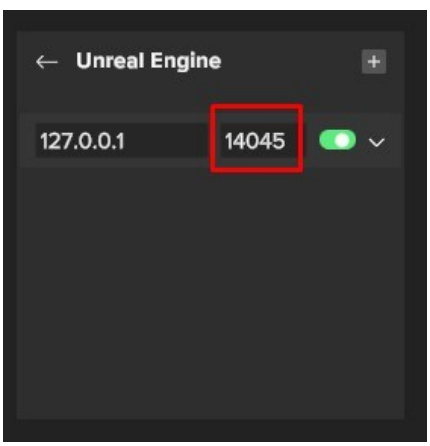


10 Metahuman Livestream Setup

1. Open Rokoko Studio, open a scene and make sure your Smartsuit is connected and paired with your Profile. Click on Start Livestream, navigate to Unreal Engine and click on the cogwheel. Make sure the port number is **14045** and enable the Livestream.

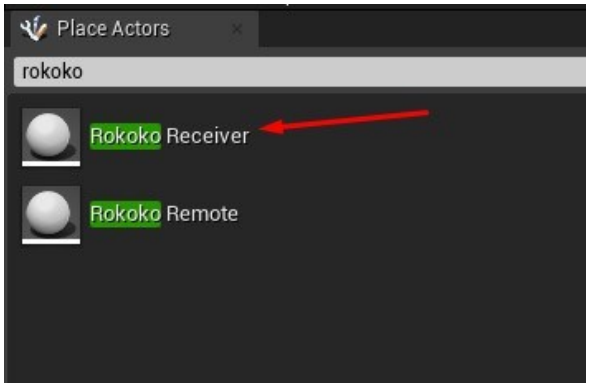


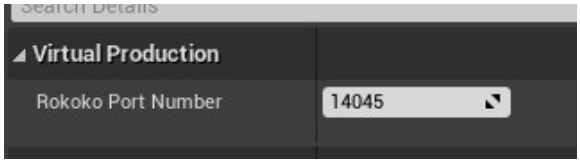




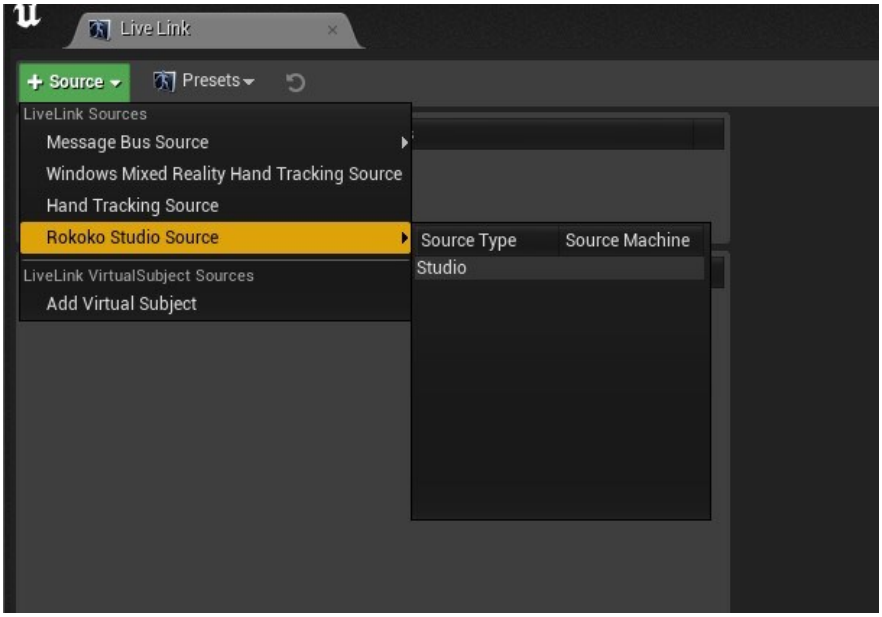


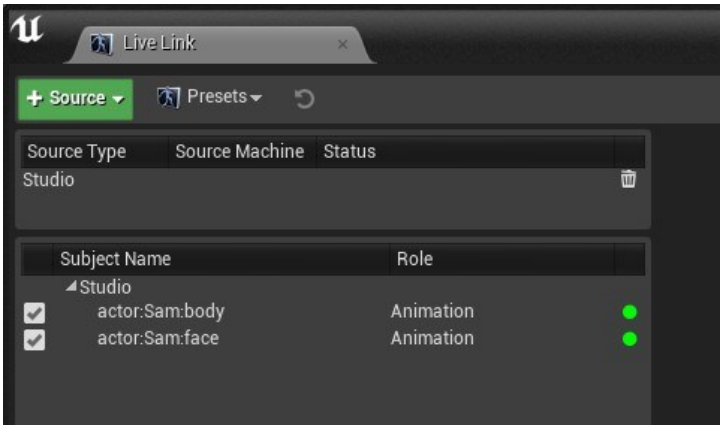
1. Back in Unreal, under Place Actors(top-left of Unreal Editor) search for “Rokoko Receiver” and drag it into the scene. Set the Rokoko Port Number as **14045**, in the Details Panel.



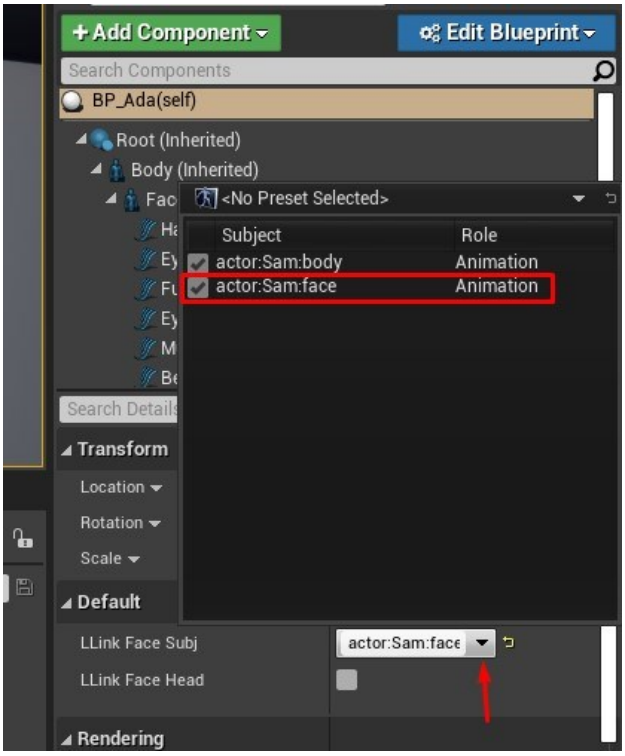


2. On the top-left bar,navigate to Window>Live Link and then Source>Rokoko Studio Source>Studio.





3. In the editor ‘s viewport, select the “BP_Ada”, and in the Details Panel, set the “LLink Face Subj”, as your Actor’s face capture from Rokoko Studio.



Finally, hit play to begin Livestreaming.

