Quality Data for Analysis and Validation in Process Simulate Human Hand VR

Worker injuries and insurance cost go up while productivity deteriorates when beautiful workspace designs fail ergonomically. The compatibility of today's hardware i.e. Motion Capture gear and Virtual Reality HMDs, and software i.e. Manufacturing planning solutions have equipped manufacturers to validate designs and build optimum workspaces. This eliminates injuries, increases productivity and creates a human-centric workspace.

Introduction

Assembly Planning and its validation are together an important tool among manufacturers. This tool comes as a software that validates and further analyses ergonomic ease of human tasks in various environments via virtual simulation. It also validates the effectiveness and suitability of product designs. Validating workspace and product designs and the serviceability of products remains some of the key areas where Digital Factory and Factory 4.0 software & hardware are making an impactful difference.

While such a solution allows users to create a realistic virtual human called Jack or Jill for full body task validation and ergonomic analysis, in many cases such as 'serviceability testing' it acts as a data overkill as the only data points required to validate the task is of a hand or multiple hands in sync. This is why the feature of 'Disembodied hand' is important.

Brands such as Siemens' Tecnomatix and Dassault's DELMIA are the leaders in providing the most sophisticated and comprehensive PLM software tools today. So, how does one ensure that the methodology used is precise and elevates the test purpose instead of defeating it? As workforce costs and strict legislation rise globally, it is an increasingly important challenge to create a better, safer and sustainable productive human-centric workspace at the lowest costs.

Verification and Validation without Motion Capture

Using an assembly planning and validation solution without a Motion Capture gear is possible and can be done in the following steps;

1. **First, use hypothesis to identify and solve the problems**
   Creating hypotheses of the problems that may occur when the actual task is being conducted by a worker onsite, and providing hypothetical solutions that may resolve it provides a broad range of environments and events to work with.

   The problem here is that to get to the closest hypothesis a broadly experienced professional who works systematically and understands the standard ergonomics compliance relevant to the workplace being created is required.

2. **Second, use various pre-made animated motions stuck together to better visualise which hypothesis is the best to proceed with.**
   Using pre-rendered automatic animations such as automatic stair and ramp climbing, posture prediction, automatic grasp and reach tools to closely guess the problem and its relevant solution helps provide a good picture to support and work with the hypotheses.

   The problem here is that it is impossible to create all the animations necessary for ergonomic simulation in their *time-correct* and natural *posture final state*, resulting in awkward animations that look wrong even when they are technically correct, confusing users and designers alike with ***clunky*** animation.

Overall, in the above solution there are four major problems,

1. **Specialists are key**
   Ergonomic and Animation specialists are required to complete the validation correctly. These need to be highly knowledgeable professionals who understand the importance of the job and complete it with minimal error.

2. **Time consuming**
   It takes a lot of time, in most cases more than 4 hours to create just 1 minute of the workers tasks with specialists onboard and this is the reason why most manufacturers do not bother testing unless it is for a complete human task that is critical in nature.

3. **Less Value for More Money**
   Purchasing a manufacturing solution is a serious decision and requires good fund allocation. When such a purchase is not realised right within the set deadline in spite of spending time and consulting experts, it acts as an expenditure over an investment.

4. **Quality Compromise**
   In spite of using all the resources, the overall methodology of virtual validation ends up with '*hit and miss*' results which only defeats the purpose of the task. This process requires more effort and provides less accurate results hence up to just a few years ago only a few pioneering organizations like Daimler, Toyota, Skoda, Hyundai, Boeing, and Airbus were able to afford to equip a motion capture gear for their R&D department, but today, after the crash of mocap prices in 2015/16, almost all Digital Factory design teams have access to Motion Capture systems.

The latest approach deals with verification and validation using digital factory tools clubbed with motion capture gear as the 'true' motion data source. For a disembodied hand task this means working with a high-fidelity glove that can track hand and finger motions while being user friendly.

EXO GLOVE finger capture for PSH-VR

Today PLM software like DELMIA and Tecnomatix offer an additional 'Motion Capture' module that enables movements of a real human body or just hands to animate the digital avatar within the virtual work environment. A Motion capture gear plays a vital role in providing quality data for validation and analysis. The key benefits are,

1. First-hand and 'real/true' test of each designed environment.
2. Human factor issue identification, finding alternatives for improved processes as well as glitches in the designs, all in Real-Time.
3. Record and use true complex simulations.
4. Save motions and reuse them for further analysis, training and communication purposes at a later time.

In spite of these benefits, the disembodied hand feature was not fully realised as there was no glove with enough fidelity at a pocket-friendly price that supported these software capabilities. Hence, while AiQ-Synertial was developing the EXO GLOVE, they worked closely with Siemens' Tecnomatix team to make sure that none of their software's key features were missed in the final design. The EXO GLOVE can now be referred to as a high fidelity go-to glove for PSH-VR's Disembodied Hands (with Delmia following soon after).

The EXO GLOVE has been designed to work seamlessly with the Siemens PSH-VR Disembodied Hands. Several factors that produce quality data for analysis were kept in mind.

The key factors include,

1. **Easy to use Advanced Technology**
   The EXO GLOVE is a 5th generation product of the AiQ-Synertial Technologies. It has been designed to provide a heightened tactile experience, unconstrained mobility and scaling control for fingers. It also includes a sensor for the forearm.

2. **Full mixture of kinematics and Digital Factory features**
   With the advanced kinematics feature, the user can test variations of natural human motions to verify and validate which in turn allows better collision detection as well as truer interaction with objects virtually.

3. **Virtual Reality (VR) compatible**
   The EXO GLOVE comes with an HTC VIVE plugin that keeps objects at true distances between the fingers and the digital mock-ups in VR; this clubbed with object interaction provides seamless verification and validation of data.

A combination of advanced technology, advanced kinematics, and virtual reality compatibility provided by the EXO GLOVE results in quality finger input data with enough high fidelity for the task to be effective and pocket friendly price for the glove to be affordable by majority of the manufacturers.

Using the EXO GLOVE in PSH-VR

The EXO GLOVE can be set up in PSH-VR in 7 steps to capture the natural hand data.
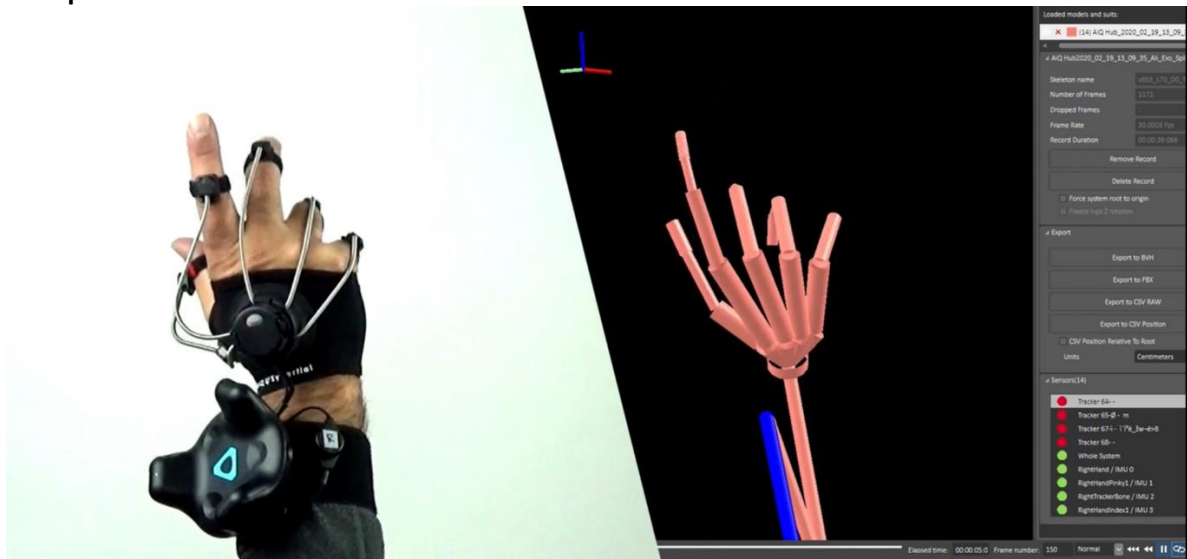
1. **Set up the Glove**

Image 1 EXO GLOVE after setup while getting ready for high accuracy. Source: https://vimeo.com/39371420

Once the glove is unboxed, select the best ring size for your fingers. The 8th sensor of the glove can be used interchangeably for the thumb or the forearm, once you have selected the best configuration for your requirement, wear the glove and select SynDash to Connect the glove to it. Start the glove in SynDash and ensure that all sensors are green to confirm 'high accuracy', then choose a skeleton file provided by AiQ-Synertial and customise it to the hand size you want to test for best accuracy.

2. **Calibrate the glove**

Image 2 Calibration of the EXO GLOVE. Source: https://vimeo.com/410787043

Calibrate the glove in 6 seconds with two poses. You may customise the timing according to your comfort.
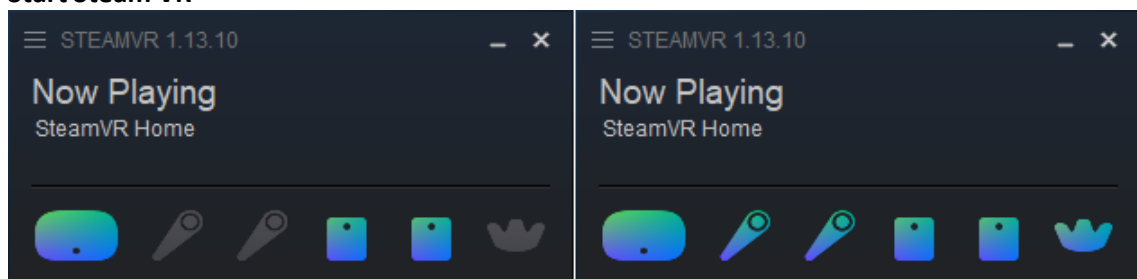
3. **Start Steam VR**

Image 3 Steam VR before and after connecting to VIVE controllers and pucks. Source: An interview with Noah DVH

Connect the VIVE controllers and pucks to Steam VR.
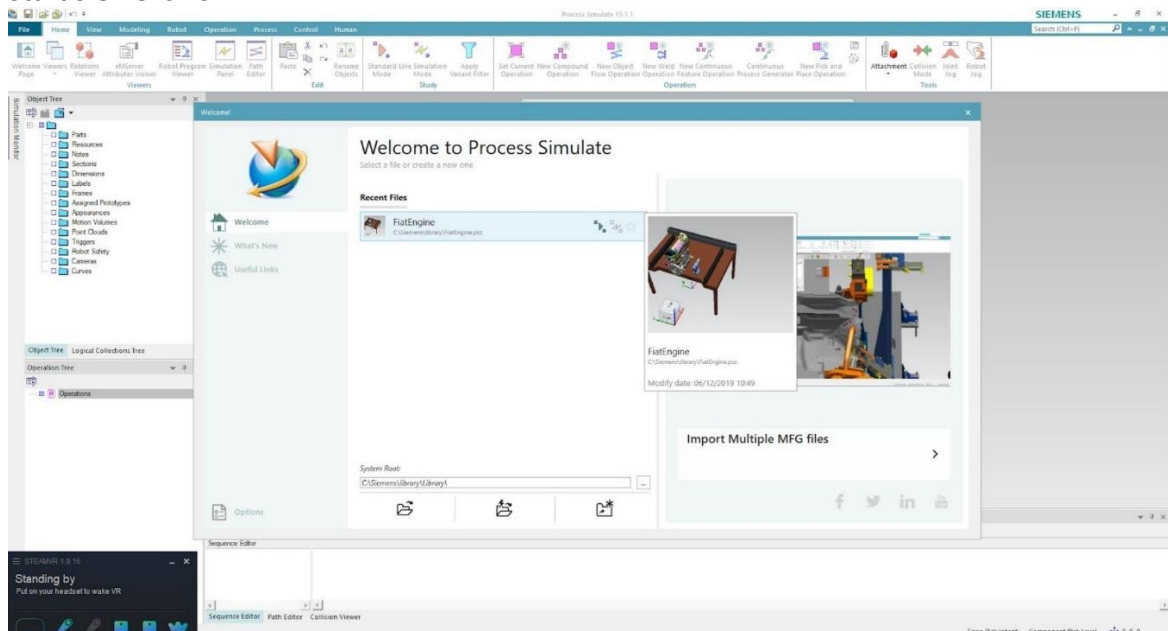
4. **Start Siemens PSH-VR**

Image 4: Selecting a scene in PSH VR. Source: Connecting SynDash to PSH VR step by step guide

Open Siemens Tecnomatix PSH and select the scene that you would like to use. Start the PSH server and create a hand. Then, start Virtual Reality (VR) in PSH.

5. **Connect SynDash to PSH-VR**

Image 5: Connecting SynDash to PSH VR. Source: Connecting SynDash to PSH VR step by step guide
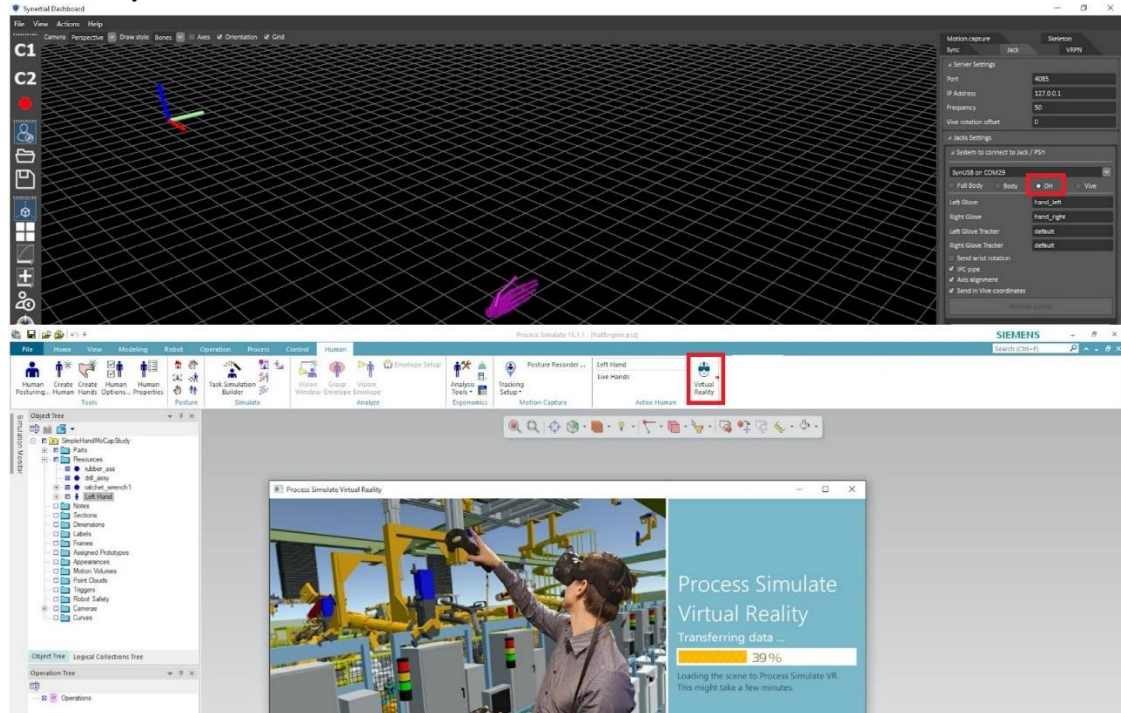
Use the 'Jack' tab to select 'DH' in SynDash and connect SynDash to the PSH server and Virtual Reality.

6. **Scaling with the Glove**

Image 6: Selecting constraint for scaling. Source: Connecting SynDash to PSH VR step by step guide.
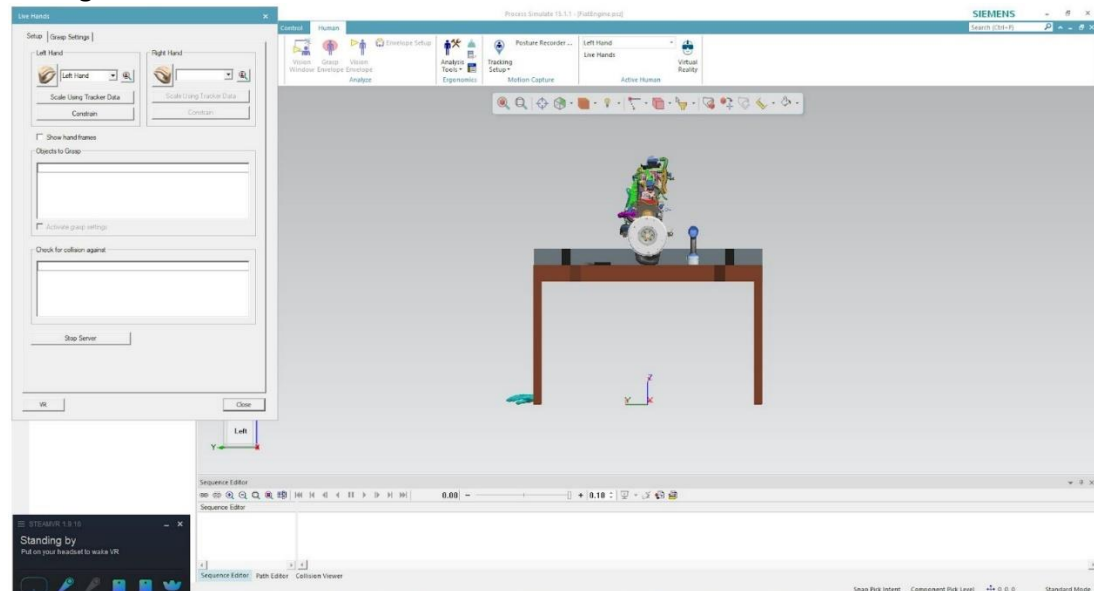
Constrain the hand frames from SynDash to the hand in PSH. Scale the hand so that the measurement from SynDash is imported into PSH. Make sure to constrain before you scale.
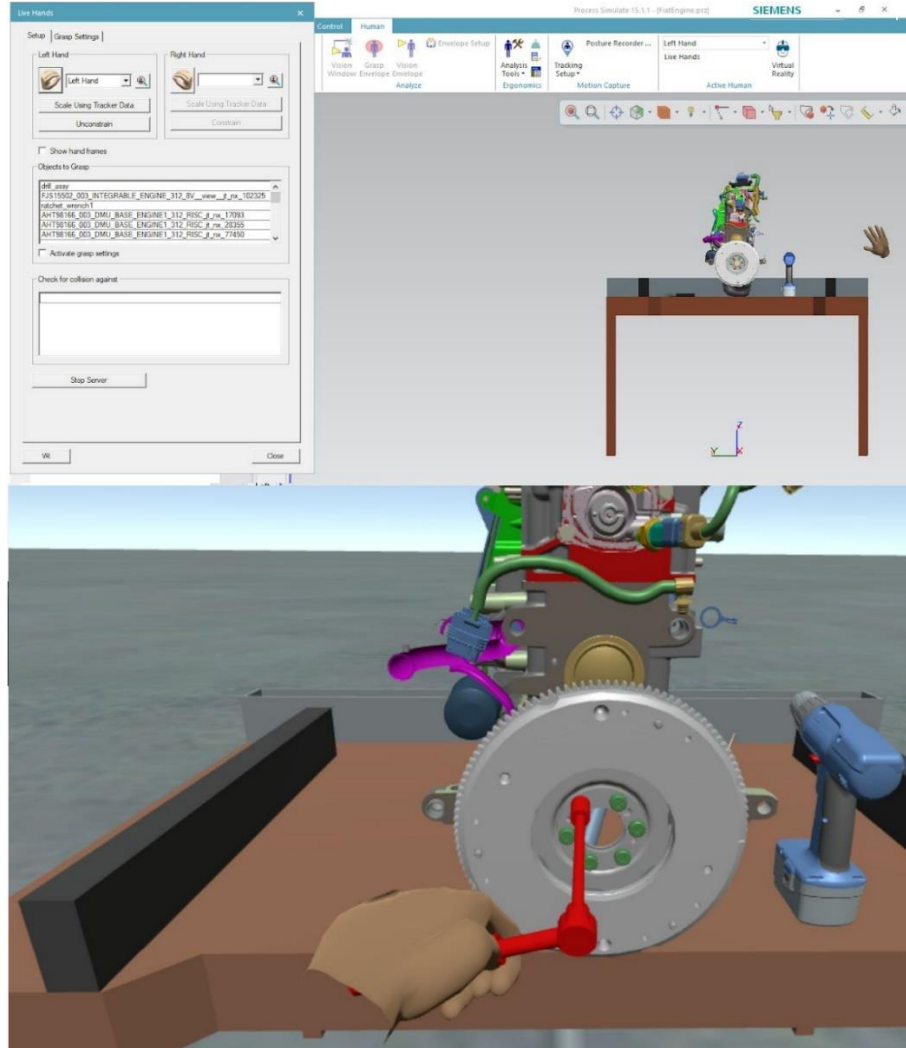
7. **Select objects to grasp**

Image 7: Selecting object to grasp and working in PSH-VR. Source: Connecting SynDash to PSH VR step by step guide.

Open grasp settings and choose the objects you would like to interact with and test and you are ready to go.

Advantages of the EXO GLOVE in PSH-VR

1. 6-second calibration that includes 2 poses. The timing can be customised.
2. Freedom of using a single or a pair of gloves for various tasks.
3. Flexibility of adjusting the size of the hand model.
4. Stay attached to the glove as you teleport.
5. Grab and place objects within a virtual environment.
6. User-configured grasp and collision tolerances.

Conclusion

Human-centric workspaces can no longer afford to have errors in their design. Manufacturers have all the tools in the form of hardware and software to verify and validate specific tasks and comply with the required ergonomic standards. It is thus important to select the right combination of features to meet the critical success points for quality data capture which in this case is natural and high accuracy human motions, the ability to interact with objects within the virtual environment, the digital infrastructure to be able to work on specific tasks quickly and easily.

About the Author

Ritu Srivastava is the Sales and Product Communications Manager at AiQ-Synertial Technologies Ltd where she helps her clients understand the best solution package relevant to their project. Prior to this she was under the training and mentorship of Ali Kord, the creator of the Synertial Technologies motion capture systems.

AiQ-Synertial Technologies Ltd has been providing premium Motion Capture Solutions to professionals such as High-end researchers, Sports and Rehabilitation coaches, high-tech manufacturers, and Animators globally for over 25-years.

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References

1. *Exo Glove promo video: https://vimeo.com/398251419*
2. *AiQ Synertial - Siemens PSH VR features: https://vimeo.com/377786607*
3. *Virtual assembly: https://vimeo.com/371407946*
4. *AiQ Synertial Siemens Virtual Assembly: https://vimeo.com/371406443*
5. *Process Simulate Human PDF*
6. *Motion Capture Toolkit for Tecnomatix human applications PDF*
7. *Siemens Jack manual v8.2*
8. *Tracklab Case study : https://tracklab.com.au/case-studies/virtual-reality/skoda-auto/*
9. *An interview with Ali Kord.*
10. *An interview with Noah DVH*
11. *An interview with Peter Skorik*
12. *Connecting SynDash to PSH VR - step by step guide*
13. *Left Hand 1-2 Calibration: https://vimeo.com/410787043*