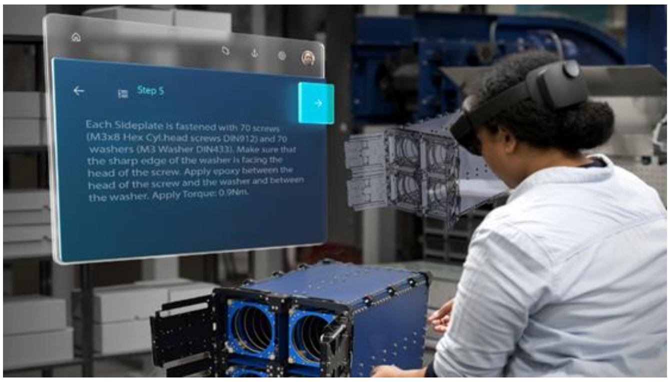
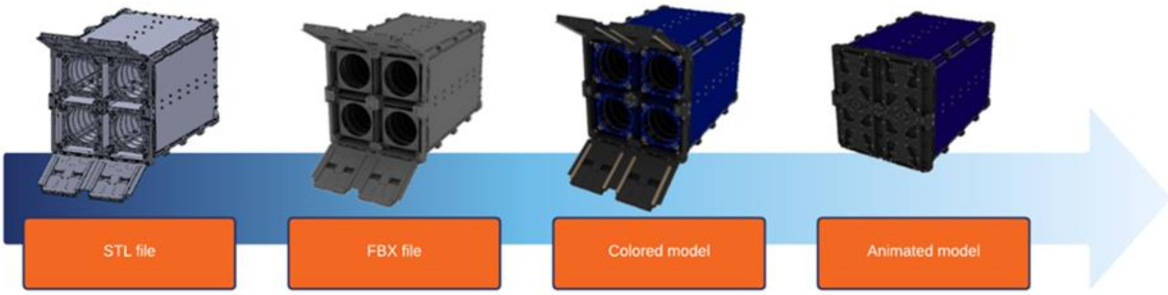
AR in support of AIT for QuadPack 4-3U Deployer

A case study was performed to investigate the potential of Augmented Reality (AR) in optimising Assembly and Integration (AIT) processes applicable to the commercial space domain. In particular, an AR tool was developed to run on the HoloLens 2 and to be used during the main assembly activity of a QuadPack 4-3U type provided by ISISpace. The tool was developed using as much as possible off-the-shelf solutions and with a strong focus on the highest practical impact at the lowest cost. A validation test was performed comparing key parameters in the assembly process during execution with and without the developed solution.



1 Approach

An AR tool was developed using an off-the-shelf software solution. Microsoft Dynamics 365 Guides, a straightforward tool with limited but sufficient functionality, was chosen as the basis of the development. Main reason for this choice is that it is a proven, well supported and affordable solution, both in terms of licenses as well as customisation effort. Where other solutions offer computer vision related functionality (object recognition), Dynamics Guides digital manuals are simply triggered by QR code scanning. This approach, apart from simplicity in implementation and lower license cost has the added value that no integration with a CAD based database nor cloud storage of potentially proprietary is needed. Because of these simplifications, most development effort went into the creation of a clear, effective and usable User Interface, based on detailed and unambiguous animations of procedures to be performed.



2 Validation

A validation scenario was created in order to quantify the added value of the developed tool compared to the existing way of working. To this end, part of the QuadPack assembly procedure (doors assembly) was isolated and performed by two groups of ISISpace employees, employees trained in the QuadPack assembly procedure and employees who aren't (bit are still knowledgeable about AIT. Both groups performed the procedure twice, once using the original paper manual, once with the HoloLens. Two aspects were monitored, time to completion and the error rate.

3 Results

As mentioned, the process was performed four times:

- Process 1 – AR powered manual
    - Trained employee
    - Untrained employee

- Process 2 – Paper manual
    - Trained employee
    - Untrained employee

The validation Assembly process was split into four steps, each step dealing with a specific step in the process:

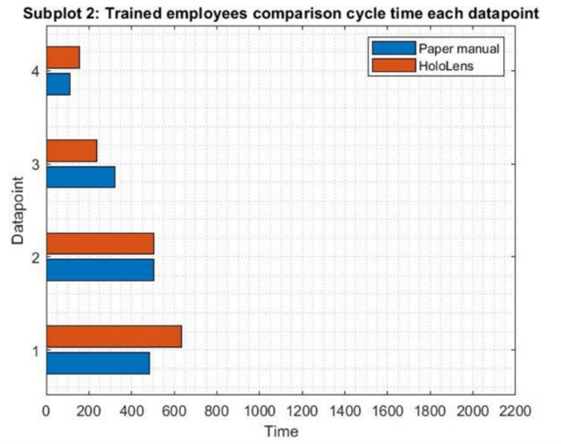
- Step 1: Completion Door #2 and #3
- Step 2: Completion Door #1
- Step 3: Completion Door #4
- Step 4: Finish door assembly

Two aspects were monitored

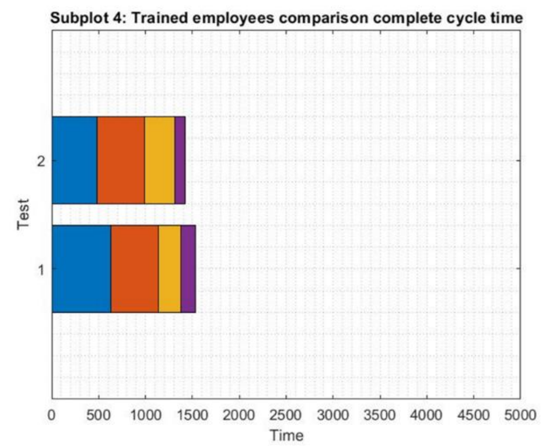
- Time to completion
- Error rate

3.1 Time to completion

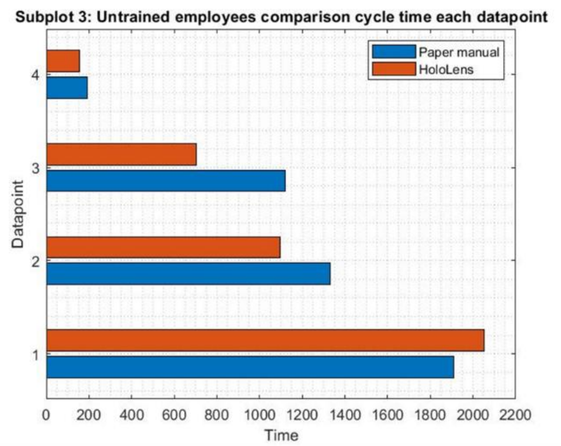
The figures below provide a clear picture in the sense that for untrained employees time to completion is reduced significantly (~12%) (right bottom graph). From the left graphs (both bottom and top) it can be seen that for step 1 completion time is in fact higher when using the HoloLens than without. This can be attributed to the time it takes to get accustomed to using the tool and the hardware when using it for the first time. When eliminating this step from the equation (by for example improving intuitiveness of the UI further) brings further reduction of time to completion by up to 26%. In this case, even trained personnel will experience an optimisation (albeit it small (~5%)). Typical time savers perceived were the structured approach of for example parts gathering (kitting), where the AR tool showed the needed parts by code and model to avoid confusion.



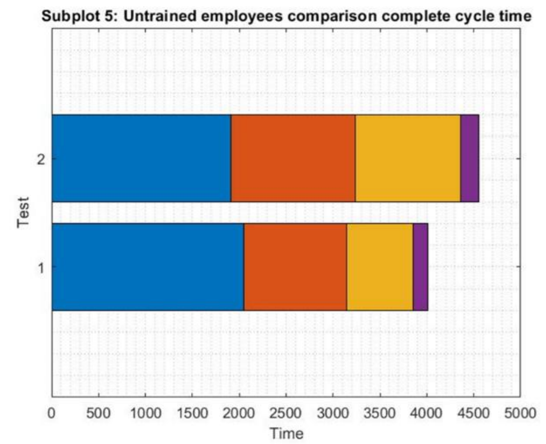
Trained employees comparison cycle time each datapoint



Trained employees comparison complete cycle time



Untrained employees comparison cycle time each datapoint



Untrained employees comparison complete cycle time

3.2 Error rate.

As expected, the effect of using Augmented Reality of the number of errors made was mostly visible in the tests performed by untrained employees. When using the paper manual an untrained employee made 12 mistakes in the overall process on average. This number was reduced to a single error when using the HoloLens solutions. Without the AR tool, some employees (untrained) were unable to finish the assembly process without support from a third person. With the AR tool everyone finished the process by him/herself. The perceived reason for this optimisation is the actual design of the digital manual which asks for explicit confirmation of a step performed before moving to the next.

4 Conclusions

A conclusion of the presented case study can be formulated in that employees not trained in a specific procedure will benefit significantly from the use of AR powered support tools when compared to traditional support tools such as paper manuals. This is already apparent in a relatively straightforward tool as presented here and will most likely become even more apparent when additional functionalities are added and when even more focus is put on intuitiveness of the User Interface.

Of course, the above conclusion shall always be regarded in the overall frame of cost versus benefits. In that respect, from the monitored aspects the reduced error rate is clearly the most appealing, as in the worst-case errors lead to catastrophic failure. However, even when looking at the reduction in time to completion a quick and dirty assessment already show that AR technology is promising and can provide significant benefits. It is important to note that these benefits are most likely not uniquely observed in assembly and integration processes but similarly in other processes of a certain level of complexity where the impact of making errors is significant. This can be for example in quality or product assurance, system operations, or in maintenance. Highest benefits are found in industries, companies and projects of a relatively high value, risk and complexity (both in terms of the system itself as well as the assembly chain) where there is a need to often train or support new staff (due to new assembly processes or due to high staff turnover).

Are you interested in a case study for your specific situation, or do you want to discuss how we can implement these solutions for you, reach out to us!

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