



Title: Virtual reality training system for aerospace industry

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Introduction

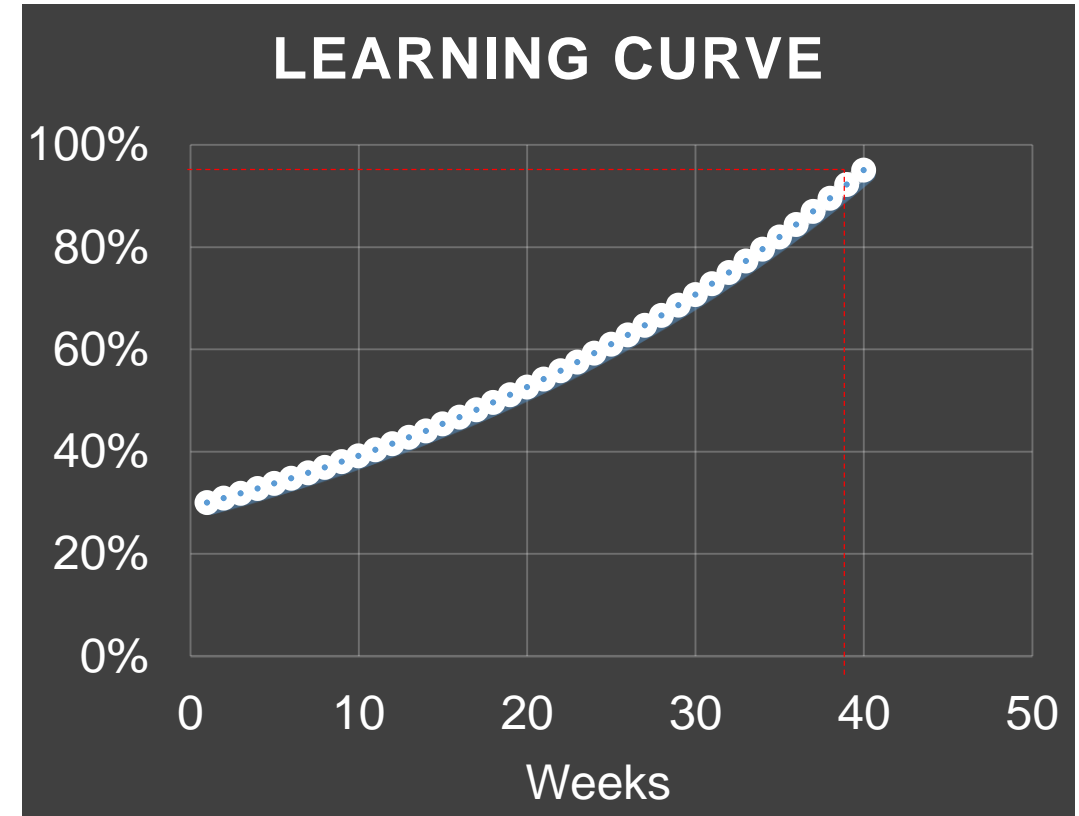
In Mexico, Manufacturing attrition is 59% per year (INDEX 2019, p. 5)

Learning curve for high complex manufacturing environments as aerospace is 9 months

Objective: Reduce learning curve from 9 to 1 month through immersive learning

High Complexity environment:

- “n” number of hand tools, hardware, fixture jigs and many pieces.
- Low volume and high mix of work content
- Ergonomics risks



9 Months to meet learning curve

Problem: How to reduce learning curve and meet these requirements:

1) A standard and autonomous training tool

2) A sustainable Training

Best Solution

Immersive learning environment (ILEs)

are **learning** situations constructed by software tools including

- game-based **learning**,
- simulation-based **learning**, and
- virtual 3D worlds.

Methodology

Method:

- Compare traditional training in a class-room vs. virtual reality and immersive learning
- Participants: 20 new employees under the new virtual reality training
- Analysis: Compare two samples, current state vs. virtual reality

Data gathering process:

- After 6 months compare
 - Defects quantity
 - Cycle time

Analysis:

26% of the defects explain 91% of the problems (Fig 1)

13 defects are the reasons for increasing the learning curve

There are two universes caused by the different manufacturing processes

Learning curve increases because there are two processes that need to be learned

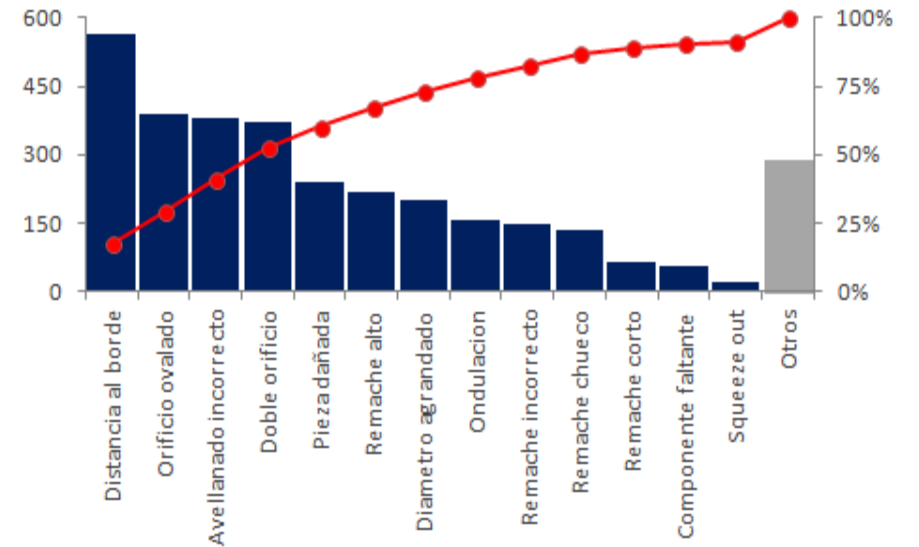


Figura 1 Pareto Cantidad de defectos Fuente (Favela, 2019)

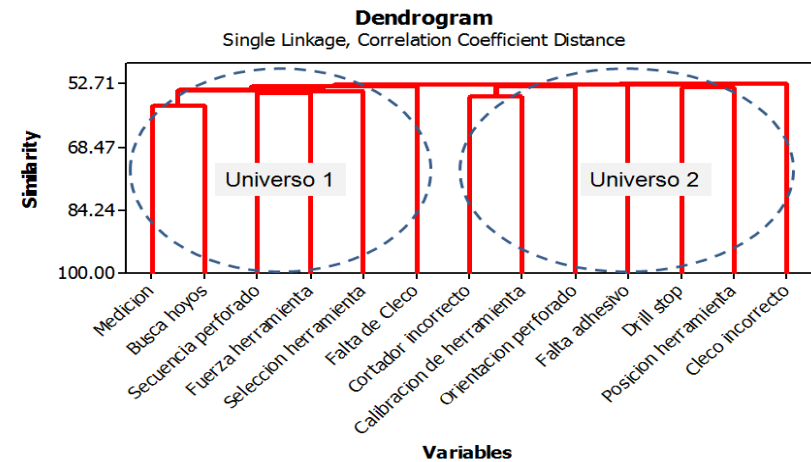


Figura 2 Dendrograma para agrupación de causas y defectos Fuente (Favela, 2019)

Designing virtual reality:

Breakthrough

Aerospace Industry has very complex processes and depends on human factor to make them

It is not easy to implement technology

Breakthrough: Learn complex processes faster without trial & error

Answer based on TRIZ Principle:
Simulation

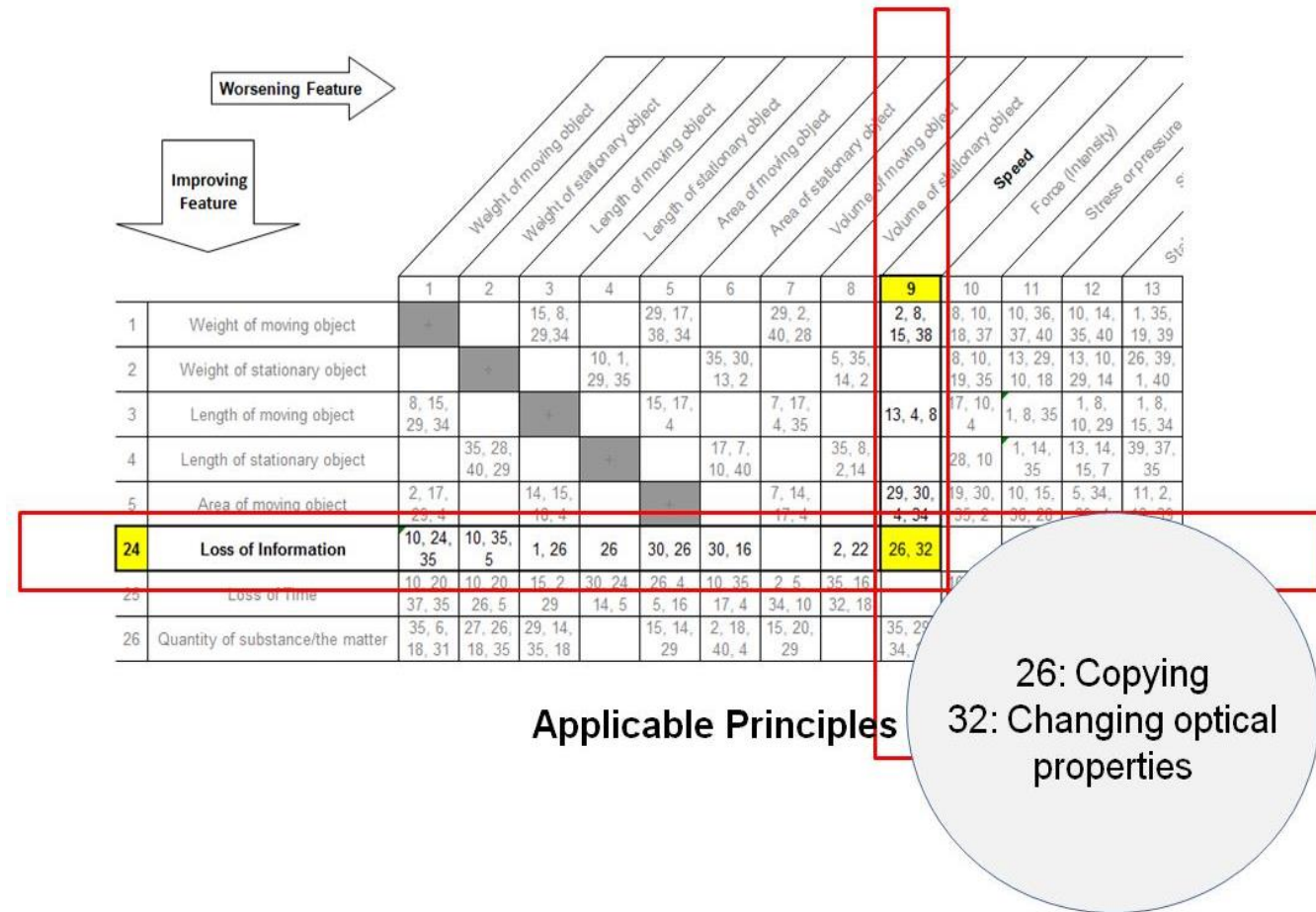


Figura 5 Análisis TRIZ para el aprendizaje (Favela, 2019)

3D modular training:

Solution

Develop a 3D environment to program Virtual Reality in Leap Motion and Oculus rift

Program the modules that will impact ergonomics, defects and cycle time

Tools and systems were designed to learn and interact with the critical manufacturing processes in a 3D virtual reality system



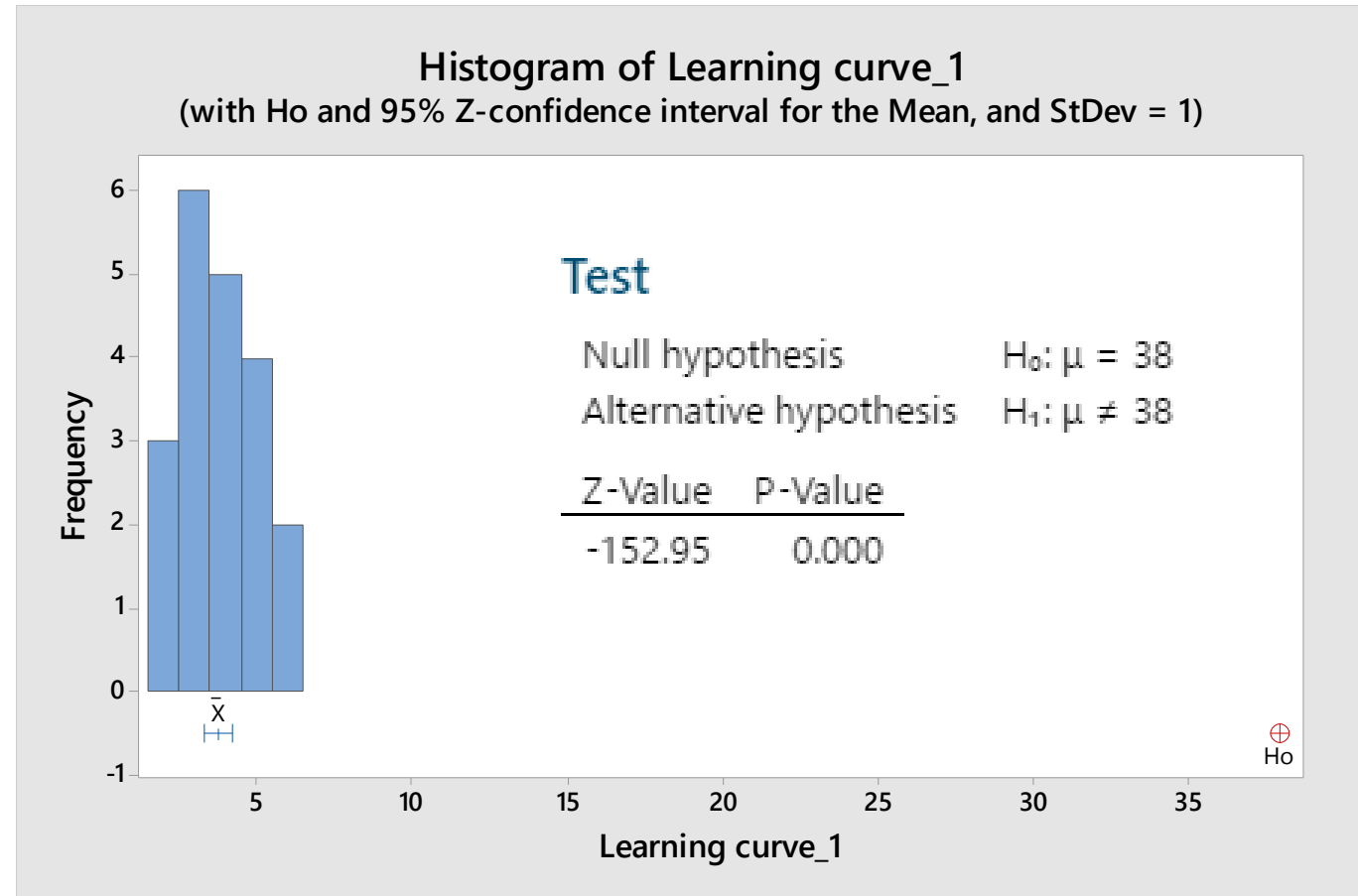
Figura 7 Sistema de realidad virtual Leap motion y Oculus rift (*Leap motion and Oculus rift, 2019*)



Figura 10 Módulo de instalación de puertas con taladro 90 a grados (*Favela, 2019*)

Results

- Virtual reality is significantly better than traditional training (95% level of confidence)
- In the Z-confidence test, 3D virtual reality is better than 38 weeks of the traditional training with an average of 4 weeks and max of 6 weeks

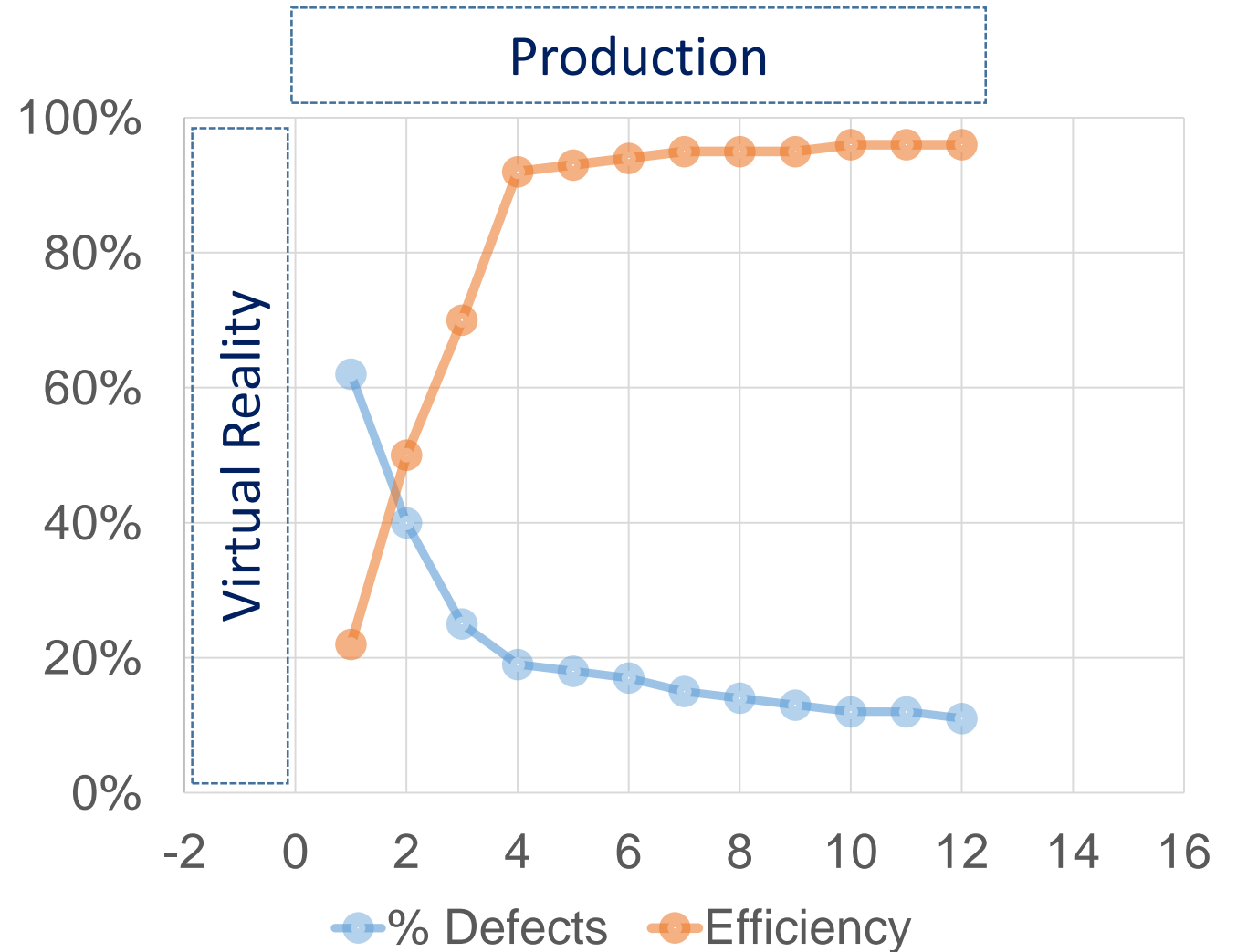


\$1.0M annual recurrent Savings USD

84% defect reduction for lack of knowledge in new employees

New employees 4 times faster than before one month after hiring process

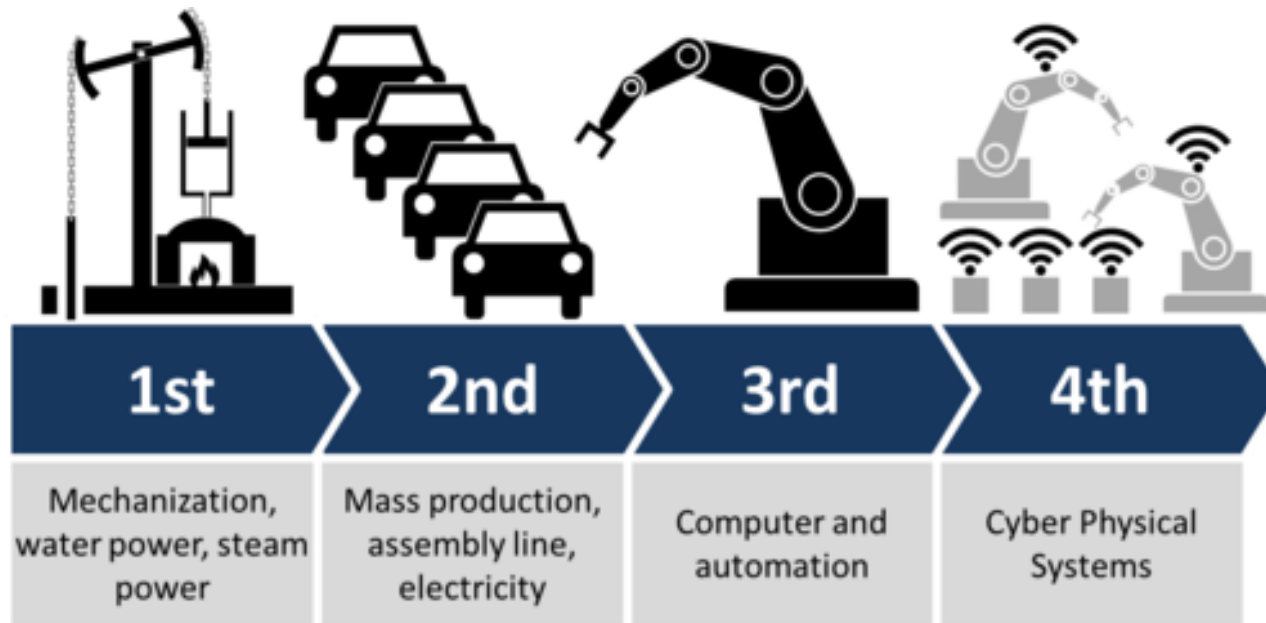
- \$124K scrap
- \$162K better efficiency
- \$388K less rework
- \$320K less turnover



6 Weeks to achieve knowledge and efficiency, and skill set ready at 4th month

Annexes

Background: Industry 4.0



Hardware



Software



Timeline

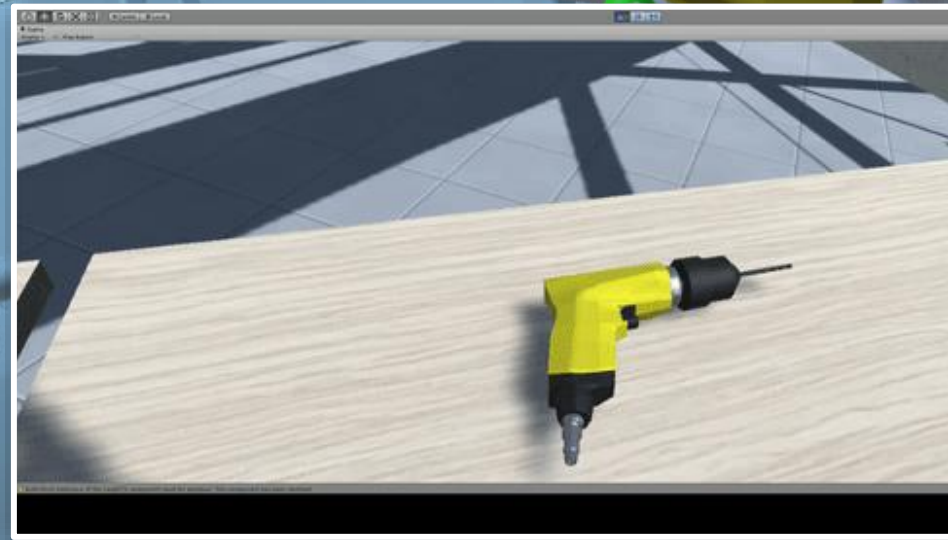
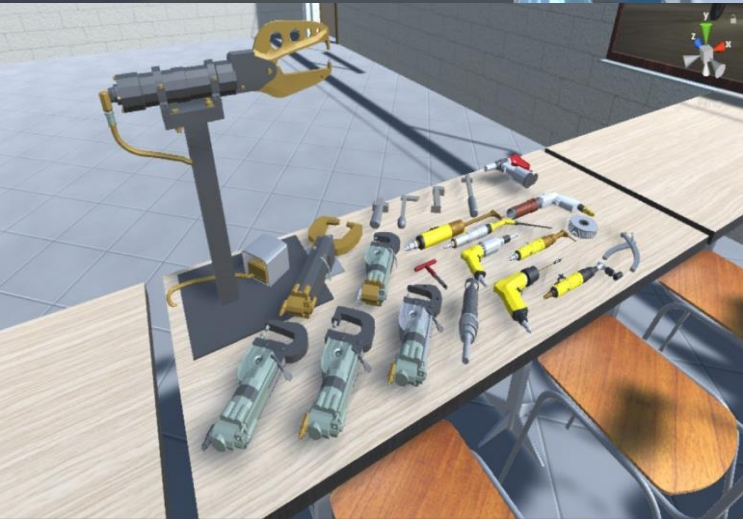
Milestone	Date
Idea, Concept Design	2015 Q1
Sheet Metal Training	2015 Q2
Virtual Reality training	2015 Q3
Purchase hardware & software	2015 Q3
3D design & mechanisms (1,322 items)	2015 Q3-Q4
Coding: Vector programming and animation	2016 Q1-Q2
Virtual Reality programming	2016 Q2-Q3
Interface programming and databases	2016 Q4
Production environment	2017 Q1 and On

- Eliminate learning curve
- 80% less workmanship defect
- 50% better efficiency new people

Una vez instalada, hay que girar la llave para aflojar el Drillstop. Usa tu dedo índice para empujar la llave y girarla según el indicador.

START 1

TEMPORAL METER 0



Conclusions

- 1) Virtual reality is a critical tool to learn faster
- 2) In aerospace industry, it helps to migrate from basic riveting and drilling operations to learn the work into a 3D environment system allowing the person to simulate the true manufacturing environment
- 3) The 14 virtual reality modules developed impacted positively to the learning curve
- 4) It is difficult to identify talent to program Virtual reality, it is not a technology that could be easily implemented everywhere

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