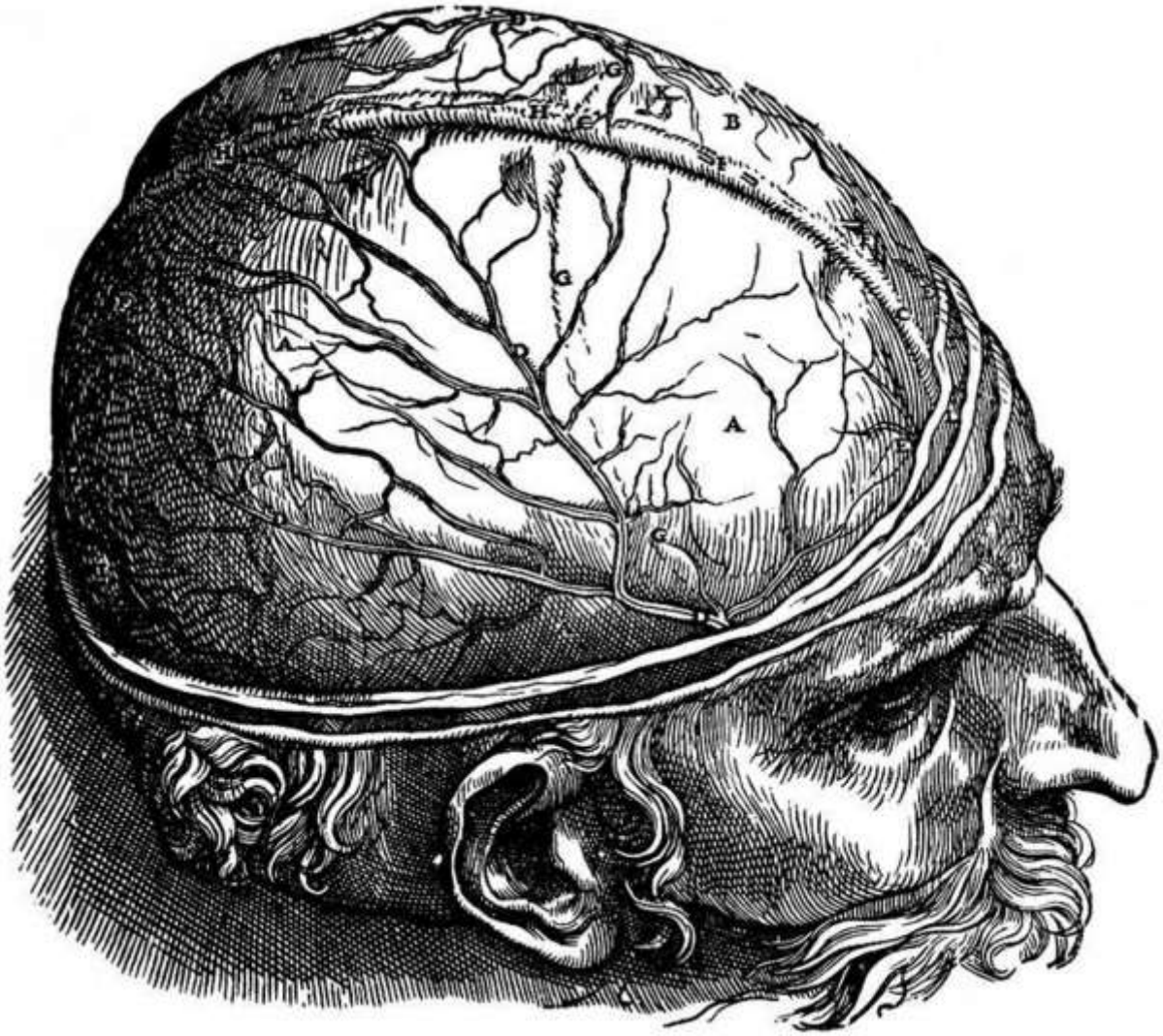
Innovate!
Materials and Methods in Healthcare Simulation

By Barry M. Robinson, Simulation Technologist


A
B
C
G
H

I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail.

Abraham Maslow, "*Toward a Psychology of Being*" 1966

Be Brave

Be Creative

Innovate!

Innovation, Renovation, and Resuscitation –
Creativity and the use of materials

Innovation

The World Wide Web hypertext system. Although previous networks had used hypertext, the web was an innovation. It used the components of the previous systems in novel and unexpected ways.

Shown, at right, is Sir Timothy John Berners-Lee, the inventor of the World Wide Web.

Renovation

Modern cellphones are direct descendants of the plain old telephone system (POTS). Cellphones provide basic voice communications. These have been renovated by the addition of new features and improved usability (e.g. mobility, text-messaging). Shown to the left is the inventor of the cell phone, Martin "Marty" Cooper, in 2007

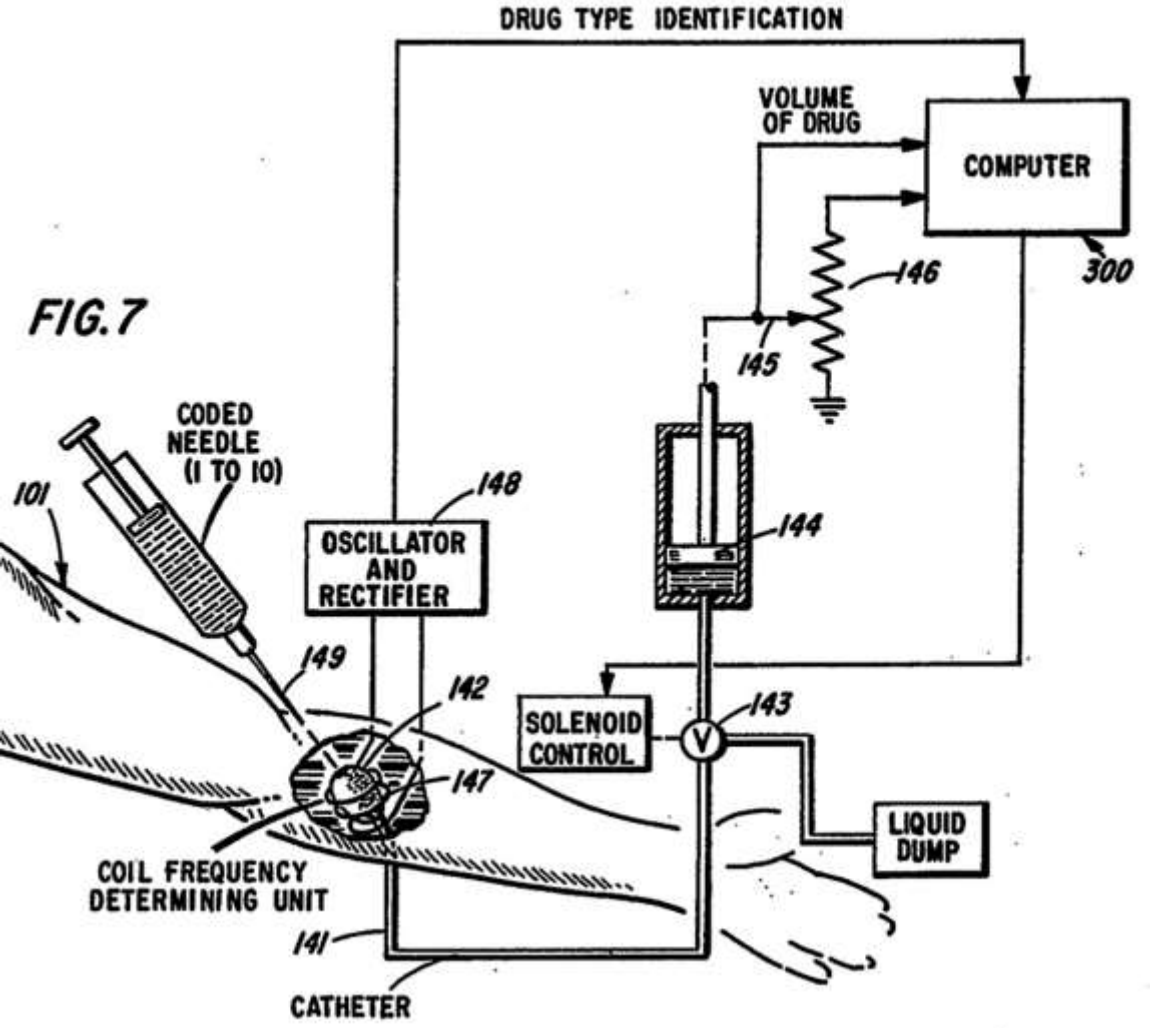


FIG. 7

Resuscitation

The Sim-One mannequin, developed by Stephen Abrahamson et al in the late 1960s used an early RFID system to detect drugs given via IV. The Sim-One was never commercialized.

This system, with an updated digital RFID, was resuscitated by Laerdal for use in the SimMan 3G.

Making molds

General considerations.

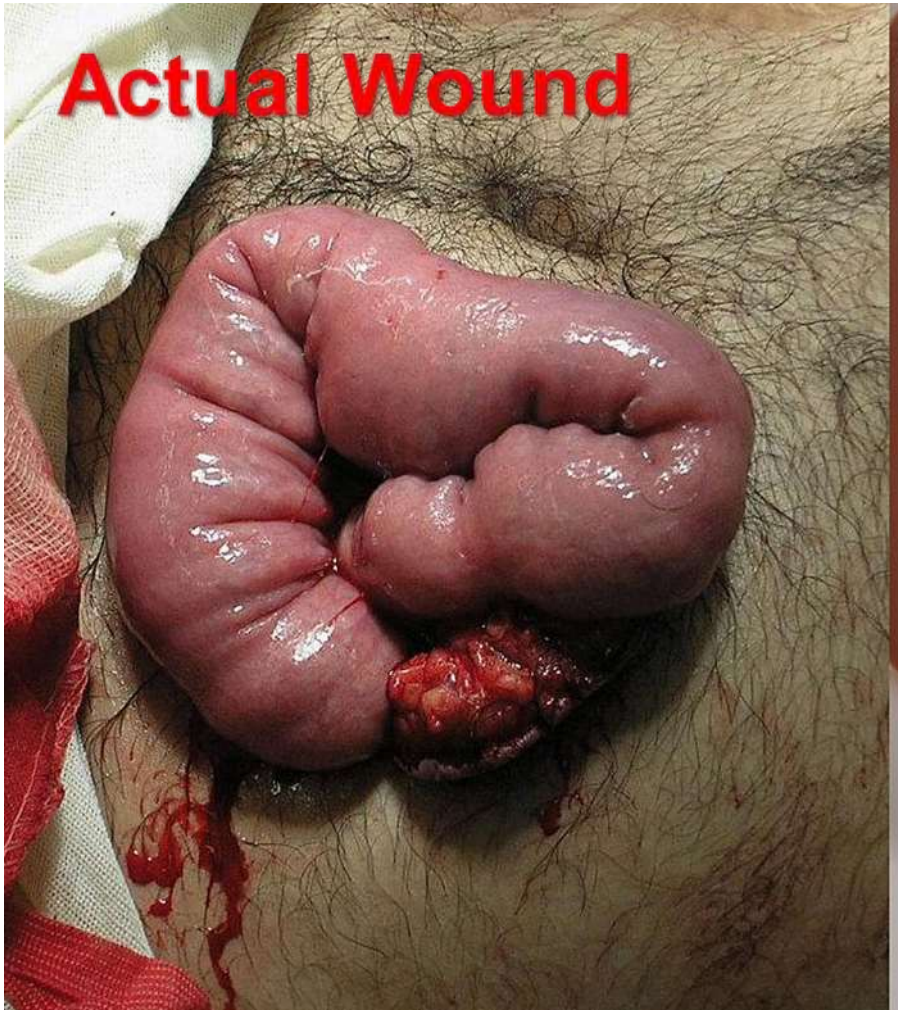
- Use a mold when you need multiple copies.
- Use when you need detail or approval.
- Some types of material need to be molded. (e.g. some types silicone which cannot be thickened for sculpting)

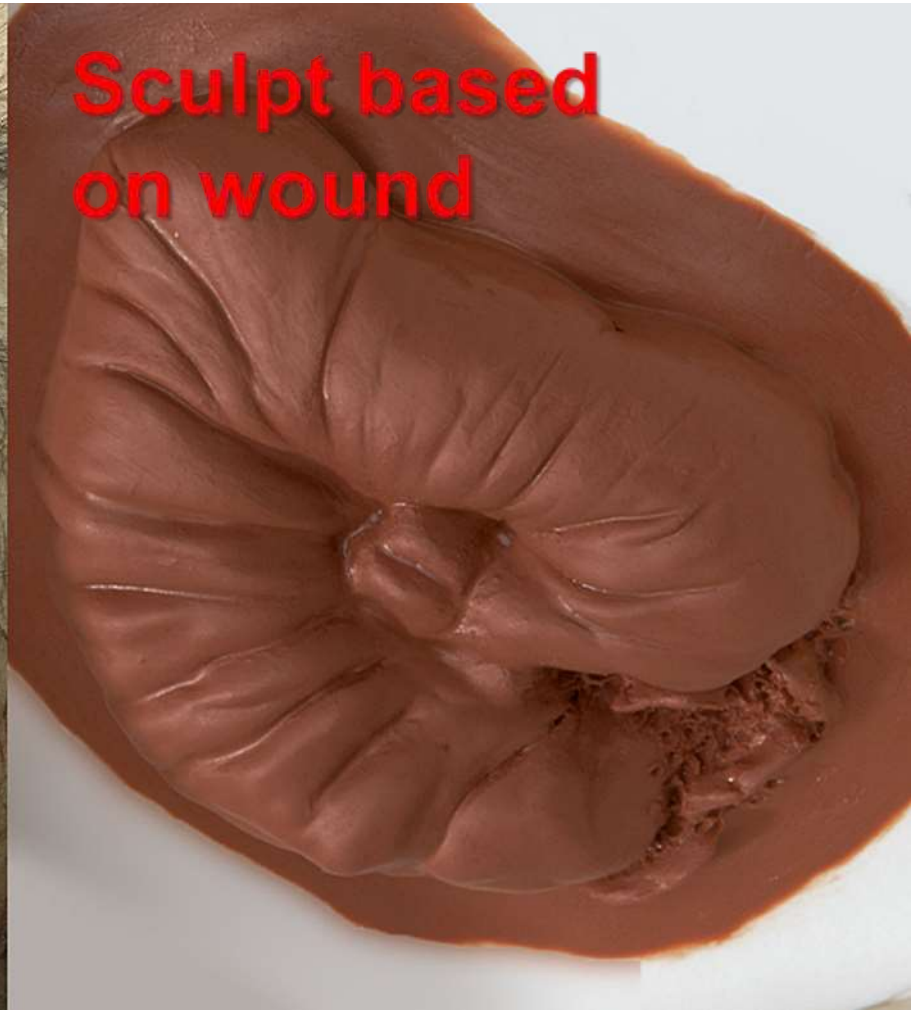
Plate molds

- Flat molds in which one side of the mold is open and the material being cast is flat.
- Can be made from stone (plaster), silicone, or other materials.
- Limit undercuts.
- Primarily used for casting flexible materials such as silicone, gelatin, and (gasp!) latex.

The Original Sculpt

- Use only non-sulphur plastiline (NSP) for your original sculpt. Sulphur can inhibit silicone.
- Try to avoid undercuts in sculpts. The amount of undercutting depends on the strength and flexibility of the material you are casting.
- You may have to use a multi-part mold or a flexible mold with a rigid, keyed support for sculpts with undercuts.


Actual Wound


Sculpt based
on wound

Stone molds

- **Ultracal 30:** A very hard plaster used to make molds for use in industry. Usually released. Has a pot life of 30 minutes.
- **Pottery plaster:** A porous plaster used to make molds for slip casting. Slip molds should NOT be released.
- **Plaster of Paris:** Soft, not very strong, has a short pot life and should **not** be used in mold making.

Silicone molds – Mold Max 30

- Flexible. Excellent for sculpts which have undercuts. Large or thin wall molds require a rigid support which has been keyed to the silicone mold.
- For most materials silicone molds do not require a release. Nothing sticks to silicone except silicone. (silicone in a silicone mold **MUST** have a release)
- Silicone mold material can be thickened for brush on applications. As always, be aware of the pot time.

Silicone

What is it? Silicone is a rubber-like compound based on silicon chemistry (sand: silicon dioxide).

Uses: prosthetics, medical devices, non-stick items, molds.

Characteristics: variable softness/hardness(shore index). Electrical insulator. Doesn't absorb water.

Nothing sticks to silicone (except silicone).

Types of silicone

- Most silicones that consumers will use are Room Temperature Vulcanized (RTV), the material cures at room temperature 21°C.
- Construction silicone, often used as a sealant, is a moisture cured RTV. This type of silicone will generate acetic acid as a by-product of curing. In addition, isopropyl alcohol or lithium-based additives can inhibit curing of this product. It is sometimes used in simulation but only in a limited way.
- **Never** apply moisture cured silicone to skin!

Tin catalyst silicone

- Two-part silicone.
- Frequently used in mold making.
- Generates alcohol as a by-product of curing.
- Some types of this silicone must be weighed out in unequal proportions using a laboratory balance.

Platinum catalyst silicone

- Skin-safe silicones are usually platinum catalyst.
- Sensitive to sulfur compounds (e.g. latex) which can cause the silicone not to cure. You must be clean and precise.
- Available in a wide range of hardness and cure times.
- Many platinum silicones can be modified to change the shore hardness.

How to use silicone

- Measure A and B components by volume.
- Pot life is the amount of time you have after you **begin** mixing to mold or manipulate the mix.
- Demold time is the time the silicone takes to **fully** set. The demold time is dependent upon the ambient temperature.
- Use a wooden toothpick to remove bubbles from the silicone and get it to flow into detailed parts of the mold.

Modifying the characteristics of silicone

- **Intrinsic colour:** colour incorporated into the silicone. Use flocking or pigment
- **Thixotropic additive:** Thickens the silicone for free-form sculpting or brush-up molds.
- **Shore index modifiers:** Makes the silicone softer and often stickier. With enough modifier added the silicone will make a self-stick prosthetic.
- **Thinners:** Make the silicone less viscous for molds with fine detail.

Painting silicone

- Many artists have painted silicone prosthetics with a mixture of clear silicone caulking, naptha, and artist's oil paints. This method is **not** recommended.
- Commercial paints are available such as FuseFX paints. You can also mix pigments (e.g. Silc-Pig) with a fast-setting silicone and use that as a paint.


Artists paints may contain lead and cadmium compounds.

Silicone adhesives

- A fast-setting platinum silicone such as Skin-Tite can often be used as an adhesive.
- One part silicone adhesives are usually expensive but are useful for repair work.

Glycerin

What is it? A colourless, odourless, viscous liquid.

Characteristics

- Hygroscopic retains water
- Anti-fungal it helps to prevent fungus growth.

Why it is a handy material for healthcare simulation?

- Non-toxic, does not irritate the skin.
- Cheap and readily available.
- Helps compounds retain moisture.
- A versatile plasticizer.

Gelatin

Characteristics:

Available in various toughness (bloom number). The higher the bloom number the tougher the gelatin. Prosthetic gelatin 300 bloom, Food Grade gelatin 225 bloom

Uses: Make low-cost prosthetics.

Modifying the characteristics of gelatin:

Use glycerin and sorbitol to control the toughness.

Gelatin

Colouring and painting gelatin: Gelatin can be coloured intrinsically with flocking and water-based pigments. Gelatin can be painted with PAX paint.

Zombie skin: Paint liquid gelatin mix on parchment to make a handy destroyed "skin". Great for moulage.

Molding and demolding: Use a released mold. Pour into warm mold; a cold mold will cause the gelatin to set before it can run into fine detail in the mold. Powder with baby powder when removing from mold to prevent sticking.

Pros-aide and prosthetic adhesives

What is it? A prosthetic adhesive, used for sticking prosthetic appliances to skin.

How to use properly. Apply to skin or the object in a thin coating. Pros-Aide goes on milky and tries to a tacky transparent state. When it is dry then it can be stuck down.

Common errors. Not allowing the Pros-Aide to dry.

Removal: Use isopropyl myristate or Pros-Aide remover.

Pros-aide and prosthetic adhesives

Pax paint: PAX paint is Pros-Aide mixed with artist's acrylic colours in a 1:1 ratio. PAX paint has high elasticity and sticks to gelatin and many other materials. Do not paint directly on human skin. Reduce tack by powdering with setting powder.

Thickening: Pros-Aide can be thickened with Cab-O-Sil, a fumed silicate. The resulting compound has the consistency of toothpaste and can be sculpted and molded.

Water-Melon Latex substitute

Why? Many healthcare workers are sensitive to latex. Some workplaces are latex free. Use Water-Melon instead of latex.

Characteristics.

Forms a tough, flexible, translucent film when dry. Can be reactivated with 99% alcohol.

What is it used for?

Can be used in place of latex for sealing makeup.

Can be slush cast in an unsealed, unreleased stone mold for lightweight prosthetics.

Adhesives

Polyvinyl acetate: White glue, carpenter's glue.

- Use for porous materials such as wood and paper.
- Dries by contact with air.
- Not good for damp or wet environments.

Cyanoacrylate: Crazy glue, Super glue, Loctite.

- Not a space filler, brittle bonding.
- Cures with moisture so can be used on damp materials or underwater. It **will** bond to your skin if you are not careful.
- Can dissolve some types of plastics.
- Remove with acetone.

Hot glue:

- Quick bonding on many items including wood and many types of plastic. This glue can burn you.
- Sets by cooling.

Epoxy

- Two part adhesive
- Excellent adhesive for difficult materials including metal.
- Space filling
- Available as a liquid or a putty.
- Cures, does not need to be exposed to air.

Solvents

Acetone: Removes cyanoacrylate adhesives.

Mineral spirits: Removes uncured silicones. Some types of mineral spirits may be proprietary formulations.

Isopropyl alcohol 99%: Weakens or dissolves Pros-Aide, Water-Melon, alcohol-activated paints, and many other materials used in makeup.

Naptha: Dissolves many materials. Available in small quantities as Zippo lighter fluid.

Citrus terpenes: Solvents made from citrus fruit. Often has a strong orange smell. Can leave a greasy film.

Solvents

Cautions

Many solvents can form an explosive atmosphere at relatively low concentrations. Some solvents may be particularly irritating to people.

The overuse of solvents when cleaning can deteriorate finishes, loosen parts bonded with adhesives, and remove necessary lubricants. Always use caution and use the least amount of solvent to accomplish your task.

SaFEtY

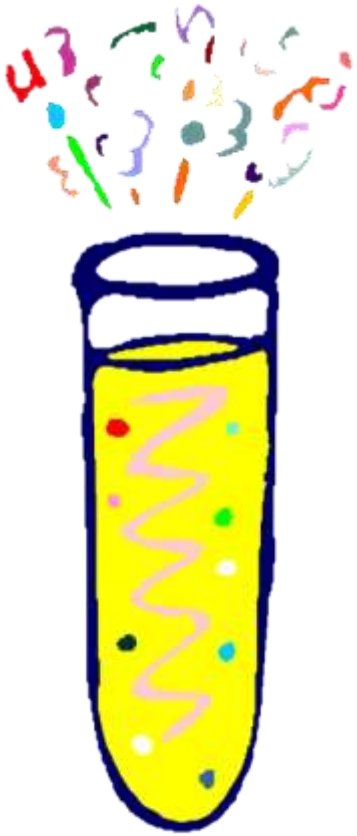
Don't fear chemicals!

but

Be familiar with the properties and safe handling practices of **all** products that you use.

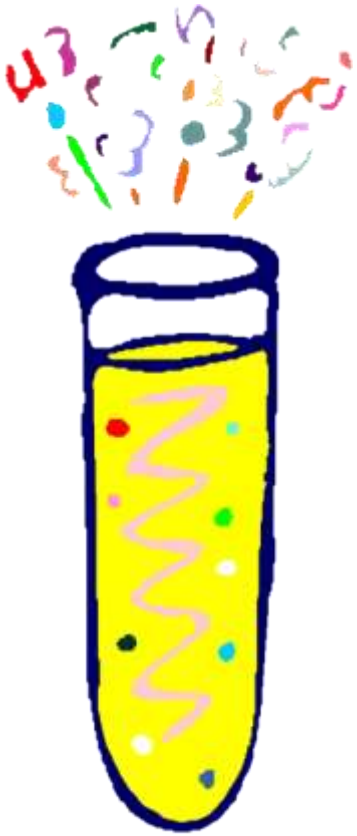
Plaster of Paris can reach more than 60°C as it sets. A 16 year old student in the UK lost 8 fingers while trying to cast her hands in Plaster of Paris in 2007. She misunderstood the teacher's instructions.

Always read and understand the technical documents, including the MSDS for all the products you use, even the products that seem simple and harmless.



Measuring and Mixing:

- Use the bathroom, rehydrate, and turn off your cellphone before you start!!!
- Know your pot time before you start. Review the product data sheet.
- Have all of your materials and tools available BEFORE you begin. This includes additives and pigments. Have you released your mold or original?
- Use separate mixing rods for each component to prevent cross-contamination.
- Thoroughly stir the individual components before beginning.
- Do not mix very small amounts; it amplifies any mistakes you make in measuring.



Measuring and Mixing:

- Measure twice, cut once.
- Use measuring containers which are accurate (many disposable containers are NOT). In most cases use separate containers of the same type to measure your liquids.
- Do not try to measure both liquids in a single container; it is very easy to make a mistake and ruin the entire batch.
- Do not mix by sloshing components together; this does not adequately mix the components.
- Do not whip components together; this incorporates air into the mix which is difficult to remove.
- Scrape the sides of the container while mixing.
- Mix in an area of the proper temperature, usually 20°C to 24°C. Ditto for your mix components.

Practical Examples

Gel Effects

There are several different formulas for gel effects depending upon what you need it for.

Standard

- 14g Gelatin (food grade, 2 x 7g packets)
- 30mL Glycerin
- 15mL Water

Gel Effects

There are several different formulas for gel effects depending upon what you need it for.

Prosthetic

- 20g Gelatin, Prosthetic grade, 300 Bloom
- 45mL Glycerin
- 40mL Sorbitol 70% solution
- 5mL Water

Simulated Povidone-iodine

Problem: Real povidone-iodine stains task trainers and mannequins. The colour of povidone-iodine also indicates the area has been treated.

Goal: Develop a non-staining substitute for povidone-iodine. It should have the same characteristics (coat the surface evenly), but be easy to remove with no staining.

Development: Used a gravy browning (no spices!) for the colour. Modified with glycerin and dish washing detergent for flow, and alcohol for flow and smell.

Simulated Povidone-iodine

- 40mL Crosse & Blackwell Gravy Browning
- 150mL water
- 40mL glycerin
- 5 drops of hand dish washing detergent
- 20mL isopropyl alcohol (70%)

Go here for links and info:
http://www.barrymrobinson.ca/northern_simulation_2017.html

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Slide 7 - Dr. Martin Cooper, the inventor of the cell phone, with DynaTAC prototype from 1973 (in the year 2007). photo by Rico Shen Creative Commons Attribution-Share Alike 3.0 Unported
https://commons.wikimedia.org/wiki/File:2007Computex_e21Forum-MartinCooper.jpg

Slide 8 – Image from U.S. Patent #3,520,071, S. Abrahamson et al, *Anesthesiological Training Simulator*, Filed Jan. 29, 1968, patent granted July 14, 1970. U.S. Patent,. https://www.uspto.gov/

Slide 12 (left) – from trauma.org, *Penetrating jejunal injury with evisceration 01*, Leonardo Hassegawa, Curitiba, Brazil, May 28, 2007, Evisceration + Grade I Jejunal lesion following stab with fluorescent lamp., Creative Commons Attribution-Noncommercial-Share Alike 2.5 License, http://www.trauma.org/index.php/main/image/566/

Slide 37 - Photograph issued by the Health and Safety Executive of the hands of the 16-year-old girl. Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence.
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