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Abstract

Large-scale impressions are important evidence in crime scene investigations. Impressions come from many sources and may occur on any impressionable surface. Examples of large-scale impressions include tire treads, road scars, foot wear impressions, or even an impression of a depression from an exploded IED or shallow grave. Impressions can be made on a small scale from tool mark impressions and palm prints. The thorough documentation of impression evidence becomes difficult and costly when the impression is large. Research into cost-effective and timesaving methods of impression casting is needed so this valuable source of evidence in an investigation is not under documented. This study investigated the development of an alternative casting material for large-scale impressions from low-cost materials. Spray foam was tested individually and with releasing agents. Test formulations included various caulking compounds, fiberglass resin, acrylic, Mold Builder Liquid Latex™ and Monster Liquid Latex™. A mixture of a latex-based caulking compound and liquid latex resulted in a pourable and thick casting material without the need of an additional releasing agent. The addition of calcium nitrate tetrahydrate in both solid and solution forms improved curing time, but the shortened curing time prevented an impression being made. Creating a compound to document large-scale impression evidence from low-cost, commercially available materials is possible, although further research is needed to solve the problem of long curing times.

Cost-Effective Alternatives to Casting Material for Large Scale Impressions

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STYLE MANUAL

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Introduction

Large scale impressions are an important aspect of evidence at crime scenes. Impressions originate from different sources and may occur on any impressionable surface. Examples of large-scale impressions include tire treads, road scars, foot wear impressions, or even an impression of depression from an exploded IED or shallow grave. Examples of small scale impressions include tool mark impressions and palm prints. Thorough documentation of impression evidence becomes difficult and costly when the impression is large. Research into cost-effective and time-saving methods of documentation of large-scale impressions using casting material is needed so this valuable and important source of evidence is not under-documented in an investigation.

An impression is an important part of a criminal investigation. Impressions can be made to demonstrate the depth of field, which is lost when photographed. Though technical advances have brought 3D imaging in use at many crime scenes and many accident investigations, it is essentially a video of the scene. An impression is 3-dimensional; it can be held and observed. [1] Three-dimensional imaging of an impression is helpful, but an impression can make more of an impact with a jury, especially since the impression is evidence from the scene. The impression needs to stand up over time, not break or disintegrate, not shrink, be able to be handled and stored, and give a very detailed impression. Having the impression is the opportunity to present details of the evidence in an investigation a three-dimensional image may not contain. [2]

An example of a large-scale impression is a road scar, which is an important part of an accident investigation. When a vehicle involved in an accident is damaged in such a

way in which metal parts come in contact with the roadway surface, the road is damaged. Parts of a vehicle which may come into contact with the roadway include bent wheels, drive shaft, broken tie rods, transmission housing, the frame of the car, or the point of maximum engagement (point of impact). The damaged road will contain scars, scratches or gouges. Road scars are seen prevalently in rollovers and head-on collisions. Road scars are considered evidence and can determine the locations of impact, the area of impact, and the direction of movement of a vehicle or object involved in the crash.[3] In an accident investigation, the impression of the road scar and the vehicle part which made the road scar are matched up. Most traffic accident investigations involving a serious injury or death are concluded within 4 hours. If casting an impression of the road damage is part of the documentation of the scene, ease of use of the casting material and a reasonable cure time are essential.

The different casting options most used for impressions are Accutrans™, Mikrosil™, Durocast™, Smooth-Cast™, and dental stone. There are multiple advantages and disadvantages of these materials with regards to ease, cost, and result of impression. Optimal results are proportional to cost.

Accutrans™ is the "Cadillac of Casting Material," although the cost can be prohibitive at $0.45 per gram. Accutrans™ sets in only 4 minutes at approximately 20 degrees Celsius (when used for small-scale impressions).[4] It is so detailed it can be placed under a scanner or camera and the impression has little to no shrinkage. Accutrans™ core component is polyvinylsiloxane. Accutrans™ is non-toxic, but it should be kept away from contact with the eyes.

Mikrosil™ sets in approximately 6-7 minutes (when used for small-scale impressions) and is used for microscopic observations due to its high contrast. The negative aspect of Mikrosil is it comes in very small tubes and must be mixed by hand. Mikrosil is more cost-effective than Accutrans™ at $0.15 per gram. Its core component is polydimethylsiloxane with a proprietary catalyst.

Durocast™ results in a very detailed impression, can mixed by hand, and can cast the ink depth of a $100 bill. Its cost is $0.14 per gram and the core component is dimethyl polysiloxane.

Smooth-cast™ is very labor intensive, although it is easy to apply using a dispensing gun and much more cost effective at $0.030 per gram. The negative aspect of Smooth-cast™, along with its complicated casting method, is its components, consisting of 4,4' Methylene bis(phenylisocyanate) (MDI) and benzene. MDI can cause lung sensitization and asthma at low exposure levels[5], and benzene causes irreversible bone marrow damage with prolonged exposure at high doses.[6]

Dental stone is most often used for impressions as it is the most cost-effective casting material. It does not cast as detailed an impression as other casting materials and does cure well in colder temperatures. It takes 1-2 hours to harden and is heavy when used with large impressions as it is comprised of Plaster of Paris and a proprietary component. Dental stone can also break when dropped and must be prepared with attention to saturation of the dental powder.[7] It is half the price of Smooth-Cast at $0.015 per gram. Dental stone is 30 times less expensive than Accutrans™ and ten times less expensive than Mikrosil™. Dental stone is used by the Missouri Highway Patrol, the

Indiana Highway Patrol, and the Michigan Highway Patrol. Due to its weight and lack of durability, it will not be considered in this research, as we are casting large impressions.

For a large-scale impression measuring 4-foot-long, 2 inches wide and 2 inches deep, the calculated cost of using Accutrans™ would be approximately $1000, the cost of Mikrosil™ and Duracast™ would be approximately $400, the cost of Smooth-Cast™ would be approximately $100, and the cost of Dental Stone would be approximately $40.

New impression technology like magneto-rheological fluids, although detailed, are labor-intensive, costly, and details dissipate without a magnetic field present.[8] Scanning electron microscopes can also be used to identify patterns and details, although they are extremely cost-prohibitive and would not work for a large-scale impression.[9]

Low cost alternative applications for large-scale casting have been investigated by other researchers.[10] Spray insulating foam with a latex barrier has been used to mold an entire tire in previous research and can be very cost-effective. It takes approximately less than one hour to make an impression with the barrier and foam, costing $0.020 per gram, is lightweight and retains good detail.[10] Polyurethane spray foam is readily available at most hardware stores

Releasing agents for large-scale impressions recommended by previous research include liquid latex, hairspray, and non-stick cooking spray.[10,11,12] These preparatory coatings are used to allow the casting material to be released from the impression and to prevent debris from adhering to the impression. Liquid latex can be used as a releasing agent, as well as hairspray, when making impressions which are loose, soft, sandy or dusty.[11,12] Cooking spray is used when the impressions are moist or muddy.[2]

The goal of this study was to create a casting compound as non-toxic as possible, which can hold impression details, be cost-effective, waterproof, able to be cast and retain shape in varying environments, able to be used indoors and outdoors, easy to prepare, and have a reasonable curing time.

Chapter 2
Methods

Prior to testing, a score chart for casting material was developed to evaluate the performance of different compounds (Table 1). Spray foams, caulking compounds individually, caulking compounds with fiberglass resin, caulking compounds with acrylic, caulking compounds with Mold Builder™, and caulking compounds with Monster Liquid Latex™ were tested on Styrofoam impressed with a meat tenderizer to create detail (Figure 2). Caulking compounds were initially tested individually, then with releasing agents and additives to optimize their release from the Styrofoam or to optimize curing time.

Spray Foams

Spray foam purchased as an alternative casting material included: DAP Daptex Plus 12 oz. Window and Door Foam sealant; Great Stuff 16 oz. Gaps and Cracks Insulating Foam sealant; 3M 10.1 fl. oz. Fire-Barrier Foam, and OSI 16 fl. oz. QUAD Window and Door Installation Foam. Releasing agents recommended by previous research[5,8,9] included hairspray, liquid latex, and non-stick cooking spray. Dry shampoo was added as a possible releasing reagent. Releasing agents obtained were PAM™ Non-Stick cooking spray, Tres™ Two Extra Hold Hairspray, Sexy Hair™ Volumizing Dry Shampoo, Castin' Craft Mold Builder™ Liquid Latex Rubber, and Monster Liquid Latex™. Releasing reagents were used with the Styrofoam and spray foam. The Mold Builder™ Liquid Latex Rubber and Monster Liquid Latex™ were not used with spray foam as a releasing agent due to the extensive drying time needed and the inability to be used in all weather conditions.

Caulking Compounds

The caulking compounds used included DAP Alex 10.1 oz. Painter's All-Purpose Acrylic Latex Caulk, DAP Alex Plus 10.1 oz. White Acrylic Latex Caulk Plus Silicone, DAP Dynaflex 230 10.1 oz. Premium Indoor/Outdoor Sealant, DAP Alex Fast Dry 10.1 oz. White Acrylic Latex Plus Silicone Caulk, GE All Purpose Silicone I 10.1 oz. White Window and Door Caulk, and DAP Dynaflex 800 10.1 oz. White Premium Polymer Sealant.

Additives

3M™ Bondo All-Purpose Fiberglass Resin and Mason's Select™ Clear Acrylic Concrete Sealer were obtained to mix separately with the caulking compound to increase hardness of material and to increase curing time. The specific caulking compounds used with fiberglass resin and Mason's™ Acrylic were DAP™ Alex Fast Dry 10.1 oz. White Acrylic Latex Plus Silicone Caulk and DAP™ Alex 10.1 oz. Painter's All-Purpose Acrylic Latex Caulk. The fiberglass resin was mixed with the two specific caulking compounds at a 1:1 ratio of approximately 20 grams of resin and approximately 20 grams of caulking compound. The fiberglass resin was also mixed with the two caulking compounds at a 3:1 ratio of approximately 60 grams of resin and approximately 20 grams of caulking compound. Mason's Select™ Clear Acrylic Concrete Sealer was mixed with caulking compound at two different ratios to increase hardness and improve pourability. The acrylic was mixed with the two specific caulking compounds at a 1:1 ratio of approximately 20 grams of acrylic and approximately 20 grams of caulking compound. The acrylic was also mixed with the two caulking compounds at a 3:1 ratio of approximately 60 grams of acrylic and approximately 20 grams of caulking compound.

Castin' Craft Mold Builder™ Liquid Latex Rubber and Monster Liquid Latex™ were both mixed with the DAP™ Alex 10.1 oz. Painter's All-Purpose Acrylic Latex Caulk, DAP™ Alex Plus 10.1 oz. White Acrylic Latex Caulk Plus Silicone, DAP™ Dynaflex 230 10.1 oz. Premium Indoor/Outdoor Sealant, DAP™ Alex Fast Dry 10.1 oz. White Acrylic Latex Plus Silicone Caulk, GE™ All Purpose Silicone I 10.1 oz. White Window and Door Caulk, and DAP™ DYNAFLEX 800 10.1 oz. White Premium Polymer Sealant caulking compounds. Mixtures of each caulking compounds and Mold Builder™ were mixed at a 1:1 ratio of approximately 20 grams of caulking compound and approximately 20 grams of Mold Builder™. Mixtures of each caulking compounds and Monster Liquid Latex™ were at a 1:1 ratio of approximately 20 grams of caulking compound and approximately 20 grams of Monster Liquid Latex™. Calcium Nitrate Tetrahydrate (Fisher Chemical Lot 157486, FW 236.15) was added to improve curing time for these mixtures.

Chapter 3

Results

Spray Foam

Using Styrofoam packaging with man-made impressions from a meat tenderizer, spray foam did fill the small-scale test impression and all foams did dry quickly except for DAP™ Daptex Plus 12 oz. Window and Door Foam sealant (Table 2). It is important to note the DAP™ Daptex Plus 12 oz. Window and Door Foam sealant did not dry adequately even after a 24-hour curing time, with foam closest to the impression being extremely wet and airy, with little to no foam observed filling the impression. DAP™ Daptex Plus 12 oz. Window and Door Foam sealant was excluded from further testing due to its lack of adequate drying time and its failure to develop a good impression. Waterproof characteristics were not able to be determined from spray foam in this study. Impressions resulting from the three remaining spray foams included good detail but were very difficult to release without an adequate releasing agent. Releasing agents used included PAM™ Non-Stick cooking spray, Sexy Hair™ Volumizing Dry Shampoo and Tres™ Two Extra Hold Hairspray. The non-stick cooking spray worked well as a releasing agent, although it did fill in parts of the impression the foam was not able to reach. If an excess of non-stick cooking spray was added to an area of the foam and the resulting layer of spray was too thick, the area would not have a valuable impression. The detail of the impression was lost and the foam would not have an accurate imprint of the specific area. If the layer of non-stick cooking spray was too thin, the foam would not release well and the resulting impression would crack or break. Liquid latex was not used as a releasing agent as quick drying time and use in an outside environment were factors for use.

Due to the need for extensive preparation prior to use of the spray foam, it was determined to eliminate spray foam from further testing. Spray foam did provide a good curing time at approximately less than 4 hours and provided good detail of impressions. The spray foam was not an optimal choice for large scale impressions due to its inability to be easily used in adverse weather conditions (rain or snow), the lack of ease of use due to the requirement of an adequate releasing agent and the need for a releasing agent which would not interfere with impression detail. Spray foam was eliminated as a possibility as an alternative for large scale impressions at this time.

Caulking Compounds

Caulking compounds alone were determined to produce valuable impressions with good detail, although curing time was not optimal (Figure 3).

Fiberglass resin was eliminated as a possible additive to the caulking compounds due to the noxious fumes generated from use, the destruction of the impression made in the Styrofoam, the lack of pourability of the mixture, and the lack of increase of curing time (Figure 4). Two ratios were used including 1:1 of fiberglass resin and caulking compound at approximately 20 grams each, and 3:1 of fiberglass resin at approximately 60 grams and caulking compound at approximately 20 grams. The consistency of the fiberglass resin with the caulking compound was similar to frosting at the 1:1 ratio and a somewhat thinner consistency at the 3:1 ratio, although still relatively thick and not pourable. Toxicity was an NFPA health rating of 2, and after mixing with the caulk compounds, the resulting toxicity was not optimal as the resin mixture slowly dissolved the Styrofoam (Figure 3). Ability to provide a waterproof compound was also not determined and the parameter marked accordingly. Mason's™ Clear Acrylic was

eliminated as it did not increase curing time although it did provide good impression detail and was able to be spread. Two ratios were used including 1:1 of acrylic and caulking compound at approximately 20 grams each, and 3:1 of acrylic at approximately 60 grams and caulking compound at approximately 20 grams. The consistency of the acrylic with the caulking compound was similar to yogurt at the 1:1 ratio and a much thinner consistency at the 3:1 ratio, which was somewhat pourable. Ability to provide a waterproof compound was also not determined and the parameter marked accordingly (Table 3).

After spray foam, fiberglass resin and acrylic were ruled out as options, attention was turned to the caulking compounds. Caulking compounds were administered to Styrofoam impressions and parameters scored (Table 4). Each caulking compound scored similarly as they were able to hold details in an impression well. After determining the caulking compound by itself would be difficult to use in large scale due to difficulty of administration to an impression, a releasing agent was added. The releasing agent mixed with the caulking compound at a 1:1 ratio at approximately 10 grams each, either Mold Builder™ or Monster Liquid Latex™, resulted in a thick, pourable compound. The compound mixture would cure over a period of time (approximately less than 12 hours) depending on environmental conditions including humidity and temperature. Caulking compound with Mold Builder™ was evaluated and scored (Table 5). Caulking compound with Monster Liquid Latex™ cured faster than caulking compound with Mold Builder™ as it cured from approximately 8 to 12 hours. The mixture of Monster Liquid Latex™ and caulking compound was then determined to

be the best fit for a mixture as it released easier and cured at a faster rate than the Mold Builder™ mixture (Table 6).

Adding Calcium Nitrate Tetrahydrate to the 1:1 ratio of caulking compound and liquid latex in increments from 0.3 g to 1.5 g after measure on a Scout Pro SPE202 Balance (SN 7130521491) resulted in an increase in curing time in solid form, although the resulting mixture was similar to cottage cheese (Figure 4). At 1.5 grams of Calcium Nitrate Tetrahydrate, the curing time was less than 30 seconds. Curing time was less than 1 minute in small 1:1 ratios of approximately 10 grams of caulking compound to 10 grams of liquid latex, 20 grams of caulking compound to 20 grams of liquid latex, and 30 grams of caulking compound to 30 grams of liquid latex. It was determined to dissolve Calcium Nitrate Tetrahydrate in water to form a solution to add to the mixture for improved dispersal. The same increments were used from 0.3 g to 1.5 g in 0.5 mL of water. The addition of crystals to water did not result in an immediate solution. After addition of crystals to water, the container needed to be mixed for approximately 30 seconds. The solution form of Calcium Nitrate Tetrahydrate worked best, although curing time was improved so quickly, the mixture cured before being able to administer to an impression. The addition of the Calcium Nitrate Tetrahydrate solution improved texture to a smoother consistency, but consistency varied from scrambled eggs to a smooth textured ball (Figure 5). Curing time was less than 1 minute using Calcium Nitrate Tetrahydrate in either solid or solution form. Evaluation and scoring parameters were totaled for Calcium Nitrate Tetrahydrate additions in solid or liquid form to caulking compounds with Mold Builder™ (Table 7) and Caulking Compounds with Monster Liquid Latex™ (Table 8).

The Dynaflex™ caulking compounds containing limestone and diethylene glycol dibenzoate did not mix as well with the liquid latex as a caulking compound containing limestone, petroleum distillates and diethylene glycol dibenzoate (Tables 5 and 6). Once the Calcium Nitrate Tetrahydrate water solution was added, the Dynaflex™ and liquid latex mixture resulted in a smooth compound, although curing time was increased to a rate which prevented the compound from being added to an impression (Tables 7 and 8).

Mixing caulking compound in a latex form with a liquid latex resulted in a pourable, impressionable form which could be used for large scale impressions. The caulking compound in latex form with ingredients limestone, petroleum distillates, diethylene glycol dibenzoate, titanium dioxide, and quartz mixed best with either liquid latex form. Addition of Calcium Nitrate Tetrahydrate did increase curing time for these compound mixtures with a curing time of less than 1 minute. Addition of Calcium Nitrate Tetrahydrate in a water solution rather than the solid form of Calcium Nitrate Tetrahydrate provided a smoother texture of the compound mixture with minimal changes in curing time, although curing time was still less than 1 minute.

Liquid latex was determined to be the best releasing agent for spray foam from previous research[5,] which resulted in its use for this study as a releasing reagent with the caulking compounds. While working with the caulking compounds and both forms of liquid latex, Mold Builder™ and Monster Liquid Latex™, it was discovered mixing the liquid latex with the caulking compound would improve pourability, ease of release, and curing time.

Chapter 4
Discussion

The varieties of casting compounds for large scale impressions are costly and available to those agencies which are generously funded, while some compounds are cost prohibitive to smaller criminalistics laboratories and law enforcement agencies. Many agencies continue to use Dental Stone due to the cost effectiveness of the material, although its resulting impression is heavy, can chip, and can break. When considering large impressions, Dental Stone is not the advantageous choice except in regards to cost.

Spray foam was used with a releasing agent as an option for this study. It was determined, early on in the study from previous research, the spray foam could work well in an isolated environment with adequate preparation time using several coats of releasing reagent.[5] For this particular study, the materials best for alternative impressions included mixtures available for use outside, in varying temperatures, and with a short preparation time. Spray foam would require adequate protection during preparation due to environmental factors. Use of spray foam for impressions in a rainy or snowy environment would not be adequate without protection from the elements over the casting area. Spray foam was not an optimal choice for large scale impressions due to time constraints with a proper releasing agent. Spray foam would need an adequate releasing agent which would not interfere with impression detail and would provide short preparation time from releasing agent to impression lift. Additional research is suggested as spray foam did dry quickly and left good impression detail.

Mixing liquid latex with a latex-based caulking compound can produce a possible alternative casting material, although curing time is not optimal without an additional

curing material like Calcium Nitrate Tetrahydrate in a water solution. Mixing the caulking compound with liquid latex produces a yogurt-type consistency which can easily be poured into an impression. With the mixture of liquid latex, the caulking compound does not require a releasing agent. Without the liquid latex, a releasing agent is required. Although multiple releasing agents were used in conjunction with the caulking compound and liquid latex mixture, the releasing agents (hairspray, powder shampoo, and "Pam") interfered with the details of the impression and left a residue. The releasing agent filled in spaces of the impression, and the caulking compound/liquid latex mixture did not produce an accurate and complete impression. Curing of the caulking compound/liquid latex mixture curing time is not optimal for an on-scene investigation. The addition of Calcium Nitrate Tetrahydrate in a water solution to the caulking compound/liquid latex mixture will hasten the curing time, but to an accelerated rate which does not allow administration of the compound to an impression. Additional research to reduce the curing time of the Calcium Nitrate Tetrahydrate to allow administration to the caulking compound/liquid latex mixture and then to an impression is needed, or increasing the curing time with an alternative additive is needed.

Due to additional research being needed to optimize the small-scale formulation of the alternative compound, the large-scale impression trail was forfeited for this study at this time.

References

1. Yu, A. (2009). Evaluation and comparison of casting materials on detailed three-dimensional impressions. *Journal of Forensic Identification, 59*(6), 626-636.

2. Warrington, D. (2013). Collecting Impression Evidence. *Forensic Magazine*. February/March 2013 Digital Edition.

3. Martinez, L. (1994), Traffic Collision Investigation Manual for Patrol Officers. Central Arizona Regional Law Officers Training Academy. 2nd Edition.

4. Coltene/Whaledent, AG, (2017). Accutrans Frequently Asked Questions. Retrieved from https://www.accutrans.com/faq.

5. Kumar A, Dongari N, & Sabbioni G. (2009). New isocyanate-specific albumin adducts of 4,4'-methylenediphenyl diisocyanate (MDI) in rats. *Chemical Research In Toxicology, 22*(12), 1975-83.

6. Hedli, C. (1996). An overview of benzene metabolism. *Environmental Health Perspectives, 104*(Suppl.6), 1165-1171.

7. Cohen, A., Wiesner, S., Grafit, A. and Shor, Y. (2011), A New Method for Casting Three-Dimensional Shoeprints and Tire Marks with Dental Stone. *Journal of Forensic Sciences*, 56: S210–S213.

8. Gamage, R. E., Joshi, A., Zheng, J. Y., & Tuceryan, M. (2013). A 3D Impression Acquisition System for Forensic Applications. *Lecture Notes in Computer Science*, (7854), 9-20.

9. Demoli, N., Šariri, K., Stanić, Z., Maštruko, V., & Milat, O. (2004). Toolmarks identification using SEM images in an optoelectronic correlator device. *Optik - International Journal for Light & Electron Optics*, *115*(11/12).

10. Wilson, J. (2004). Casting Tires with Expandable Polyurethane Foam and Other Materials. *Journal of Forensic Identification*, *54*, 158-169.

11. Bodziak, W. J., & Hammer, L. (2006). An Evaluation of Dental Stone, Traxtone, and Crime-Cast. *Journal of Forensic Identification*, *56*(5), 769-787.

12. Battiest, T., Clutter, S. W. and McGill, D. (2016), A Comparison of Various Fixatives for Casting Footwear Impressions in Sand at Crime Scenes. *Journal of Forensic Sciences*, 61: 782–786.

Table 1

Scoring Parameters for Compounds and Compound Mixtures

Rating	Poor = 1	Fair = 2	Average = 3	Good = 4	Excellent = 5
Toxicity of Casting Material	NFPA Diamond Health rating = 4, based on SDS	NFPA Diamond Health rating = 3, based on SDS	NFPA Diamond Health rating = 2, based on SDS	NFPA Diamond Health rating = 1, based on SDS	NFPA Diamond Health rating = 0, based on SDS
Holds Detail of Impression	Ineffective for impression detail, compound not able to hold impression	Impression detail lost, or able to be altered	Impression detail average, impression changes when pressure applied	Detailed, impression changes slightly when pressure applied	Very detailed, does not change impression when pressure applied
Cost-Effective	> $40	< $40	< $30	< $20	< $10
Waterproof (If information provided. If undetermined or not listed on SDS = n/a)	Compound not waterproof. Impression detail altered due to moisture or humidity.	Compound not waterproof. Impression detail not altered due to moisture or humidity.	Compound semi-waterproof, may be affected by humidity. Impression changes over time.	Compound waterproof, not affected by humidity. Impression changes over time.	Compound repels water. Not affected by humidity. No change to detail over time.
Can be used indoors and outdoors	Rain or snow prevents preparation and application. Indoor application prevented by fumes.	Preparation and application difficult in rain or snow. Indoor application difficult due to fumes	Rain or snow impedes preparation and application. Indoor application impeded by fumes.	Rain or snow slightly affects preparation and application. Indoor application slightly affected by fumes.	Rain or snow does not affect preparation and application. Indoor application not affected by fumes.
Ease of preparation	>30 minutes for preparation of compounds	< 30 minutes for preparation of compounds	< 10 minutes for preparation of compounds	< 5 minutes for preparation of compounds	< 1 minute for preparation of compounds
Time to cure	>12 hours	< 12 hours	< 8 hours	< 4 hours	< 1 hour
Can be made in large batches	Ineffective for application, unable to pour and unable to apply manually	Difficult for application, difficult to pour or difficult to spread manually	Not as easy to apply, not easy to pour or not easy to spread	Thicker mixture, can pour easily or easy to apply	Thin mixture, can pour easily or very easy to apply
Total Score					

Table 2

Spray Foam Scores

Parameter	3M Fire	Daptex Plus	Great Stuff Gaps/Cracks	Osi Quad
Toxicity of casting material	3	4	3	3
Holds detail of impression	5	1	5	4
Cost-effective	4	5	4	4
Waterproof	n/a	n/a	n/a	n/a
Can be used indoors and outdoors	n/a (indoor only)	n/a (indoor only)	n/a (indoor only)	n/a (indoor only)
Ease of preparation	5	5	5	5
Time to cure	5	1	5	5
Can be made in large batches	5	5	5	5
Total Score	27	21	27	26

Table 3

Resin/Fiberglass Mixture Scores

Parameter	Fiberglass Resin/DAP Alex Latex Caulk (1:1 and 3:1)	Mason's Acrylic/ DAP Alex Latex Caulk (1:1 and 3:1)	Fiberglass Resin/ DAP Alex Latex Caulk (1:1 and 3:1)	Mason's Acrylic/DAP Alex Latex Caulk (1:1 and 3:1)
Toxicity of casting material	3/4	4/4	3/4	4/4
Holds detail of impression	4	5	4	5
Cost-effective	4/5	3/5	4/5	3/5
Waterproof	n/a	n/a	n/a	n/a
Can be used indoors and outdoors	4	4	4	4
Ease of preparation	4	4	4	4
Time to cure	1	1	1	1
Can be made in large batches	4	5	4	5
Total	24/26	25/27	24/26	25/27

Table 4

Caulking Compound Only Scores

Caulking Compound Only Parameters	DAP Alex All-Purpose Acrylic Latex Caulk	DAP Alex Acrylic Latex Caulk Plus Silicone	DAP Dynaflex 230 Sealant	DAP Dynaflex 800 Sealant	DAP Alex Fast Dry Latex Plus Silicone Caulk
Toxicity of casting material	4	4	4	4	4
Holds detail of impression	4	4	4	4	4
Cost-effective	5	5	5	5	5
Waterproof	5	5	5	5	5
Can be used indoors and outdoors	5	5	5	5	5
Ease of preparation	4	4	4	4	4
Time to cure	1	1	1	1	1
Can be made in large batches	5	5	5	5	5
Total	33	33	33	33	33

Table 5

Caulking Compound with Mold Builder™ Scores

Caulking Compound with Mold Builder Parameters	DAP Alex All-Purpose Acrylic Latex Caulk	DAP Alex Acrylic Latex Caulk Plus Silicone	DAP Dynaflex 230 Sealant	DAP Dynaflex 800 Sealant	DAP Alex Fast Dry Latex Plus Silicone Caulk
Toxicity of casting material	4	4	4	4	4
Holds detail of impression	4	4	4	4	4
Cost-effective	5	5	5	5	5
Waterproof	5	5	5	5	5
Can be used indoors and outdoors	5	5	5	5	5
Ease of preparation	5	5	4	4	5
Time to cure	2	2	2	2	2
Can be made in large batches	5	5	5	5	5
Total	35	35	34	34	35

Table 6

Caulking Compound with Monster Liquid Latex™ Scores

Caulking Compound with Monster Liquid Latex Parameters	DAP Alex All-Purpose Acrylic Latex Caulk	DAP Alex Acrylic Latex Caulk Plus Silicone	DAP Dynaflex 230 Sealant	DAP Dynaflex 800 Sealant	DAP Alex Fast Dry Latex Plus Silicone Caulk
Toxicity of casting material	4	4	4	4	4
Holds detail of impression	4	4	4	4	4
Cost-effective	5	5	5	5	5
Waterproof	5	5	5	5	5
Can be used indoors and outdoors	5	5	5	5	5
Ease of preparation	5	5	4	4	5
Time to cure	3	3	3	3	3
Can be made in large batches	5	5	5	5	5
Total	36	36	35	35	36

Table 7

Caulking Compound with Mold Builder™ plus [$Ca(NO_3)_2 \cdot 4H_2O$] Scores

Caulking Compound with Mold Builder Parameters plus [$Ca(NO_3)_2 \cdot 4H_2O$]	DAP Alex All-Purpose Acrylic Latex Caulk	DAP Alex Acrylic Latex Caulk Plus Silicone	DAP Dynaflex 230 Sealant	DAP Dynaflex 800 Sealant	DAP Alex Fast Dry Latex Plus Silicone Caulk
Toxicity of casting material	4	4	4	4	4
Holds detail of impression	n/a	n/a	n/a	n/a	n/a
Cost-effective	5	5	5	5	5
Waterproof	5	5	5	5	5
Can be used indoors and outdoors	5	5	5	5	5
Ease of preparation	5	5	5	5	5
Time to cure	5	5	5	5	5
Can be made in large batches	5	5	5	5	5
Total	34	34	34	34	34

Table 8

Caulking Compound with Monster Liquid Latex™ plus [$Ca(NO_3)_2 \cdot 4H_2O$] Scores

Caulking Compound with Liquid Latex Parameters plus [$Ca(NO_3)_2 \cdot 4H_2O$]	DAP Alex All-Purpose Acrylic Latex Caulk	DAP Alex Acrylic Latex Caulk Plus Silicone	DAP Dynaflex 230 Sealant	DAP Dynaflex 800 Sealant	DAP Alex Fast Dry Latex Plus Silicone Caulk
Toxicity of casting material	4	4	4	4	4
Holds detail of impression	n/a	n/a	n/a	n/a	n/a
Cost-effective	5	5	5	5	5
Waterproof	5	5	5	5	5
Can be used indoors and outdoors	5	5	5	5	5
Ease of preparation	5	5	5	5	5
Time to cure	5	5	5	5	5
Can be made in large batches	5	5	5	5	5
Total	34	34	34	34	34

Figure 1

Styrofoam impression detail with meat tenderizer

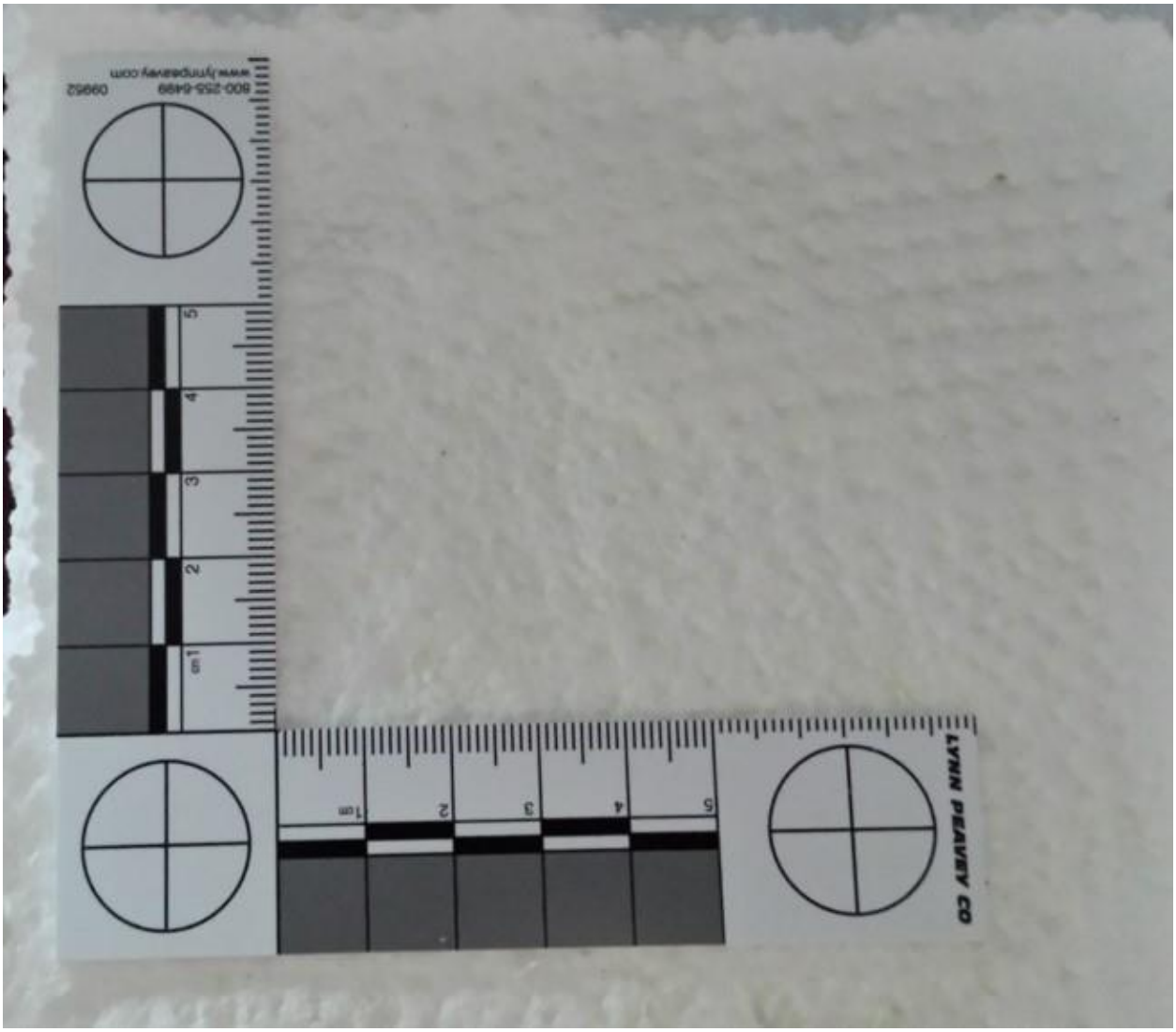


Figure 2

DAP™ Fast Dry Acrylic Latex Caulk Plus Silicone Only – Good Impression Detail

Figure 3

Fiberglass Resin with DAP Fast Dry Acrylic Latex Caulk plus Silicon 3:1 Ratio

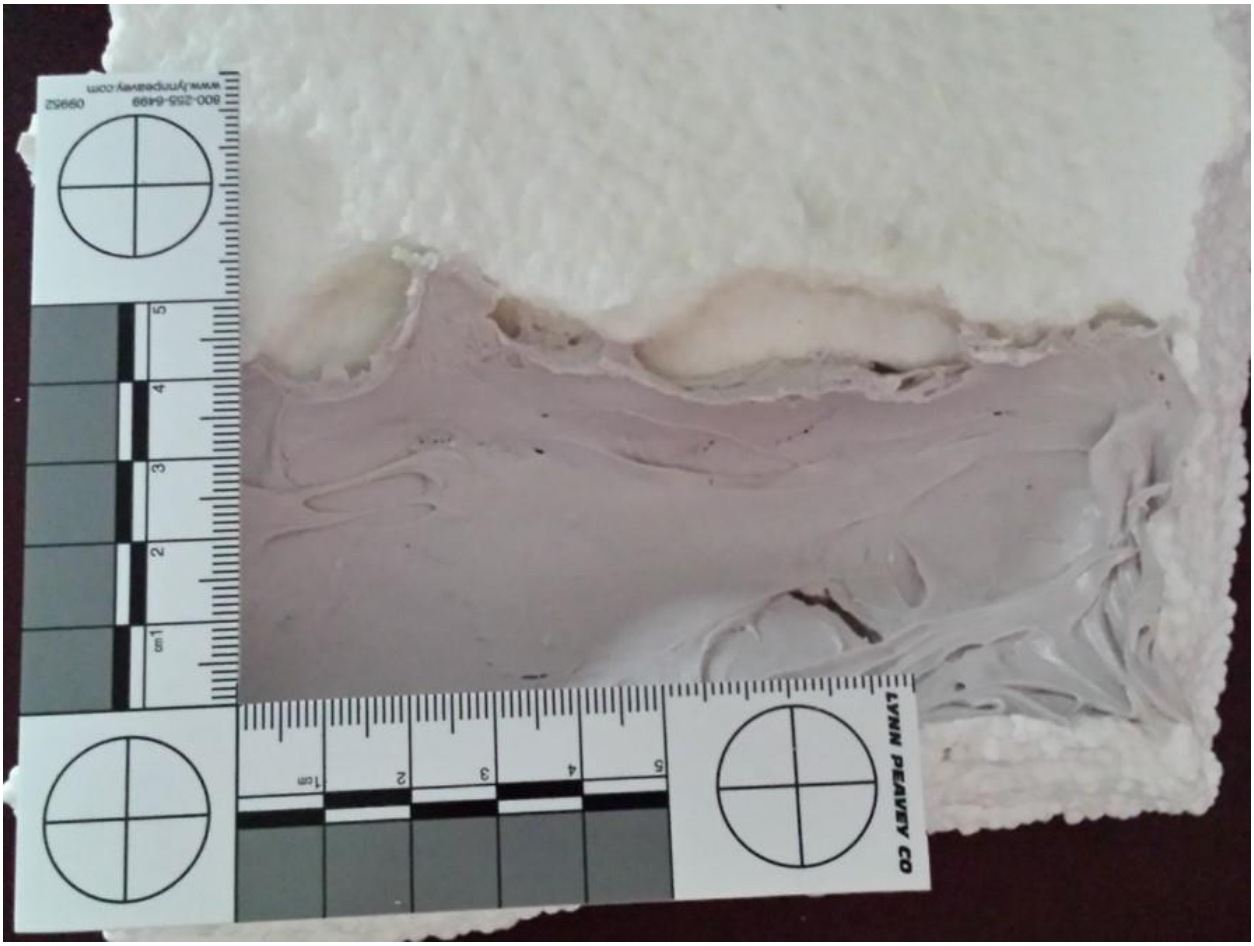


Figure 4

Caulking Compound with Monster Liquid Latex™ plus [$Ca(NO_3)_2 \cdot 4H_2O$] in solid form

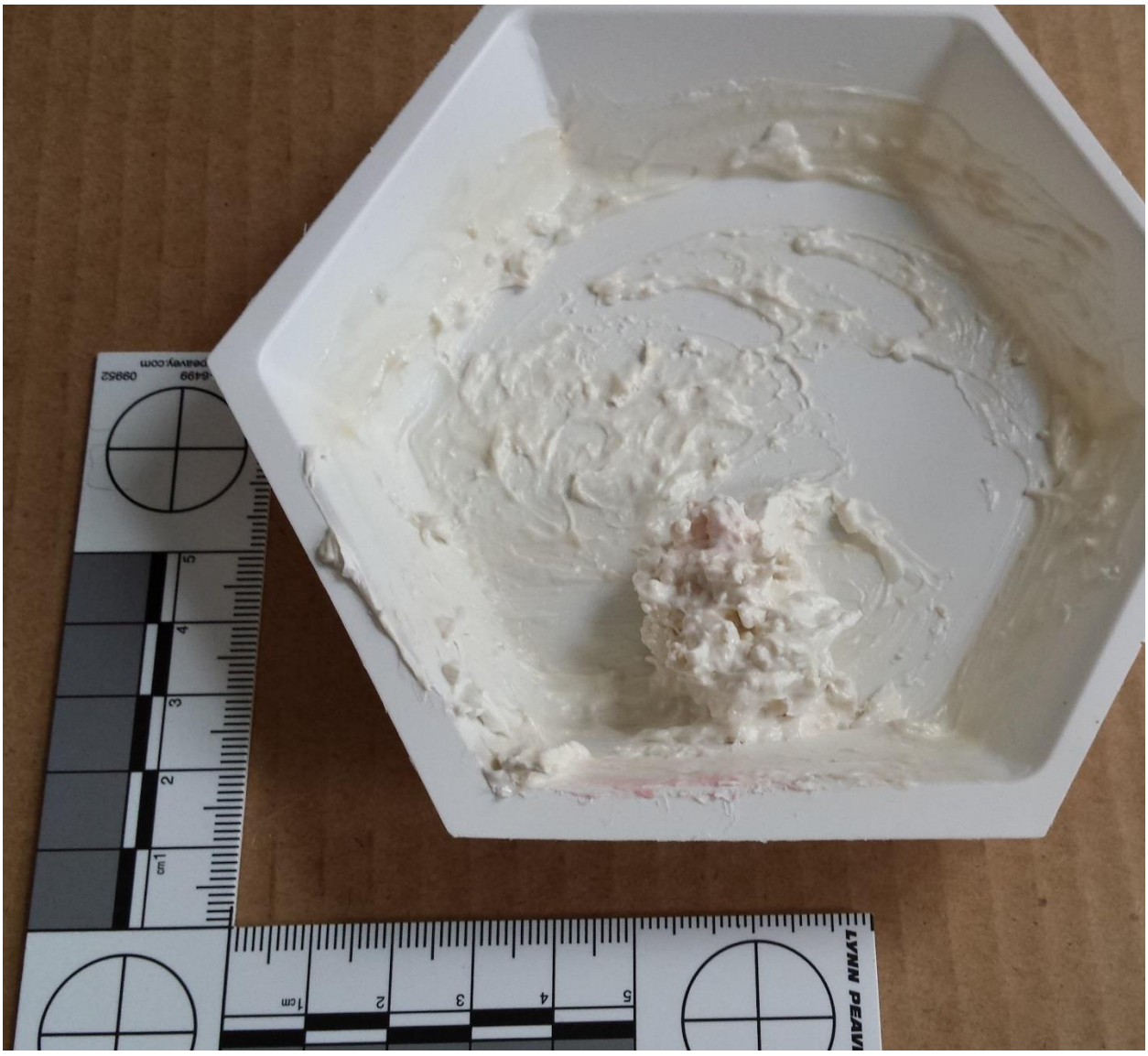
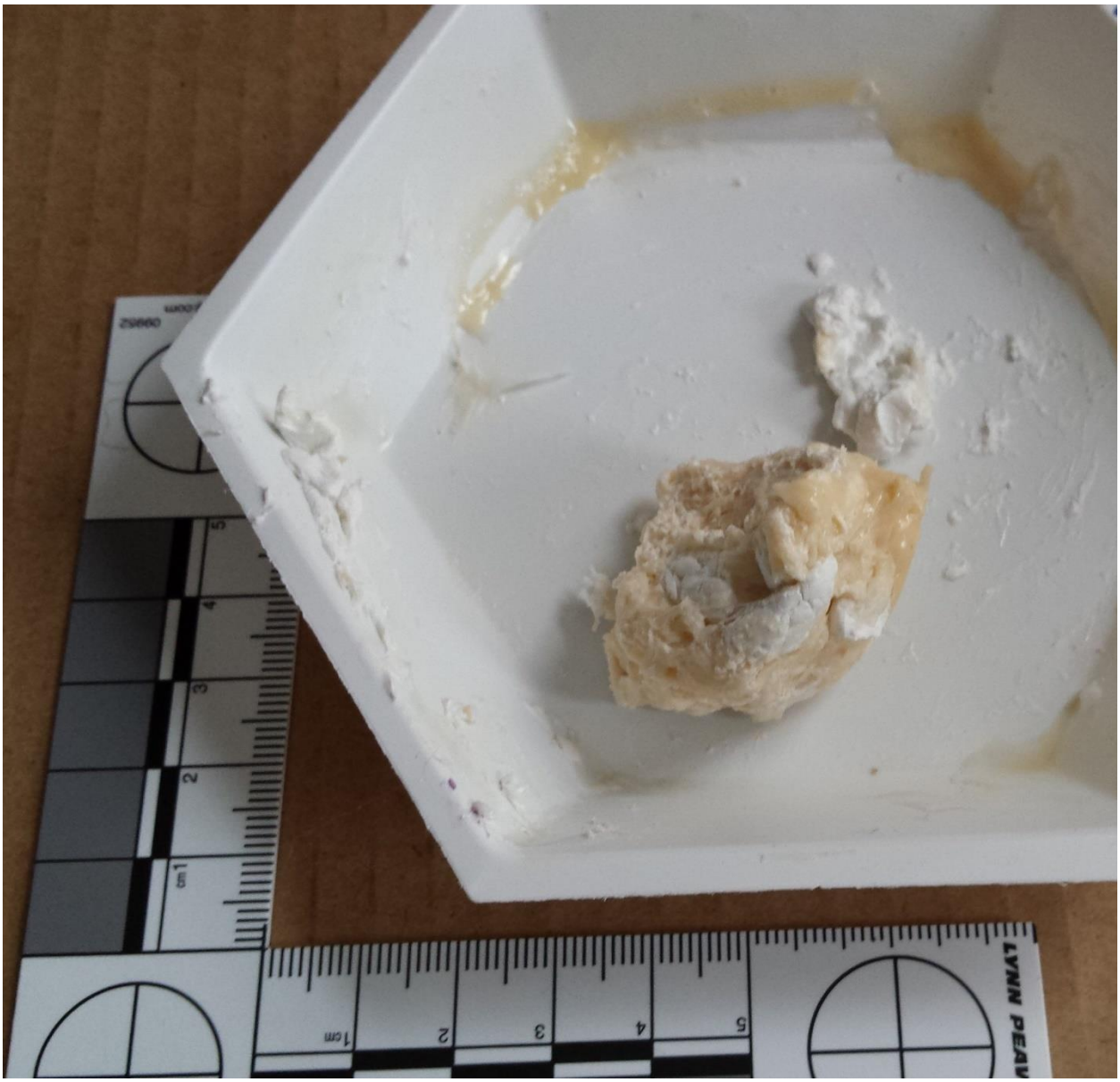


Figure 5

Caulking Compound with Monster Liquid Latex plus $[Ca(NO_3)_2 \cdot 4H_2O]$ in solution form



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