Trends in Computer Graphics

Unit 7

Virtual Reality(VR) and Animation

Virtual Reality(VR)

Virtual Reality(VR)

- **Virtual reality** or **virtual realities** (**VR**), also known as **immersive multimedia** or **computer-simulated reality**, is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment to allow for user interaction. Virtual realities artificially create sensory experience, which can include sight, touch, hearing, and smell.
- Most up-to-date virtual realities are displayed either on a computer monitor or with a virtual reality headset (also called **head mounted display**)
- Some simulations include additional sensory information and focus on real sound through speakers or headphones targeted towards VR users

Why Virtual Reality(VR) ?

- VR is able to immerse you in a computer-generated world of your own making: a room, a city, the interior of human body. With VR, you can explore any uncharted territory of the human imagination.

History of VR(Virtual Reality)

- 1929 – Link
  - Mechanical flight simulator

Link trainer taken at Warhawk Air Museum in Nampa, Idaho by Tony Speer.

History of VR(Virtual Reality) cont...

- 1956
  - Sensorama
  - Multimodal display of a motorcycle ride through Brooklyn
    - Sight
    - Sound
    - Smell
    - Vibration
  - 1957 HMD(head-mounted display) patent


sensorama


sensorama

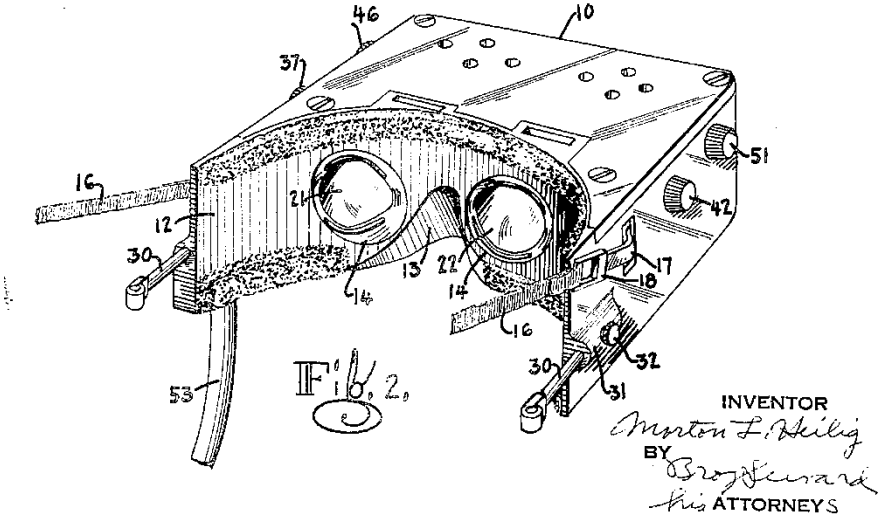
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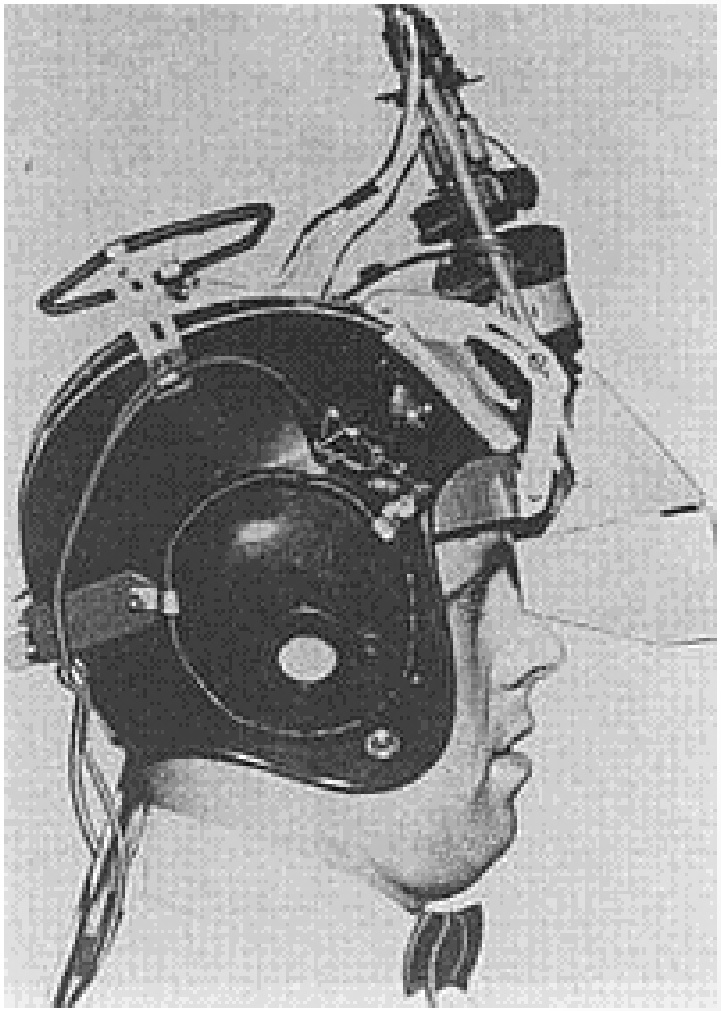
Fig. 2.
INVENTOR
Morton L. Heilig
BY
Brogan & Girard
his ATTORNEYS

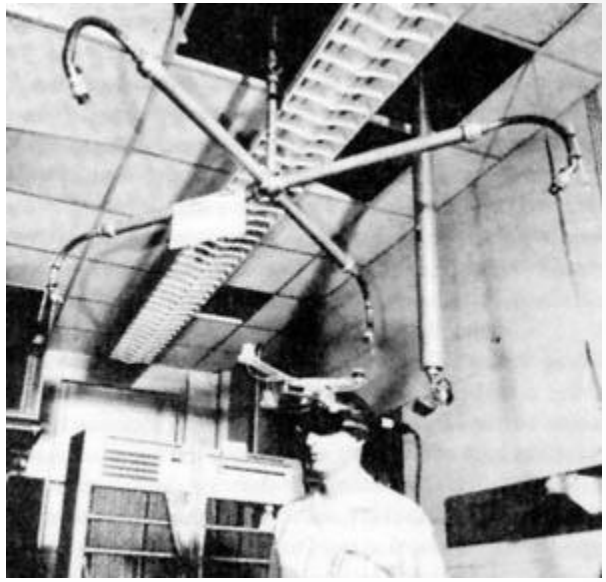
History of VR(Virtual Reality) cont...

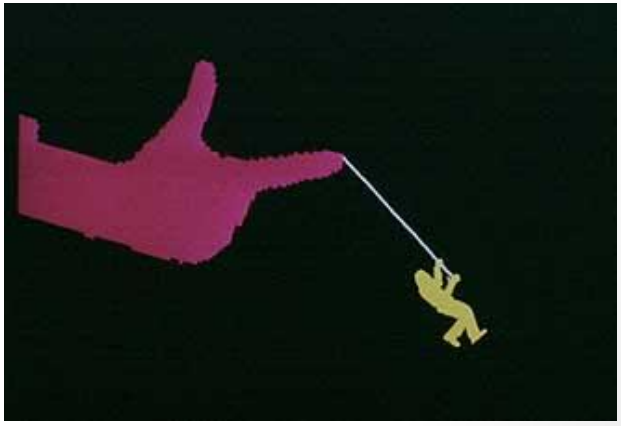
- 1961 – Philco
  - Telepresence with a HMD
    - Remote camera
  - Magnetic head tracker
  - Single CRT



Birth of Modern VR

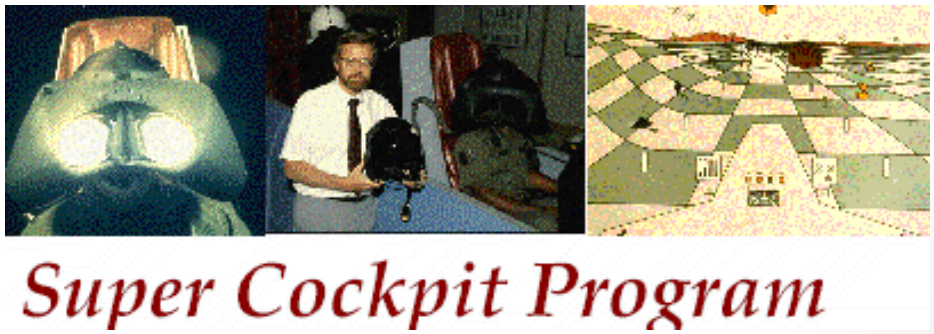
- 1963
  - Interactive graphics
  - Sketchpad
- 1965
  - Ultimate display paper
- 1968
  - A Head-mounted Three-Dimensional Display
- 1970
  - Videoplace - movie
- 1974 – Jim Clark
  - Ph.D. on HMD's





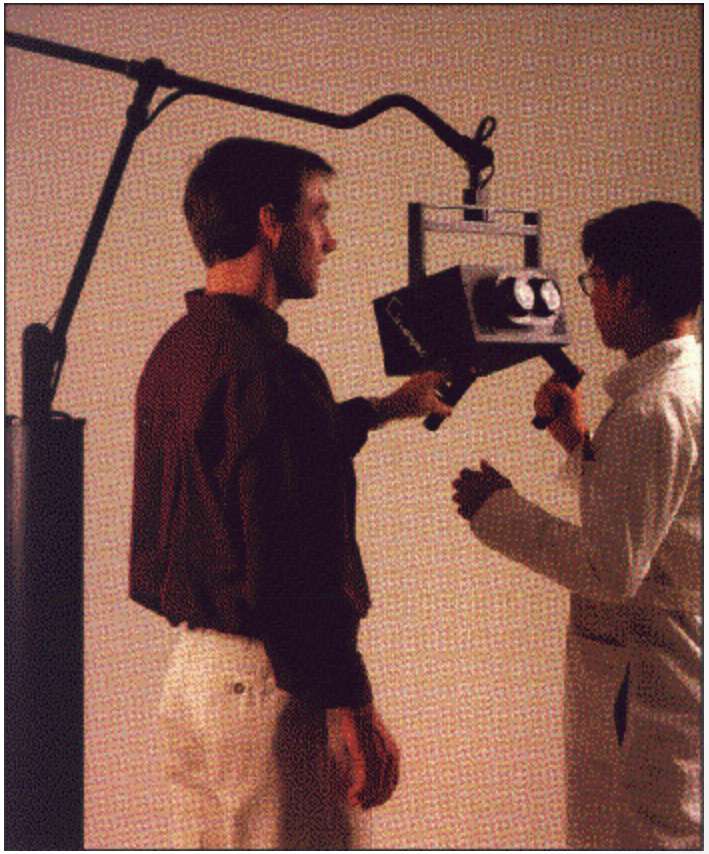
The Next Wave

- 1980's – Scott Fisher (NASA-Ames)
  - VIEW project –
  - movies – start 2:05
- 1980's – Jaron Lanier
  - "Virtual Reality"
- Tom Furness
  - Super cockpit



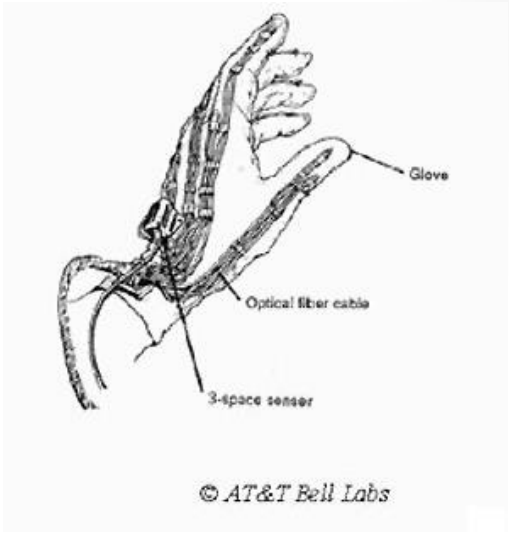
More displays

- 90s - Fakespace boom
  - High resolution
  - ergonomic



Gloves

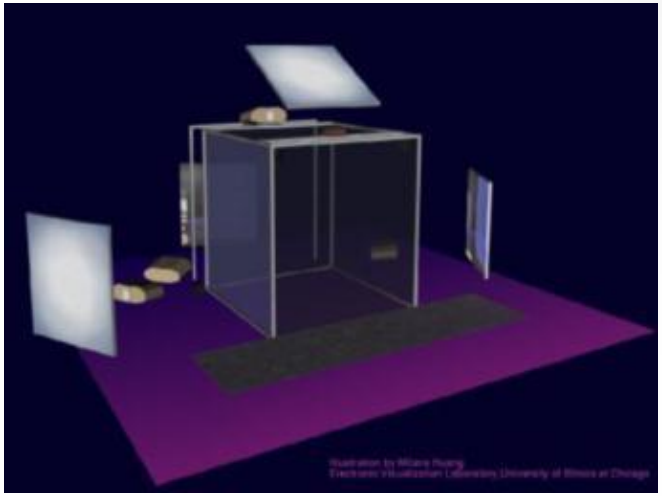
- 1977 – Sayre
  - Light tube attenuation to measure bend
- 1981 – Grimes (Bell)
  - Bend, tactile sensors
- 1984 – VPL
  - VPL DataGlove
- 1993 Utah/MIT
  - Dextrous Hand Master (Hollerbach)



Dextrous Hand Master, Exos

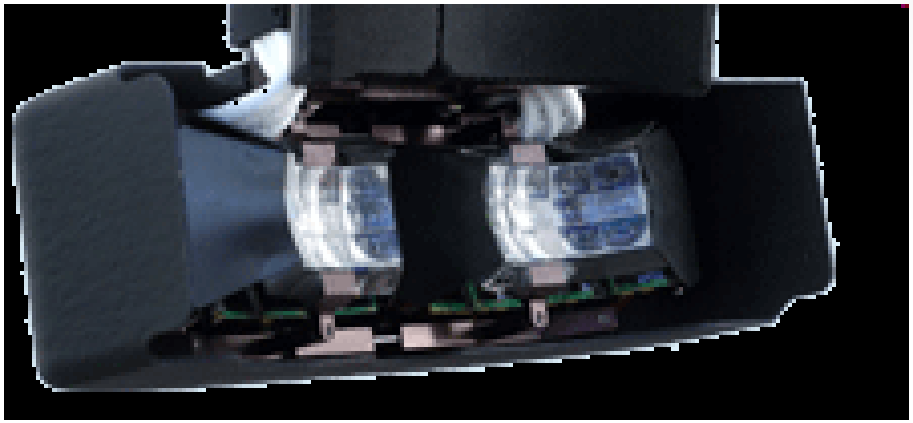
CAVE displays

- 1992
  - Users in a projected room
  - CAVE movie



Current Companies

- Sensics
- Intersense
- Raytheon
- Nintendo
- Track-IR

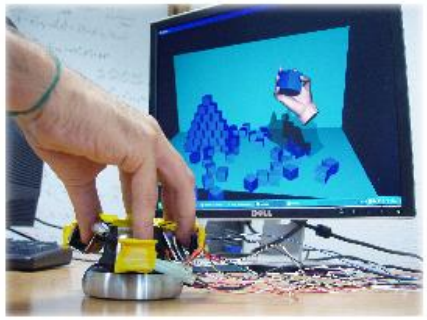


Types of VR(Virtual Reality)

1. Windows on World(WoW) (also called Desktop VR)
2. Immersive VR
3. Telepresence
4. Mixed Reality(Augmented Reality)
5. Distributed VR

1.Windows on World(WoW)

- Also called Desktop VR.
  - Using a conventional computer monitor to display the 3D virtual world.

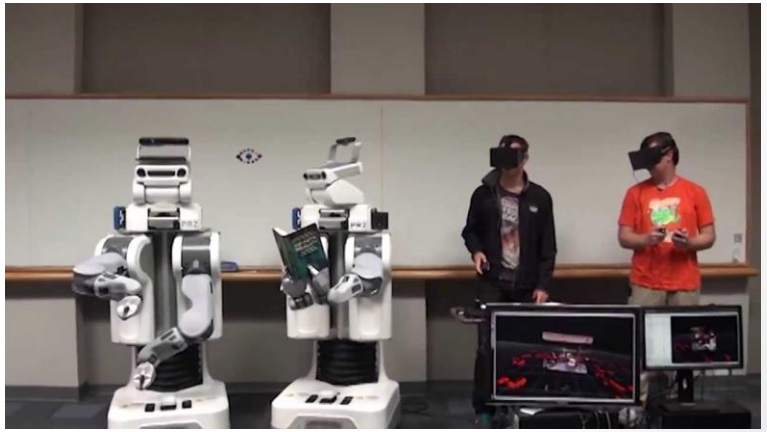


2.Immersive VR

- Completely immerse the user's personal viewpoint inside the virtual 3D world.
- The user has no visual contact with the physical word.
- Often equipped with a Head Mounted Display (HMD).

3.Telepresence

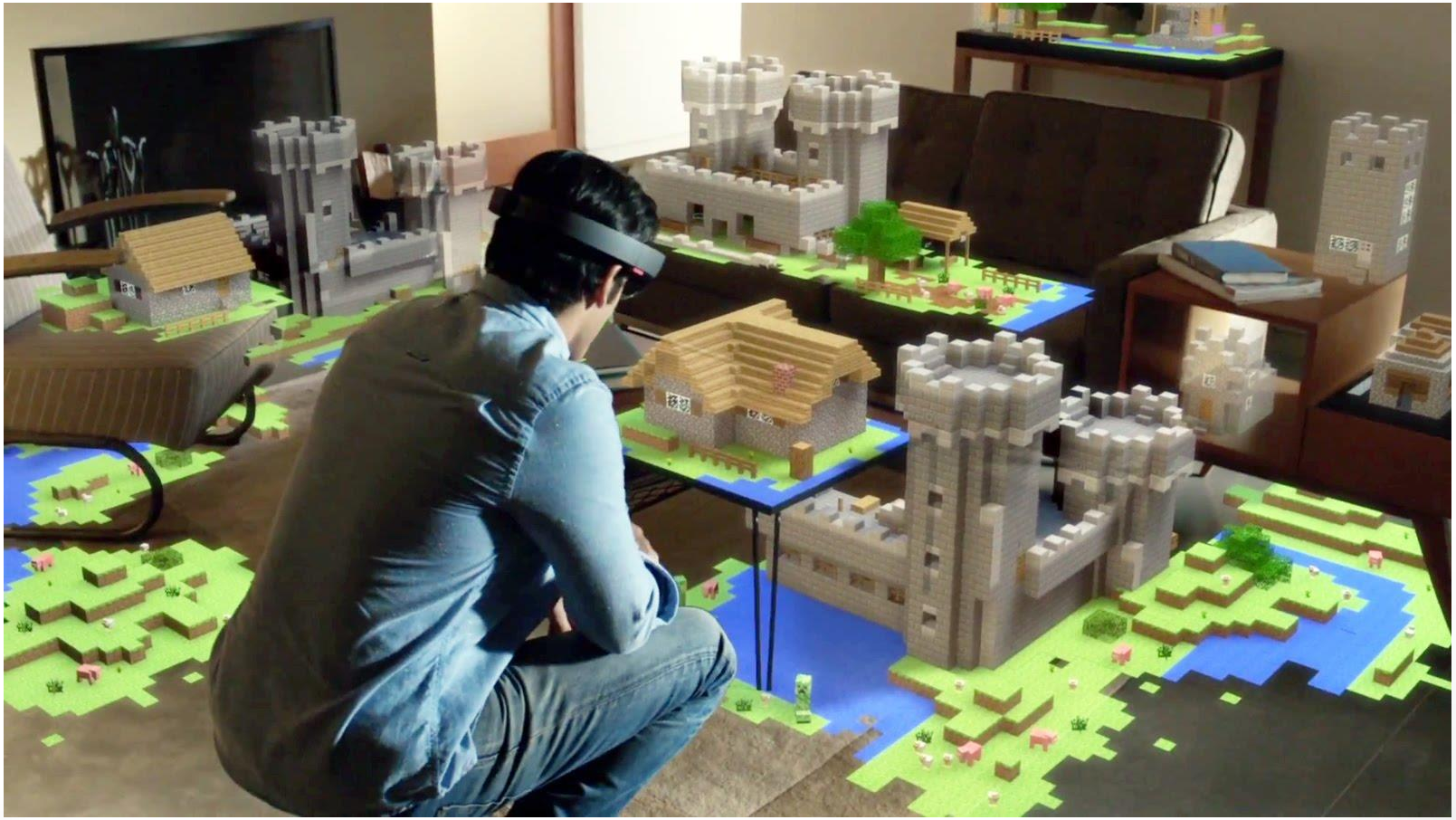
- A variation of visualizing complete computer generated worlds.
- Links remote sensors in the real world with the senses of a human operator. The remote sensors might be located on a robot. Useful for performing operations in dangerous environments.



4.Mixed Reality(Augmented Reality)

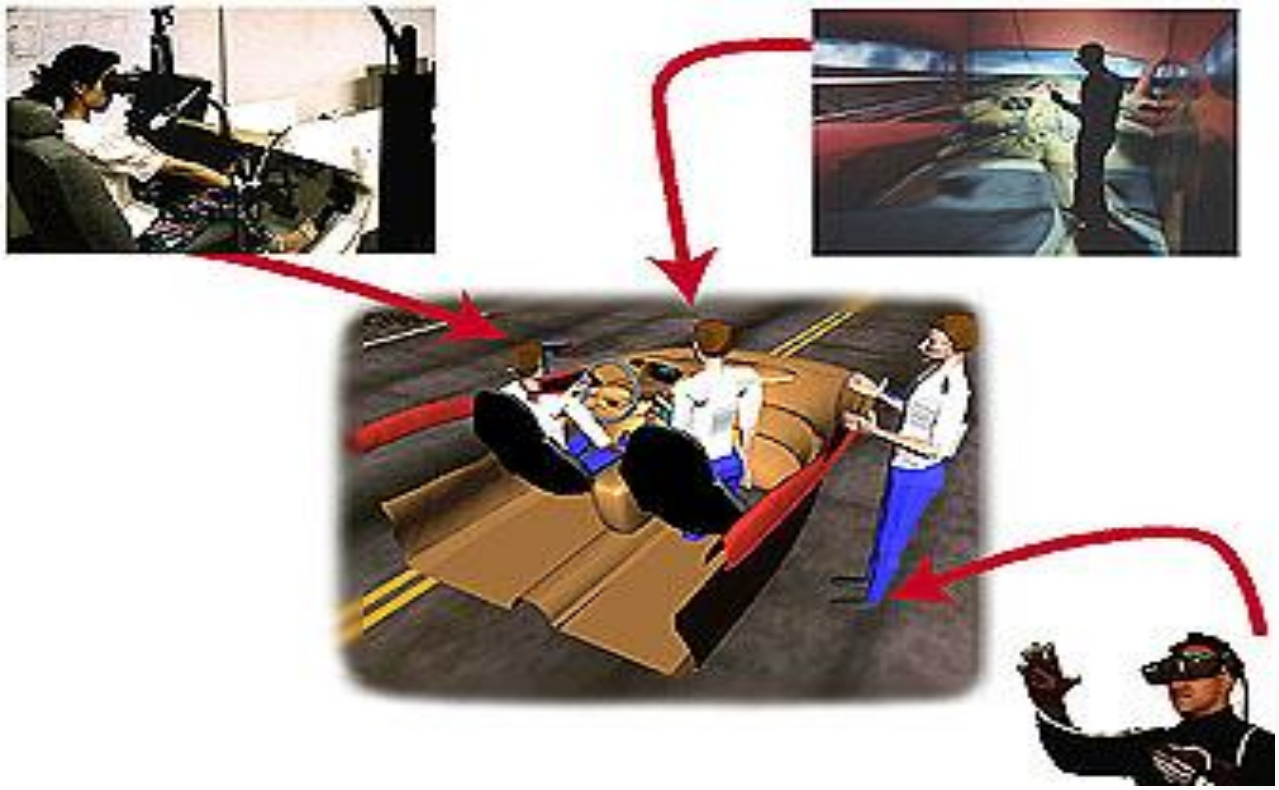
- The seamless merging of real space and virtual space.
- Iintegratee the computer-generated virtual objects into the physical world which become in a sense an equal part of our natural environment.

Augmented VR



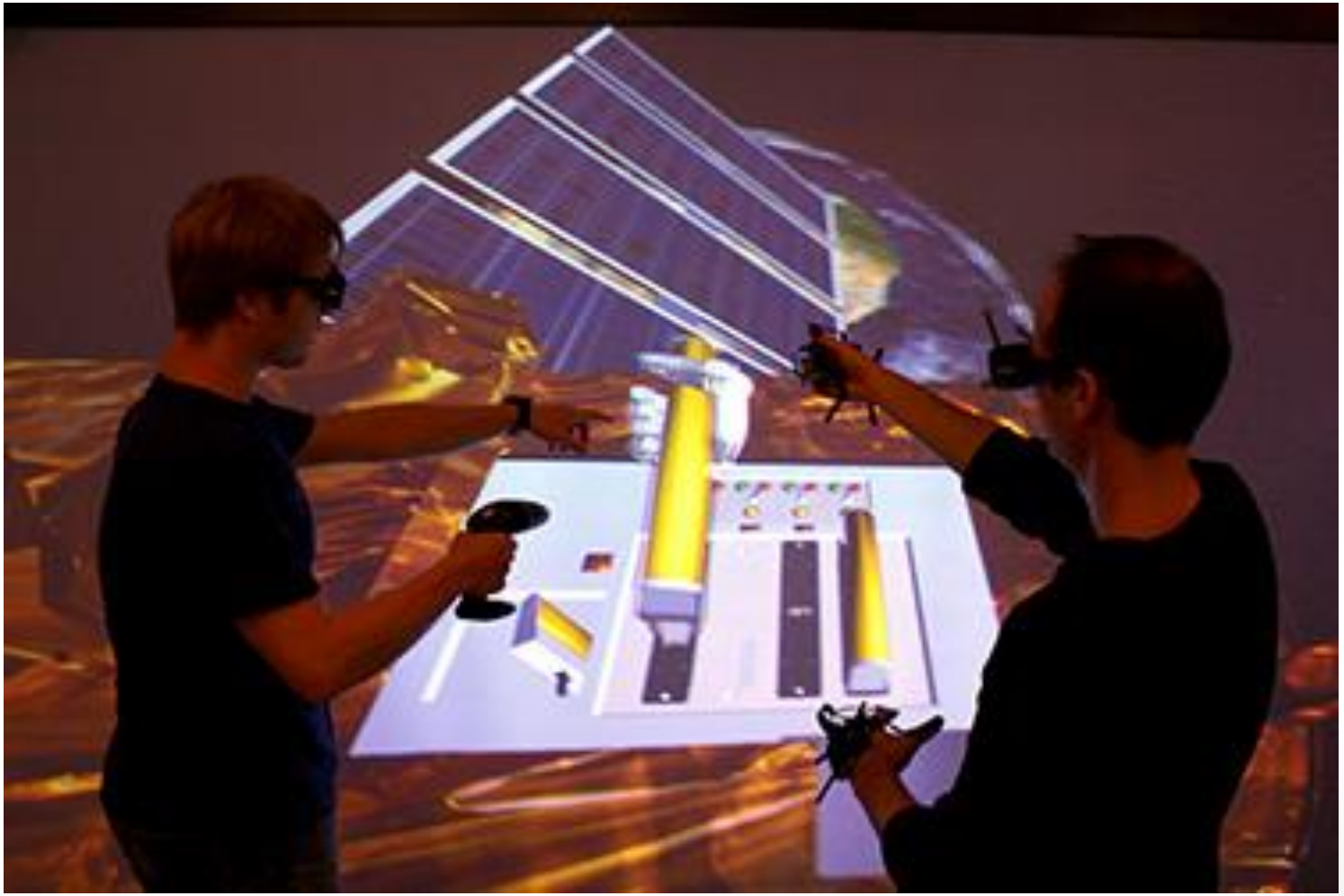
5.Distributed VR

- A simulated world runs on several computers which are connected over network and the people are able to interact in real time, sharing the same virtual world.



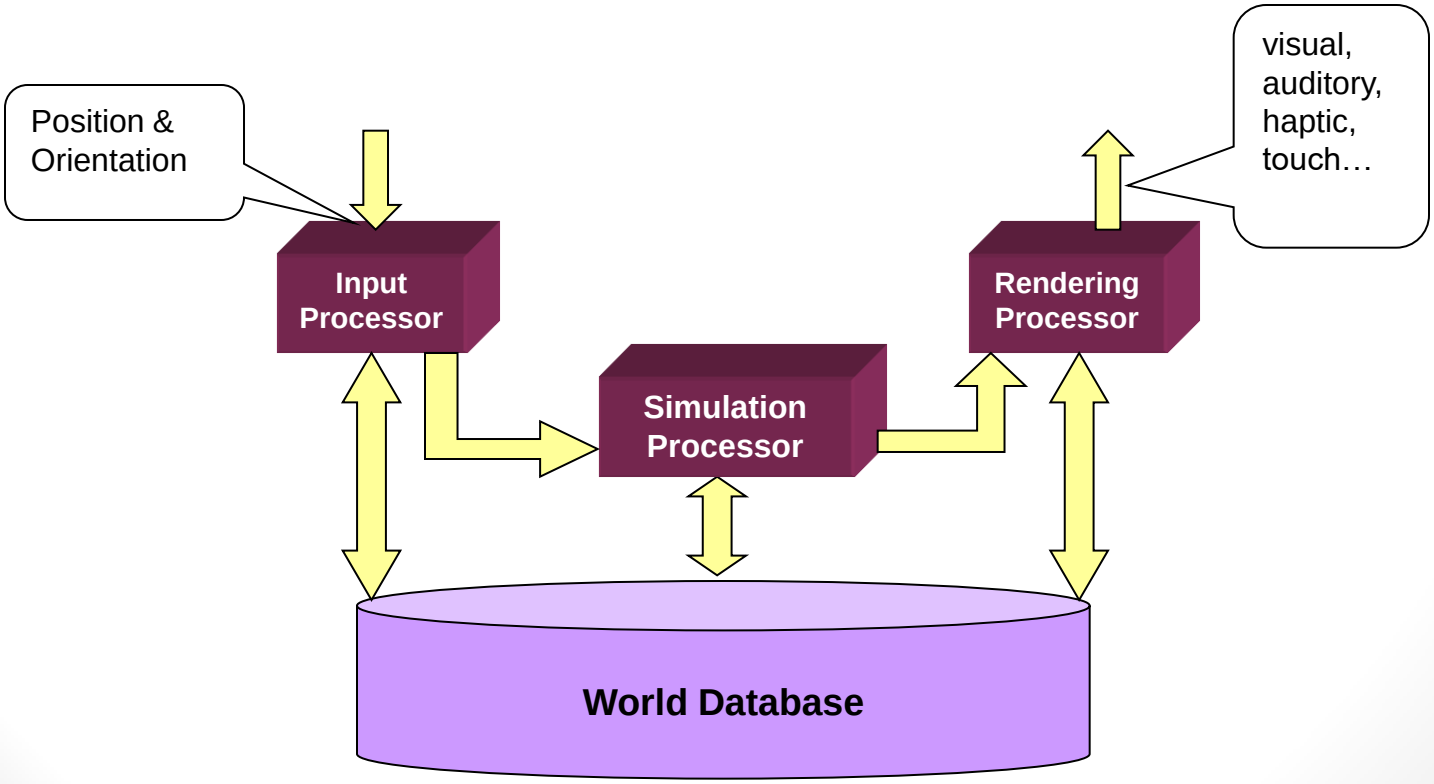
Distributed VR

Distributed VR



Architecture of VR System

- Input Processor, Simulation Processor, Rendering Processor and World Database.



Input Processor

- Control the devices used to input information to the computer. The object is to get the coordinate data to the rest of the system with minimal lag time.
- keyboard, mouse, 3D position trackers, a voice recognition system, etc.

Simulation Processor

- Core of a VR system.
- Takes the user inputs along with any tasks programmed into the world and determine the actions that will take place in the virtual world.

Rendering Processor

- Create the sensations that are output to the user.
- Separate rendering processes are used for visual, auditory, haptic and other sensory systems. Each renderer take a description of the world stat from the simulation process or derive it directly from the World Database for each time step.

World Database (World Description Files)

- Store the objects that inhabit the world, scripts that describe actions of those objects.

Application of VR

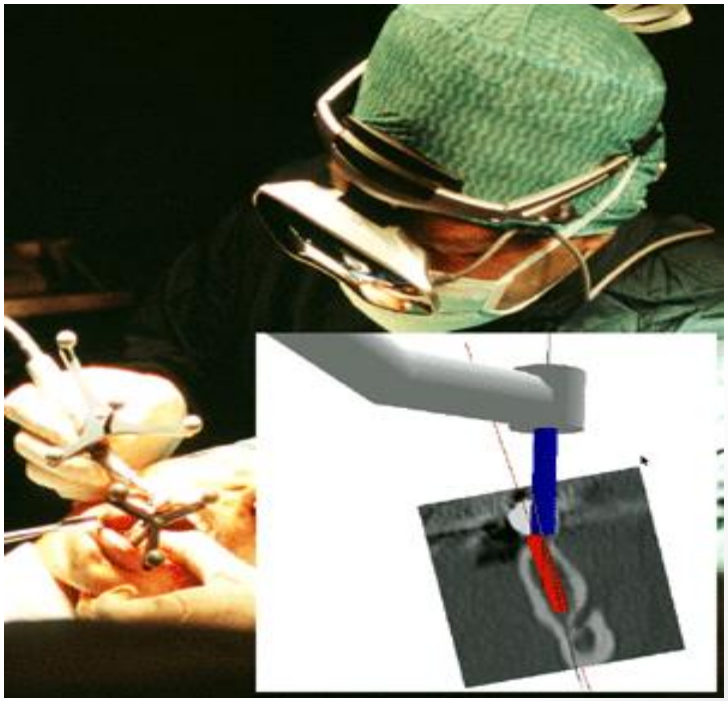
- Education and training
- Video Games
- Fine art
- Heritage and archaeology
- Architecture design
- Urban Design
- Therapy
- Theme parks
- Concerts
- Retail
- Film
- Media
- Motion pictures

Application of VR

- **Entertainment**
  - More vivid
  - Move exciting
  - More attractive

Applications (Cont'd)

- **Medicine**
  - Practice performing surgery.
  - Perform surgery on a remote patient.
  - Teach new skills in a safe, controlled environment.



Applications (Cont'd)

- Manufacturing
  - Easy to modify
  - Low cost
  - High efficient

Applications (Cont'd)

- Education & Training
  - Driving simulators.
  - Flight simulators.
  - Ship simulators.
  - Tank simulators.

Concerns and challenges

- health and safety considerations of virtual reality
- The big challenges in the field of virtual reality are developing better tracking systems, finding more natural ways to allow users to interact within a virtual environment and decreasing the time it takes to build virtual spaces. While there are a few tracking system companies that have been around since the earliest days of virtual reality, most companies are small and don't last very long. Likewise, there aren't many companies that are working on input devices specifically for VR applications. Most VR developers have to rely on and adapt technology originally meant for another discipline, and they have to hope that the company producing the technology stays in business. As for creating virtual worlds, it can take a long time to create a convincing virtual environment - the more realistic the environment, the longer it takes to make it. It could take a team of programmers more than a year to duplicate a real room accurately in virtual space.

- Another challenge for VE system developers is creating a system that avoids bad ergonomics. Many systems rely on hardware that encumbers a user or limits his options through physical tethers. Without well-designed hardware, a user could have trouble with his sense of balance or inertia with a decrease in the sense of telepresence, or he could experience ***cybersickness***, with symptoms that can include disorientation and nausea. Not all users seem to be at risk for cybersickness -- some people can explore a virtual environment for hours with no ill effects, while others may feel queasy after just a few minutes.

- Some psychologists are concerned that immersion in virtual environments could psychologically affect a user. They suggest that VE systems that place a user in violent situations, particularly as the perpetuator of ***violence***, could result in the user becoming desensitized. In effect, there's a fear that VE entertainment systems could breed a generation of sociopaths. Others aren't as worried about desensitization, but do warn that convincing VE experiences could lead to a kind of cyber addiction. There have been several news stories of gamers neglecting their real lives for their online, in-game presence. Engaging virtual environments could potentially be more addictive.

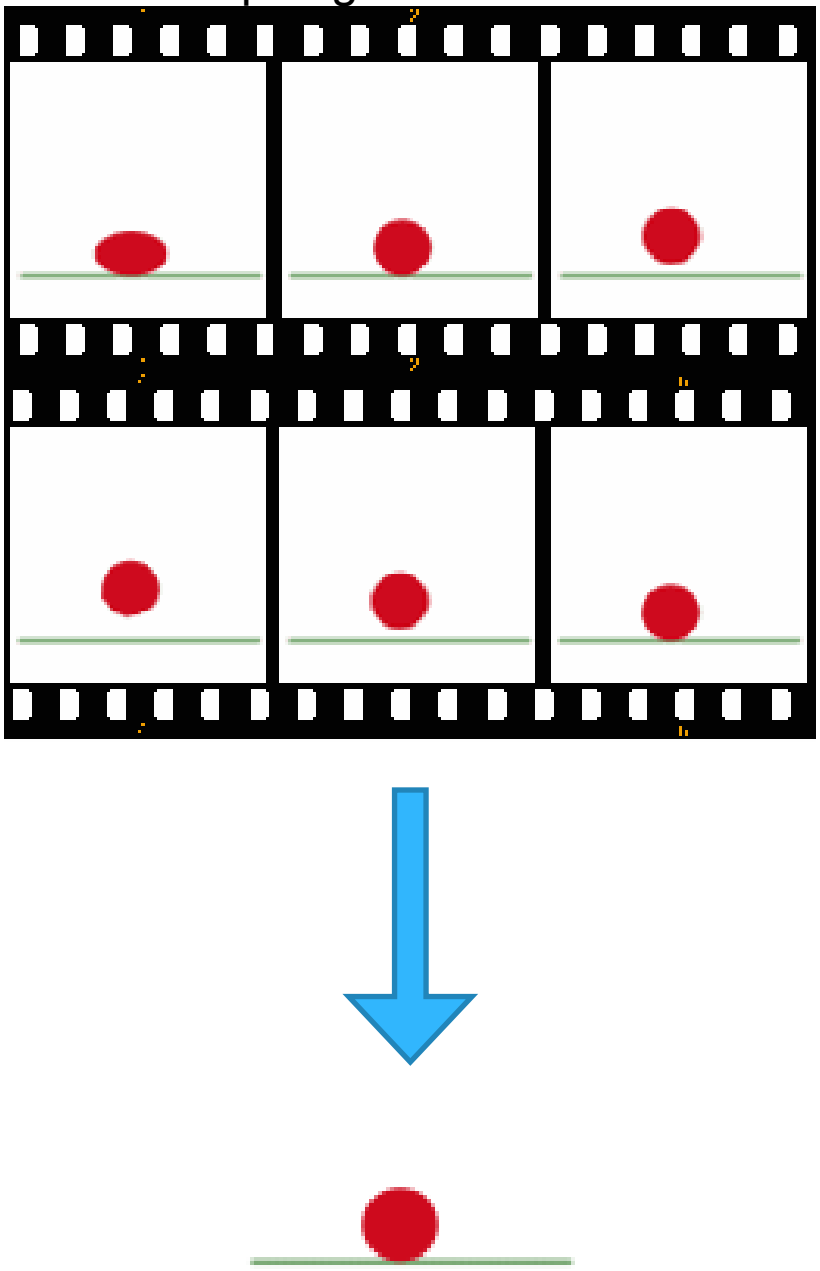
- Another emerging concern involves ***criminal*** acts. In the virtual world, defining acts such as murder or sex crimes has been problematic. At what point can authorities charge a person with a real crime for actions within a virtual environment? Studies indicate that people can have real physical and emotional reactions to stimuli within a virtual environment, and so it's quite possible that a victim of a virtual attack could feel real emotional trauma. Can the attacker be punished for causing real-life distress? We don't yet have answers to these questions.

Animation

Computer Graphics

Introduction

- **Animation** is the process of making the illusion of motion and change by means of the rapid display of a sequence of static images that minimally differ from each other. The illusion—as in motion pictures in general—is thought to rely on the phenomenon. Animators are artists who specialize in the creation of animation.
- Animation is the creation of the “illusion of movement” using a series of still images.
- A collection of static image joined together and shown consecutively so that appear to move.



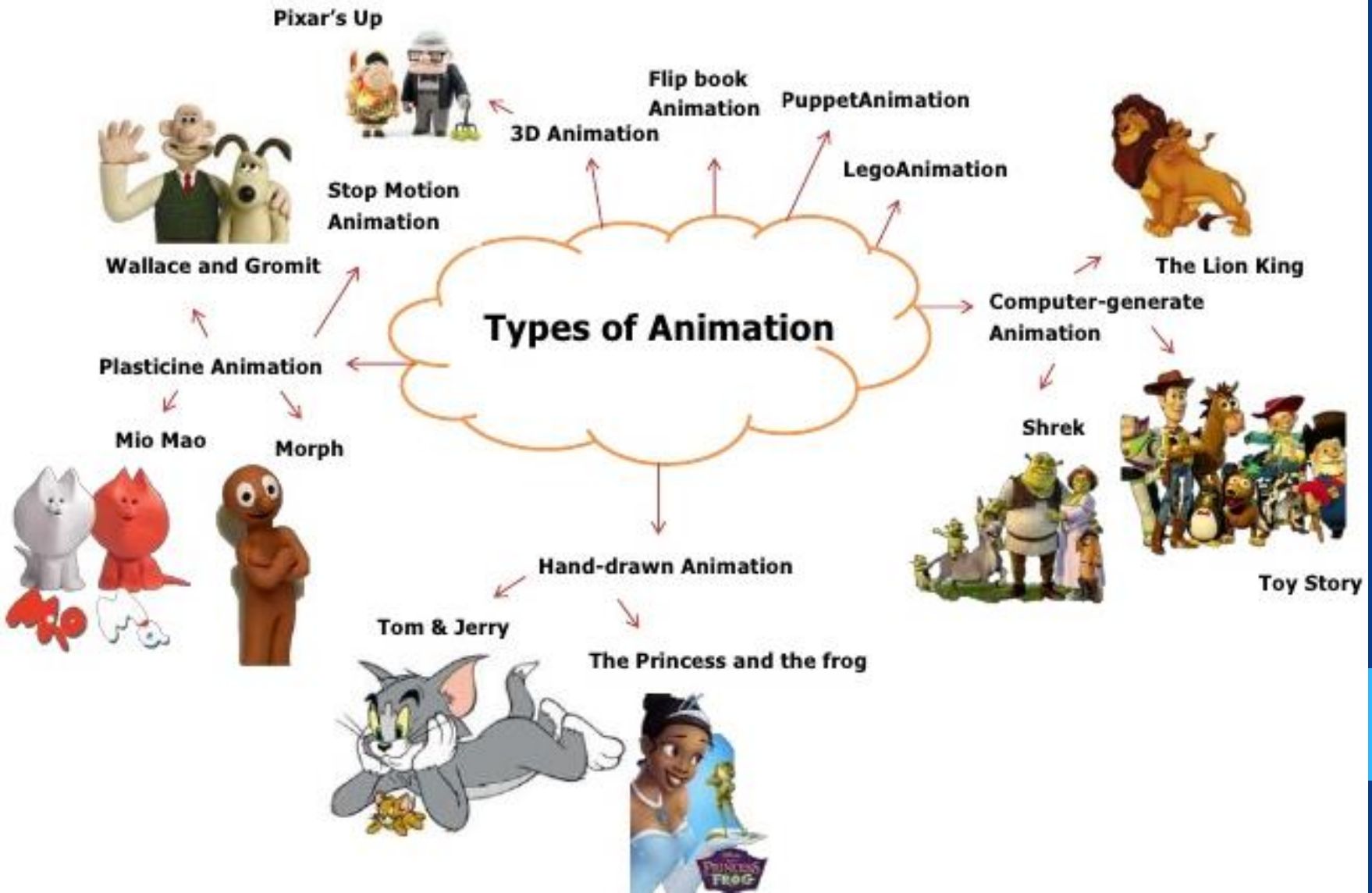
Introduction ....

- Animation creation methods include the traditional animation creation method and those involving stop motion animation of two and three-dimensional objects, paper cutouts, puppets and clay figures. Images are displayed in a rapid succession, usually 24, 25, 30, or 60 frames per second.

Types of Animation

- Hand Drawn Animation
- Stop Motion Animation
- Computer animation

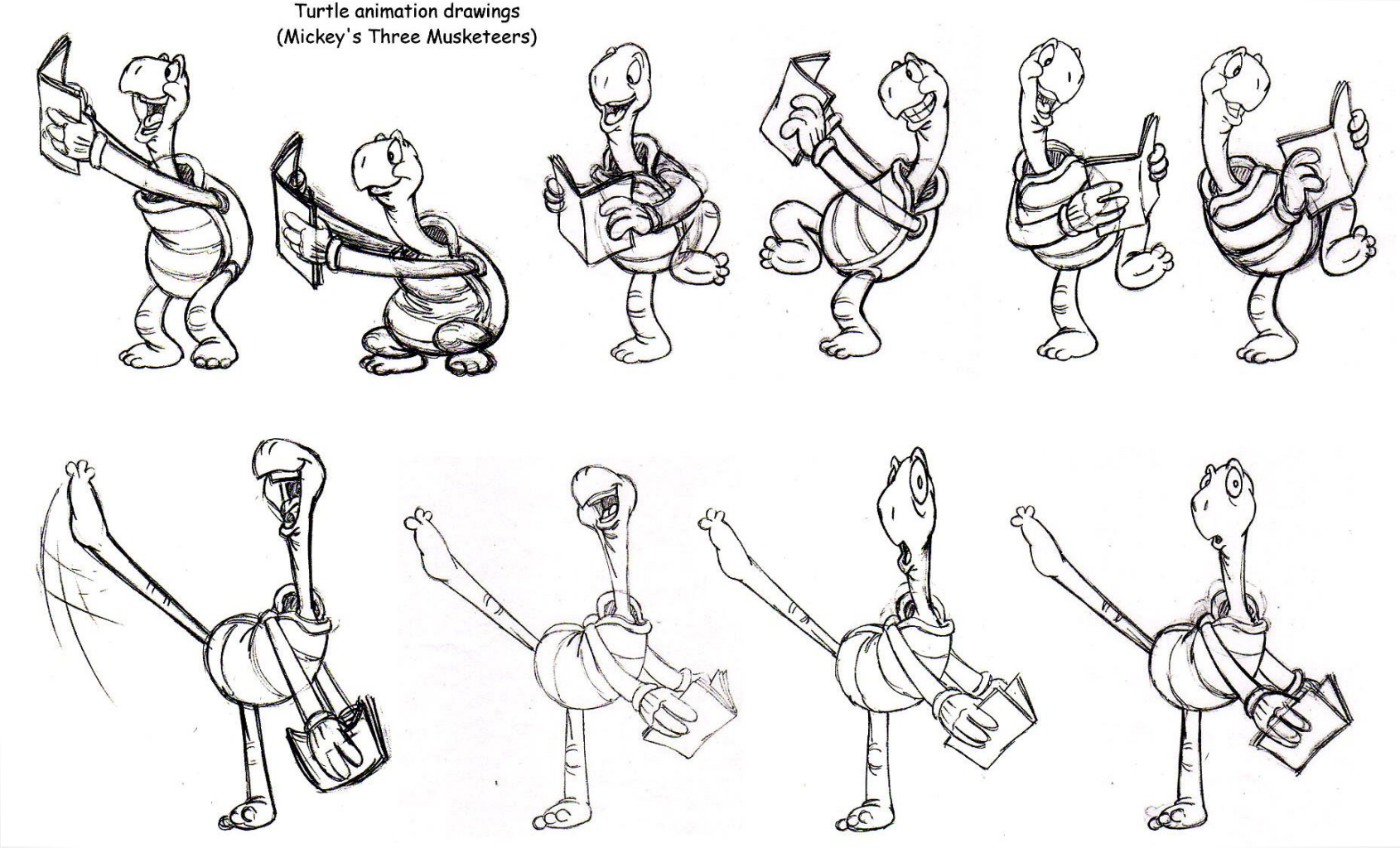
Types


Types of Animation
3D Animation
Pixar's Up
Flip book Animation
PuppetAnimation
LegoAnimation
Stop Motion Animation
Wallace and Gromit
Computer-generate Animation
The Lion King
Plasticine Animation
Mio Mao
Morph
Shrek
Toy Story
Hand-drawn Animation
Tom & Jerry
The Princess and the frog

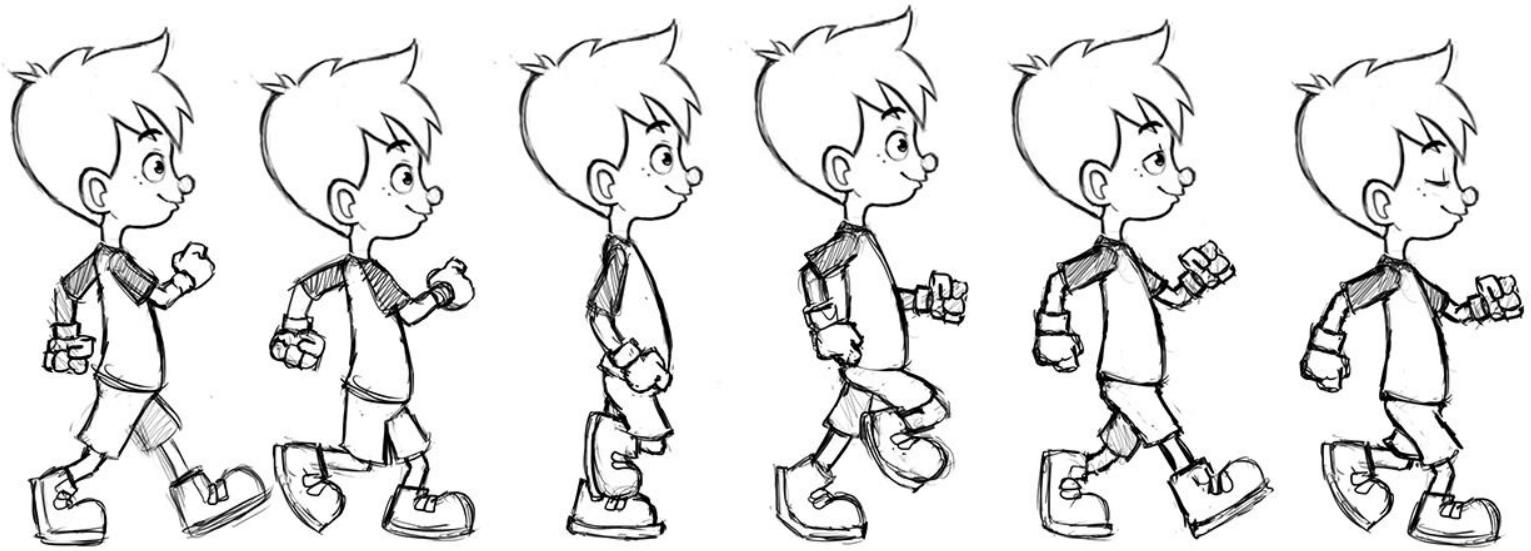
Hand Drawn Animation

- Done by an artist who draws each character and movement individually
- Very time consuming to have to draw, then color, then photograph each picture
- Draw pictures first, then color them on celluloid, then they pictures and animate them
- Very expensive due to hours of labor involved
- Examples: older Disney Movies i.e. Bambi, Fox and Hound, Cinderella etc.

Hand Drawn Animation



Hand Drawn Animation



Stop Motion Animation

- Can be done by virtually anyone, with no extensive training
- Does not take that much time relative to the other 2 methods
- Uses jointed figures or clay figures that can be moved to make motions
- Take still pictures of the individual movements, then use relatively inexpensive computer software to animate
- We use Movie Maker Software to complete our animations
- Not very expensive because all you need is a digital camera and the software comes with windows XP operating system
- Examples: star wars, robot chicken, old Rudolph the red Nosed Reindeer.

Stop Motion Animation

Stop Motion Animation

Computer Animation

- All characters and movements are generated using computer animation software
- Can also be very time consuming as they can get very complicated in movements and effects
- All characters are fully animated with no still pictures
- Can be very expensive because of the complexity of the stunts and animation being done
- Huge budgets because the animation sequences more complicated these days eg. The war scenes in Lord of the Rings etc.
- Examples: Toy story , finding Nemo, Matrix, Lord of the Rings

Introduction ....

to animate = "to bring to life"

Animation **covers changes in:**

time-varying positions (motion dynamics),

shape, color, transparency, structure and texture of an object (update dynamics) as well as lightning, camera position, camera orientation and focus.

Basic Concepts **of animation are:**

Input Process

- Key frames, where animated objects are at extreme or characteristic positions must be digitized from drawings.
- Often a post-processing by a computer is required.

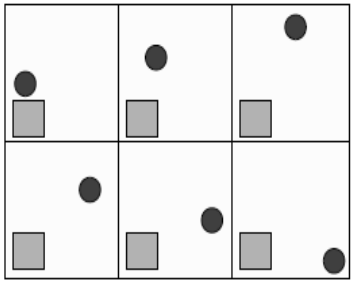
Composition Stage

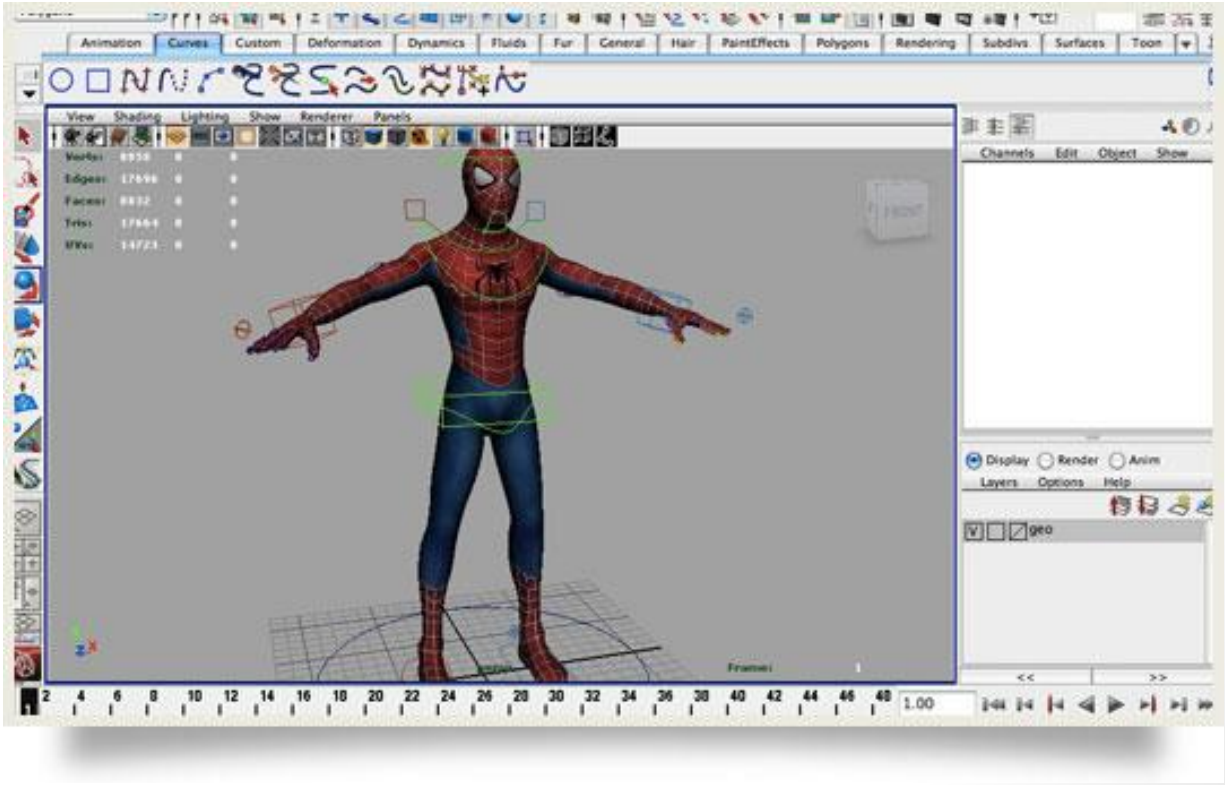
Foreground and background figures are combined to generate an individual frame.

Placing of several low-resolution frames of an animation in an array leads to a *trail film* (pencil test), by the use of the *pan-zoom* feature (This feature is available for some frame buffers).

The frame buffer can take a part of an image (pan) and enlarge it to full screen (zoom).

Continuity is achieved by repeating the pan-zoom process fast enough.



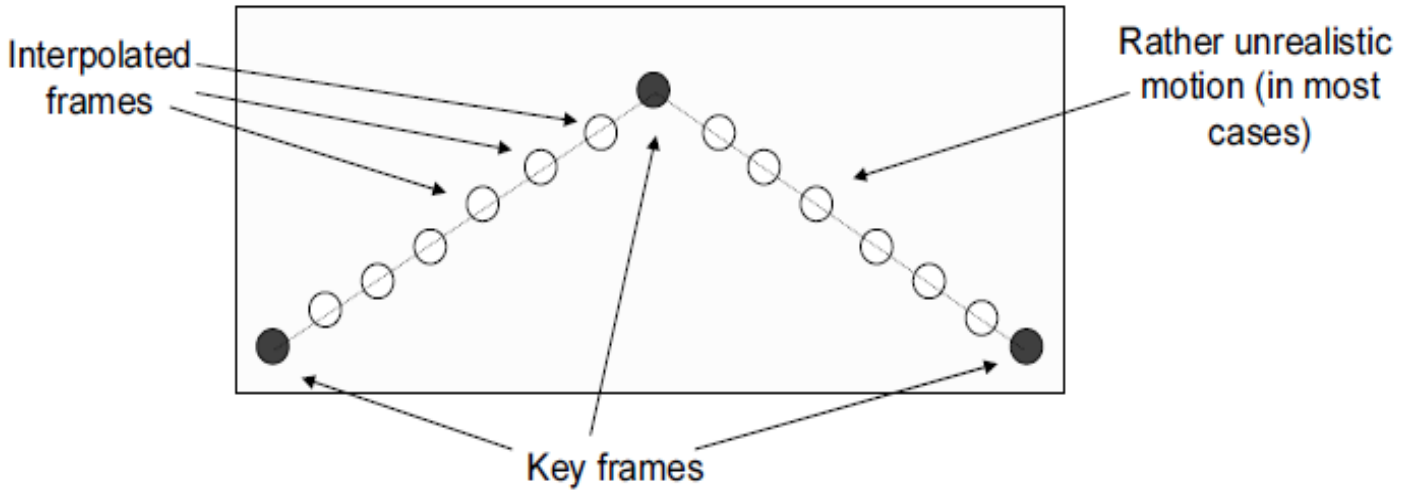


In-between Process

Composition of intermediate frames between key frames.

Performed by linear interpolation (lerping) between start- and end-positions.

To achieve more realistic results, cubic spline-interpolation can be used.



Basic Step Of Animation

1. Shooting reference video
2. Key posing
3. Blocking
4. Splining
5. Smoothing
6. Adding life

1. Shooting Reference Video

- This is a very important and **overlooked** step. It's weird how people really think they know what certain actions look like and how long they take, but in reality they are often wrong.
- Physical actions is something you **need to analyze** before animating, especially if you're a beginner.
- You have a shot of a guy throwing a baseball? Better YouTube some reference video of pitchers throwing balls. Don't assume you know what an action looks like just because you've seen it before. Looking at an action as an **animator** is completely different than looking at it as a regular viewer.

2. Posing

- After shooting a reference, it's time to create the key poses of the shot.
- These poses are called key poses because they are the most important poses of the shot. These are the poses that convey the story of the shot. We better make sure we **get those poses right**, because we're going to build on those for the rest of the process.

3. Blocking

- Once we're happy with our key poses, we start **breaking down** the movement from each pose to the next by adding '***in between***' (also known as breakdown poses or passing poses). These are the poses that connect the key poses.
- We keep adding more poses until the movement looks as good as it could, while still staying in **stepped mode** (stepped mode is when you don't allow interpolation between poses, which results in a very choppy/blocky motion).

4. Splining

- Splining is a 3D animation term. It's the process in which you convert the interpolation of the keys from stepped to spline. In other words – you make the computer connect the movement between each of your poses, and that makes the movement **look smoother.**
- The problem is that the computer doesn't do a very good job at interpolating. It only works with what it has. That's why the better the blocking is – the better the splined version is going to look.

5. Smoothing and offset

- Now that all of our keys are on spline mode, we have to work on them. We need to clean up all the curves and make sure the movement looks smooth.
- It's also a good idea to **offset** some of the actions so it doesn't look so **'stop and start'**, as if the character is doing all the motion at once. By the end of this step your shot should look pretty solid and almost finished.

6. Adding life

- This step is the a lot of fun. We've already finished with the grunt work of animating and it's time to add the fun stuff. In this step we add **small imperfections** that bring life to the character. Maybe an extra blink or a mouth twitch here and there. The difference between the last 2 steps is small but very noticeable.

Animation Uses

- Animated Movies: Million dollar industry;
- 1-20 millions spent on each movie
- Animation and computer graphics effects are used in movies frequently
- Video games
- TV programs(e.g. Weather, News)
- Used online (images, ads, chatting)
- Simulations (science and Engineering)
- Virtual Reality (e.g. second life)

Computer Animation Languages

Design and control of animation sequences are handled with a set of animation routines, which are called computer animation languages. Any general purpose language can be used, but several specialized animation languages have been developed.

- **Key Frame Systems**
  - Specialized animation languages designed simply to generate the in-betweens from the user-specified key frames.
- **Parameterized Systems**
  - Designed to specify object-motion characteristics such as degrees of freedom, motion limitations, and allowable shape changes.
- **Scripting Systems**
  - Scripting systems allow object specifications and animation sequences to be defined with a user-input script.
  - From the script, a library of various objects and motions can be constructed.

Key Frame

A **key frame in animation** and filmmaking is a drawing that defines the starting and ending points of any smooth transition. The drawings are called "frames" because their position in time is measured in frames on a strip of film.

Morphing

It is derived from the word metamorphosis, which means the transformation shape, appearance of one thing into another. The transformation of object shapes from one form to another is called morphing.

Also it can be defined as:

- Transition from one object to another.
- Process of transforming one image into another.

Morphing...

Finished !!!!!