The Not-Quite-Edible House: Making Healthy Material Choices

Jacob Racusin, New Frameworks
Brian Just, Vermont Energy Investment Corporation
Introduction

Jacob
Why, what, who, and how

- Our approach
  - Why we care
  - Chemicals/pollutants
  - Who matters
  - Recommendations (Brian vs. Jacob)
- Scope/limits
Objectives

- Identify 5 overlooked design basics that can have high impacts on building occupants.
- Identify 5 simple low-cost material solutions to reduce toxins in the building.
- Identify 5 deeper approaches towards improving the healthfulness of a building.
- Understand which product certifications matter across various categories of construction materials.
References and research

[Brian]
Primary references

- BuildingGreen, https://www.buildinggreen.com/
Research: 1

Research: 2


Research: 4


Research: 5

- **Consumer product chemicals in indoor dust: A quantitative meta-analysis of U.S. studies.** Mitro, S.D. et al. Environmental Science & Technology. Article ASAP. DOI: 10.1021/acs.est.6b02023
Typical build

- 25’ x 40’ 2-story
Design basics

[Jacob]
Top 5

1. Prioritize healthy surfaces and finishes that you (or your food) interact with \textit{routinely} (touch / inhale)
   - Countertops
   - Cabinetry
   - Fixtures

2. Prioritize healthy surfaces and finishes that surround you and that you interact with \textit{occasionally} (touch / inhale)
   - Walls (hard goods, finishes)
   - Floors
   - Ceilings
Top 5, cont.

3. Prioritize hidden stuff that there’s tons of – consider toxicity, concentration, and exposure path
   - Framing
   - Sheathing
   - Insulation
   - Sealants

4. Design smartly and thoughtfully – more on this later...

5. Install balanced ventilation with:
   - Filtration capability
   - High efficiency heat or energy recovery
Major components
Wood

Jacob

Framing and Sheathing
Recommendations and Cost Impacts
Concerns

- Toxic materials (off-gassing, possible contact):
  - Formaldehyde (Urea, and to lesser extent, Phenolic resin)
  - MDI (occasionally used as formaldehyde replacement)
  - Treatment chemicals and compounds
  - Toxins in adhesives (i.e. subfloors)

- Mold (particularly for OSB in damp/wet condition)

- Exposure risk
  - Dust inhalation during fabrication
  - Occupant exposure from off-gassing chemicals, touch (minor concern)
Framing notes

1. Real wood
   - Rot-resistant species for damp-service conditions, including tamarack/larch, black locust, red and (lesser extent) white cedar

http://www.wood-database.com/tamarack/
2. Treated wood

- Yesterday: CCA (chromated copper arsenate) is now banned
- Today: Copper azole and ACQ (ammoniacal copper quaternary) are standard but there are concerns
- Less common: Silica-based, thermal treatments, borate, acetylated
- Unconventional (e.g., Shoshugi-ban)

Framing notes, cont.

3. Engineered wood
   - LVL (laminated veneer lumber)
   - Glulam (glued laminated timber)
   - CrossLam (cross laminated timber structural panel)
   - I-joists with OSB web

**Great:** Can be made with smaller, faster-growing trees; can be “right-sized”; high strength

**Not so great:** Most use some sort of formaldehyde - but phenolic resins are lower toxicity than urea formaldehyde and occupant exposure is often limited
Framing: Bottom line

**Basic**

**Real wood**

ONLY where necessary, Treated and engineered wood, AND

- Keep scraps separated
- Reduce occupant exposure through design
- Workers know about required PPE
## Framing: Bottom line

<table>
<thead>
<tr>
<th>Basic</th>
<th>Inspired</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Real wood</strong>&lt;br&gt;ONLY where necessary, Treated and engineered wood, AND • Keep scraps separated • Reduce occupant exposure through design • Workers know about required PPE</td>
<td><strong>Real wood, locally milled, or confirmed untreated</strong>&lt;br&gt;ONLY where necessary, • Non-copper alternatives to pressure treated wood • Formaldehyde-free alternatives to engineered wood</td>
</tr>
</tbody>
</table>

*Some customers choose certified wood to mitigate environmental effects. Other certifications exist, but FSC (Forest Stewardship Council) are generally recognized as the most stringent / impactful*
Sheathing

1. Plywood
2. OSB (oriented strand board)
3. MgO (magnesium oxide) board
4. Fiberboard
5. Wood

Sheathing: Bottom line

**Basic**

- Plywood (over OSB)

http://www.roseburg.com/Product/plywood-sheathing/
### Sheathing: Bottom line

<table>
<thead>
<tr>
<th><strong>Basic</strong></th>
<th><strong>Inspired</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Plywood (over OSB)</td>
<td>• Structural/braced fiberboard</td>
</tr>
<tr>
<td></td>
<td>• MgO board</td>
</tr>
<tr>
<td></td>
<td>• Real wood – diagonal or braced</td>
</tr>
</tbody>
</table>


Robert Swinburne,
Cost impacts: Sheathing

- Test house wall surface coverage: 2300 SF (70 sheets)

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost/sheet</th>
<th>Total</th>
<th>Premium (7/16 OSB)*</th>
<th>Premium (ZIP OSB)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” plywood</td>
<td>$25</td>
<td>$1,750</td>
<td>$700</td>
<td>$70</td>
</tr>
<tr>
<td>1/2” MgO</td>
<td>$35</td>
<td>$2,450</td>
<td>$1,400</td>
<td>$770</td>
</tr>
<tr>
<td>3/4” fiberboard</td>
<td>$30</td>
<td>$2,100</td>
<td>$1,050</td>
<td>$420</td>
</tr>
<tr>
<td>1” boards*</td>
<td>$24</td>
<td>$1,680</td>
<td>$630</td>
<td>$0</td>
</tr>
</tbody>
</table>

*Compared to 7/16” OSB at $15/sheet, $1050 total
**Compared to Huber Zip OSB at $24/sheet, $1680
***Labor cost for board sheathing will be higher
Insulation

[Brian]

Summaries by Application
Recommendations and Cost Impacts
Introduction

- This could be a whole separate presentation
  - 98-page guide, version 3, updated last summer

Disclaimer: The BuildingGreen report was used to inform these choices, but our picks don’t necessarily match theirs
Concerns (Building Green considerations)

- Energy savings / performance
- Embodied energy and carbon
- Global warming potential
- Ozone-depleting components
- Halogenated flame retardants
- Raw material acquisition
- Hazardous components
- Chemical byproducts and residuals
- Fiber shedding
  - End-of-life issues
  - Durability
  - Cost

Environment

Health

Other
Insulation: Bottom line

Cavity fill

Basic

- Dense-packed cellulose - top pick
- Mineral wool batts
- Spray-applied or dense-packed fiberglass
- Fiberglass batts
Insulation: Bottom line

Inspired
- Dense-packed wool
- Straw/hemp (panels, bales, infill)
- Cotton/hemp/wool batts (grade 1)

http://endeavourcentre.org/

https://www.nevilllong.co.uk/products/view/157/black-mountain-sheeps-wool-insulation-15s
Insulation: Bottom line

Insulating sheathing

**Basic**

**Exterior:**
- Rigid mineral wool (formaldehyde-free? even better) - *top pick*
- Polyiso (also available in bonded OSB product)
- Phenolic foam (e.g. Kooltherm)

**Interior:**
- Rigid mineral wool (formaldehyde-free? even better)
- Polyiso
- Phenolic foam (e.g. Kooltherm)
Insulation: Bottom line

Insulating sheathing

**Inspired**

**Exterior:**
- Fiberboard (multiple types)

**Interior:**
- Fiberboard (multiple types)
- Cork
Insulation: Bottom line

**Foundation**

**Basic**

**Interior foundation wall:**
- Polyiso
- Phenolic foam (e.g. Kooltherm)

**Exterior foundation wall:**
- Rigid mineral wool
- EPS Type II or IX

**Sub-slab:**
- Rigid mineral wool (non-structural)
- EPS Type II or IX

*Occupant exposure is minimal, so take this with grain of salt (from health perspective)*

Insulation: Bottom line

**Foundation**

**Inspired**
- **Interior foundation wall:** Various, depends on moisture
- **Exterior foundation wall:** Rigid mineral wool
- **Sub-slab:** Same
Insulation: Bottom line

Attics

**Basic**

**Flat**
- Loose-fill cellulose
- Loose-fill fiberglass (new generation formulation)

**Sloped**
- Dense-packed cellulose
- Open-cell spray polyurethane foam (where air sealing otherwise difficult)*

*Caution with moisture management: may be risky without proper vapor control and/or venting
## Insulation: Bottom line

### Attics

<table>
<thead>
<tr>
<th>Basic</th>
<th>Inspired</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flat</strong></td>
<td><strong>Loose-fill cellulose</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Loose-fill fiberglass (new generation formulation)</strong></td>
</tr>
<tr>
<td><strong>Sloped</strong></td>
<td><strong>Dense-packed cellulose</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Open-cell spray polyurethane foam (where air sealing otherwise difficult)</strong></td>
</tr>
</tbody>
</table>

*Caution with moisture management: may be risky without proper vapor control and/or venting*
“The Hazmat suit is a clue” (notes on spray foam)

- Not discounting that there may be valid uses
- Compelling reasons to consider avoiding spray foams, particularly closed cell varieties
  - Isocyanate sensitization for workers
  - Uncertainty re: safe clearance times
  - Offgassing (potentially worse with improper cure)
  - Recommendation for PPE with supplied air hood

Images: www.certainteed.com
“The Hazmat suit is a clue” (notes on spray foam)

- Not all green labeling programs consider isocyanurates in their testing protocols*
- If using, give prior informed consent to home (future or existing) occupants and workers, and use certified bonded trained installers
- For sealing applications, consider alternatives such as caulking or self-expanding tapes (e.g. EMSEAL)
  - Note that different sealing products carry different levels of toxicity

Images: www.certainteed.com
Cost impacts: Cavity insulation

- Test house: 2300 square feet of cavity space
- Prices shown per R-21 of insulation in a cavity wall (per square foot)

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost used</th>
<th>Total</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiberglass batts*</td>
<td>$1.59</td>
<td>$3,661</td>
<td>n/a</td>
</tr>
<tr>
<td>Dense-pack cellulose**</td>
<td>$0.92</td>
<td>$2,116</td>
<td>-$1,545</td>
</tr>
<tr>
<td>Mineral wool batts*</td>
<td>$1.96</td>
<td>$4,500</td>
<td>$839</td>
</tr>
<tr>
<td>Spray-applied fiberglass*</td>
<td>$1.33</td>
<td>$3,051</td>
<td>-$610</td>
</tr>
<tr>
<td>Wool*</td>
<td>$4.42</td>
<td>$10,168</td>
<td>$6,507</td>
</tr>
<tr>
<td>Cotton*</td>
<td>$3.18</td>
<td>$7,321</td>
<td>$3,660</td>
</tr>
<tr>
<td>Hemp</td>
<td>$1.99</td>
<td>$4,580</td>
<td>$919</td>
</tr>
</tbody>
</table>

*Prices based on midpoint of range in BuildingGreen reference for R-19 worth, then scaled to R-21/sf by multiplying by (21/19)
**Labor cost for cellulose will be higher
Cost impacts: Rigid insulation

- Test house: 2300 square feet
- Prices shown per R-15 worth of insulation (per square foot)

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost used</th>
<th>Total</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>XPS (3”)</td>
<td>$2.00</td>
<td>$4,600</td>
<td>n/a</td>
</tr>
<tr>
<td>Phenolic foam (2”)</td>
<td>$2.00</td>
<td>$4,600</td>
<td>$0</td>
</tr>
<tr>
<td>Mineral wool boards*</td>
<td>$1.70</td>
<td>$3,904</td>
<td>-$696</td>
</tr>
<tr>
<td>Polyiso*</td>
<td>$2.70</td>
<td>$6,219</td>
<td>$1,619</td>
</tr>
<tr>
<td>EPS*</td>
<td>$2.89</td>
<td>$6,646</td>
<td>$2,046</td>
</tr>
<tr>
<td>Fiberboard</td>
<td>$4.13</td>
<td>$9,499</td>
<td>$4,899</td>
</tr>
<tr>
<td>Cork</td>
<td>$4.65</td>
<td>$10,695</td>
<td>$6,095</td>
</tr>
</tbody>
</table>

*Prices based on midpoint of range in BuildingGreen reference for R-19 worth, then scaled to R-20/sf by multiplying by (15/19)
Flooring

Jacob

Materials and Finishes
Recommendations and Cost Impacts
Concerns

- PVC – it’s complicated*
- Emissions (offgassing) from materials, finishes, and adhesives
- Dust creation and offgassing through wear
- Recycled content that may contain VOCs, heavy metals, etc.

Favorite references
Concerns

Our “avoid” list:

- Anything PVC or “vinyl”
- Carpet (for various reasons)
  - Fly ash filler, allergen haven, mold habitat, formaldehyde off-gassing
- Many engineered floors
- Ceramic tiles from overseas
- Anti-microbial coatings
- Nano coatings

Favorite references
Flooring: Bottom line

**Basic**

- Pre-finished engineered floors (see notes below re: binders and finishes)
- Polished concrete (or no-VOC finish)
- Natural linoleum (e.g. Marmoleum), not sheet vinyl
- Ceramic tile (made in USA only*)

Certifications to look for:
- For engineered floors, look for NAF or ULEF; if you can’t find those, then NAUF or California Phase 2 Compliant

*"Made in the USA: A Healthy Choice for Ceramic Tiles", https://www.pharosproject.net/blog/show/184/ceramic-migration

Favorite references:
Flooding: Bottom line

Inspired

- Pre-finished solid wood (prefer products that don’t require adhesive)
- Cork (non-adhesive, pre-finished)
- Natural unfinished stone (e.g. slate)
- Earthen floors (low-VOC finish)
- True zero-VOC finishes (e.g. AFM SafeCoat Mexeseal, Rubio Monocoat)

Certifications to look for:
- For engineered floors, look for NAF or ULEF; if you can’t find those, then NAUF or California Phase 2 Compliant

Favorite references:
Flooring: Additional notes

- **Tiling**
  - Look for Greenguard Gold-certified backer board, if using
  - Standard sanded grouts (dry) likely more innocuous than ones with epoxy or admix
  - Look for zero-VOC grout sealers and stone sealants
    - e.g. Safecoat Grout Sealer and Safecoat Mexecoat

- **Rugs**
  - 100% wool is durable and flame resistant, but be wary of treatments
  - Look for area rugs that are CRI Green Label Plus or Greenguard Gold certified

Favorite references:
Cost impacts: Flooring

- Test house: 1000 square feet of floor space (1 story)
- Prices shown for material cost (per square foot)

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost used</th>
<th>Total</th>
<th>Premium*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-engineered wood (click fit)</td>
<td>$3.99</td>
<td>$3,990</td>
<td>$1,495</td>
</tr>
<tr>
<td>Real linoleum (click tile)</td>
<td>$5.90</td>
<td>$5,900</td>
<td>$3,405</td>
</tr>
<tr>
<td>Ceramic tile (inc. thinset, grout)**</td>
<td>$2.49</td>
<td>$2,490</td>
<td>$0</td>
</tr>
<tr>
<td>Cork (click tile)</td>
<td>$4.99</td>
<td>$4,990</td>
<td>$2,495</td>
</tr>
<tr>
<td>Slate/stone**</td>
<td>$4.66</td>
<td>$4,660</td>
<td>$2,165</td>
</tr>
<tr>
<td>Solid hardwood**</td>
<td>$4.95</td>
<td>$4,950</td>
<td>$2,455</td>
</tr>
</tbody>
</table>

*Compared 50/50 flooring mix of vinyl composite tile at $1.00/sf and carpet at $3.99/sf ($0.70/sf for padding, $3.29/sf for carpet itself); total material cost $2,495

**Note that installation labor for these items may be higher
Adhesives, Caulks, and Sealants

Materials
Recommendations and Cost Impacts
Adhesives, sealants, and caulks

**Basic**

- Greenguard Gold certified
- Low-VOC
- Water-based latex caulks and sealants wherever possible (e.g. Big Stretch)
- Solvent-free silicone caulks for wet or damp areas
- No biocides, petroleum solvents, ethylene glycol, methyl ethyl ketone (MEK), toluene, xylene, isocyanates, formaldehyde, phthalates, BPA

References
- “Buildingclean.org: Types of Sealants and Their Possible Hazards”, http://www.buildingclean.org/building/products/sealants
# Adhesives, sealants, and caulks

<table>
<thead>
<tr>
<th>Basic</th>
<th>Inspired</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Greenguard Gold certified</td>
<td>Avoid them wherever possible (mechanical installation for items like flooring and countertops)</td>
</tr>
<tr>
<td>• Low-VOC</td>
<td></td>
</tr>
<tr>
<td>• Water-based latex caulks and sealants wherever possible (e.g. Big Stretch)</td>
<td>When used,</td>
</tr>
<tr>
<td>• Solvent-free silicone caulks for wet or damp areas</td>
<td>• No-VOC choices, e.g. varieties by</td>
</tr>
<tr>
<td>• No biocides, petroleum solvents, ethylene glycol, methyl ethyl ketone (MEK), toluene, xylene, isocyanates, formaldehyde, phthalates, BPA</td>
<td>• AFM Safecoat</td>
</tr>
<tr>
<td></td>
<td>• ChemLink</td>
</tr>
<tr>
<td></td>
<td>• Forbo</td>
</tr>
<tr>
<td></td>
<td>• Pro clima</td>
</tr>
</tbody>
</table>

**References**
Walls and Ceilings

[Brian]

Materials and Finishes

Recommendations and Cost Impacts
Concerns of most common materials

- **Drywall**
  - Can contain sulfur, mercury, and other harmful chemicals*
  - But this can be minimized at low/zero cost if you know what to look for
- **Joint compound**
  - Formaldehyde and acetaldehyde (carcinogens), crystalline silica
  - “Most premixed joint compounds contain harmful biocides like tributyltin, which is a potent endocrine disruptor and is highly toxic to aquatic life.”
  - Old joint compound products frequently contain asbestos
- **Paints**
  - VOCs
  - Nonylphenol ethoxylates (hormone disruptors)
  - Biocides (often toxic, can linger in air for years)
  - Antifungal, antimicrobial additives

*“EWG’s Healthy Living: Home Guide: Drywall”, [https://www.ewg.org/healthyhomeguide/drywall](https://www.ewg.org/healthyhomeguide/drywall)
Walls: Bottom line

**Basic**

Drywall, but only with:
- “Greenguard Gold” OR “UL Environment ISR 100” certification
- Made in USA (meets sulfur requirements)
- No biocides
- No synthetic or pre-consumer recycled content gypsum (coal waste, may contain heavy metals such as mercury)

Paperless drywall (for mold-prone areas)

Use no-VOC and biocide-free, or hypo-allergenic joint compound; avoid premixed mud

Use proper PPE

Search for Greenguard Gold drywall by going to UL Prospector website (https://spot.ulprospector.com/en/na/BuiltEnvironment), then narrowing by “Building Construction Materials”, “Gypsum & Plaster Board”, and “Greenguard Gold Certification” (checkboxes on left side)

References:
- “Gypsum board: Are Our Walls Leaching Toxins?”, https://www.buildinggreen.com/blog/gypsum-board-are-our-walls-leaching-toxins
Walls: Bottom line

- Basic (Brian) Inspired Drywall, but only with:
  - "Greenguard Gold" OR "UL Environment ISR 100" certification
  - Made in USA (meets sulfur requirements)
  - No biocides
  - No synthetic or pre-consumer recycled content gypsum (coal waste, may contain heavy metals such as mercury)

  Paperless drywall (for mold-prone areas)
  - Use no-VOC and biocide-free joint compound
  - Use proper PPE

- MgO board in place of drywall
- Earth or lime plaster systems
- Wood, cork paneling (pre-finished or safe finish, ensure proper air barrier)
- Recycled wallboard product

References:
Wall finishes: Bottom line

Basic

Paint, but ONLY if:
- Labeled for zero VOCs, AND
- Green Seal-11 certified

Gypsum skim coat

Wall finishes: Bottom line

- Basic (Brian) Inspired Paint, but ONLY if:
  - Labeled for zero VOCs, AND
  - Green Seal-11 certified

- Gypsum skim coat (safe source?)

- Paint, but ONLY if:
  - Declare-listed paints (ECOS, etc.)
  - Mineral paints (e.g. Keim, Romabio)
  - Clay or lime-based finish plasters or paints

Cost impacts: Walls

- Test house: 2300 square feet of wall area

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost/sheet*</th>
<th>Total</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>½” sheetrock - bldr grade**</td>
<td>$12</td>
<td>$840</td>
<td>n/a</td>
</tr>
<tr>
<td>½” MgO</td>
<td>$48</td>
<td>$3,360</td>
<td>$2,520</td>
</tr>
<tr>
<td>½” ReWall EssentialBoard</td>
<td>$16</td>
<td>$1,120</td>
<td>$280</td>
</tr>
<tr>
<td>1”x6” T&amp;G spruce paneling</td>
<td>$58</td>
<td>$4,080</td>
<td>$3,220</td>
</tr>
</tbody>
</table>

*Wall material only; does not consider tapes, joint compound, labor, etc.

**If you find a source that doesn’t contain fly ash, let us know.
Cost impacts: Wall finishes

- Test house: 2300 square feet of wall area
- Walls only (does not include primer, ceiling, etc.)

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost/gal</th>
<th>Total</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint, builder grade</td>
<td>$20</td>
<td>$400</td>
<td>n/a</td>
</tr>
<tr>
<td>Paint, zero-VOC</td>
<td>$28</td>
<td>$560</td>
<td>$160</td>
</tr>
<tr>
<td>Paint, zero-VOC + GS-11 (e.g. “ben”)</td>
<td>$40</td>
<td>$800</td>
<td>$400</td>
</tr>
<tr>
<td>Paint, Declare listed (e.g. “Ecos”)</td>
<td>$52</td>
<td>$1,040</td>
<td>$640</td>
</tr>
<tr>
<td>Clay or lime paint (homemade)</td>
<td>$5</td>
<td>$100</td>
<td>-$300</td>
</tr>
<tr>
<td>Clay or lime paint (manufactured)</td>
<td>$52</td>
<td>$1,040</td>
<td>$640</td>
</tr>
</tbody>
</table>

*Assumes 2300 sf need covering, 3 coats per surface, 350 sf/coat = approx. 20 gallons
Cabinets, Millwork, and Countertops

[Jacob]
Materials and Finishes
Recommendations and Cost Impacts
Concerns

- Many emit formaldehyde and other VOCs
- Many have finishes that use harmful solvents

References:
Cabinets and Millwork: Bottom line

**Basic**

At minimum, look for:
- “NAF” (no added formaldehyde) OR “ULEF” (ultra-low emitting formaldehyde)*
- If edge-banded, specify veneer rather than vinyl edge-banding

Install with mechanical fasteners or use “Greenguard Gold” certified adhesives

One way to narrow down factory-made cabinetry is to go to the KCMA website (https://www.kcma.org/consumers/find-manufacturer?certifications=akc%2Cec), then narrowing by “ANSI/KCMA Certified” AND “ESP Certified”

*Be wary of items with weaker certifications, such as NAUF (no added urea formaldehyde) and CARB Compliant (unless it specifies “Phase 2”), and especially avoid standard formaldehyde resins (likely what you get with products that don’t have a certification)

References:
Cabinets and Millwork: Bottom line

Inspired

- Solid wood rather than composites, especially exposed surfaces (e.g. cabinet doors, fronts, shelves, and drawers)
- Install with mechanical fasteners or use “Greenguard Gold” certified adhesives

Be wary of items with weaker certifications, such as NAUF (no added urea formaldehyde), and especially avoid standard formaldehyde resins (likely what you get with products that don’t have a certification)

References:
Countertops: Bottom line

**Basic**

Solid surfaces that don’t require sealants:
- Ceramic tile (made in USA only)
- Engineered stone (quartz, cultured marble)
- PMMA (polymethyl methacrylate)

Install with mechanical fasteners or use Greenguard Gold-certified adhesives

AVOID list:
- P-Lam (plastic laminate), but if using specify NAF or ULEF
- Sealers with harmful solvents
- Ceramic tile where lead may be present

If needed (e.g. wood), use water-based, zero-VOC or Greenguard Gold-certified finishes and sealers

References:
Countertops: Bottom line

Basic (Brian) Inspired

Solid surfaces that don't require sealants:
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- Ceramic tile where lead may be present
- If necessary (e.g. wood), use water-based, zero-VOC finishes and sealers
  - Granite / natural stone (must use safe sealant product such as AFM SafeCoat or Mexeseal, or pre-finished with non-off-gassing sealant)
  - Concrete (must use safe sealant product such as AFM SafeCoat Mexeseal, mineral oil)
  - Wood (use Greenguard Gold-certified adhesives, safe wood sealant product such as mineral oil or oil/wax emulsion product)

References:
Cost impacts: Countertops

- 2’x10’ nominal size, 20 sf

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost/ sf</th>
<th>Total</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precut laminate, 2’x10’</td>
<td>$7.50</td>
<td>$150</td>
<td>n/a</td>
</tr>
<tr>
<td>PMMA / Acrylic solid surface</td>
<td>$35</td>
<td>$700</td>
<td>$550</td>
</tr>
<tr>
<td>Granite (min.)</td>
<td>$40</td>
<td>$800</td>
<td>$650</td>
</tr>
<tr>
<td>Quartz solid surface (min.)</td>
<td>$50</td>
<td>$1,000</td>
<td>$850</td>
</tr>
<tr>
<td>US-made tile (with safe grout/sealer)</td>
<td>Est.</td>
<td>$300</td>
<td>$150</td>
</tr>
<tr>
<td>Concrete, custom (min.)</td>
<td>$65</td>
<td>$1,300</td>
<td>$1,150</td>
</tr>
</tbody>
</table>
Plumbing

[Brian]

Materials

Recommendations
Concerns

- Lead (even with “lead free” pipes and fixtures)
- Vinyl chloride and other chemicals (from PVC)
- MBTE leaching (from PEX)
- Acidity and time can worsen (or improve) things

References:
Plumbing: Bottom line

Basic / Inspired

Pipes:
- Copper, with post-2014 “lead-free” joint materials*
- Polypropylene (PP) or PP-R** - heat-fusion joints
- ABS acceptable for drains

AVOID list:
- PVC and CPVC
- PEX

Fixtures:
- Post-2014***

* This still allows up to 0.20% lead (prior to 1986, “lead-free” could mean up to 8% lead; amended in 2011 to 0.25%)
** E.g. Aquatherm
*** “If you manufacture, sell or distribute water treatment or distribution products in North America, your products are required to comply with NSF/ANSI 61”

References:

https://www.aquatherm.com/
https://www.bernzomatic.com/
The Rest
Design strategies

- Big, common items to avoid
  - Attached/tuck-under garage
  - Wall-to-wall carpeting
  - Basements (especially finished spaces) prone to mold/moisture problems, or stored chemicals
  - High temp/humidity Indoor environmental conditions (accelerates off-gassing)

- No combustion equipment if you can swing it
  - If you can’t, sealed combustion only
  - Avoid solid fuel combustion, especially in living areas (particulates, incinerated dust)

- Design for easy-to-clean surfaces and spaces to avoid allergens, mold, and particulates from pests, dust/dust mites, mold
Furnishings, toys, and cleaners

Scope creep? Maybe, but:
- Flame retardants are everywhere
- ...so are phthalates (a type of plasticizer)
- ...and cleaners
- See handouts
Other safety-related items

- Flooring
  - Resilient, non-glossy/slippery
  - Any rugs are secured
- Grab bars and handrails
- Wary of level changes; signal them with changes in color, texture, light
- Lighting
  - Sufficient, consistent – warm colors recommended
  - Indirect / avoid glare

- Much more...

Wrap-Up
What about certifications?

Building certifications are great, but...
- Living Building Challenge can be daunting (and expensive)
- LEED: Only 4 of 110 points in “Environmentally Preferable Products”

Product certifications...
- Sure, but which ones?
Would you roast a marshmallow over it?

Pile #1:
- 2x6 cutoffs
- Mineral wool / fiberglass / straw
- Hardwood flooring
- Solid wood cabinets
- Quartz countertop

Pile #2:
- Green treated wood
- Blueboard / pinkboard / spray foam
- Laminate flooring
- Particle board / MDF cabinets
- Plastic laminate countertop
Last words

- Selling to clients
- Sniff Test vs. Outsourcing decisions to a label
- And if you are concerned about carbon impact...
Helpful references

- **Handouts:**
  - 1-page summary of the “Bottom Line” slides
  - EWG’s Healthy Home Checklist (EWG)
  - HomeFree General Spec Guidance (Healthy Building Network)
  - Not Just Dirt: Toxic Chemicals in Indoor Dust (NRDC) study

- **Suppliers:**
  - [http://www.greendepot.com](http://www.greendepot.com)
  - [https://www.thegreendesigncenter.com/](https://www.thegreendesigncenter.com/)

*Not endorsed by us, but may be good for ideas*
Jacob Racusin, jacob@newframeworks.com
Brian Just, bjust@veic.org
### The Not-Quite-Edible House: Making Healthy Material Choices: Summary of Bottom Line slides

*Note: Each project/application is different; these are not endorsements, nor is every strategy right for a given situation*

<table>
<thead>
<tr>
<th>Component</th>
<th>Basic</th>
<th>Inspired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framing</td>
<td>Real wood</td>
<td>Real wood, locally milled, or confirmed untreated</td>
</tr>
<tr>
<td></td>
<td>Treated and engineered wood <em>only where necessary</em>, and:</td>
<td><em>Only where necessary,</em></td>
</tr>
<tr>
<td></td>
<td>• Keep scraps separated</td>
<td>• Non-copper alternatives to pressure treated wood</td>
</tr>
<tr>
<td></td>
<td>• Reduce occupant exposure through design</td>
<td>• Formaldehyde-free alternatives to engineered wood</td>
</tr>
<tr>
<td></td>
<td>• Let workers know about required PPE</td>
<td></td>
</tr>
<tr>
<td>Sheathing</td>
<td>Plywood (choose over OSB)</td>
<td>• Structural/braced fiberboard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• MgO board</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Real wood – diagonal or braced</td>
</tr>
<tr>
<td>Insulation-Cavity</td>
<td>• Dense-packed cellulose (top pick)</td>
<td>• Dense-packed wool</td>
</tr>
<tr>
<td></td>
<td>• Mineral wool batts</td>
<td>• Straw/hemp (panels, bales, infill)</td>
</tr>
<tr>
<td></td>
<td>• Spray-applied or dense-packed fiberglass</td>
<td>• Cotton/hemp/wool batts (grade 1)</td>
</tr>
<tr>
<td></td>
<td>• Fiberglass batts</td>
<td></td>
</tr>
<tr>
<td>Insulation-Sheathing</td>
<td>Exterior:</td>
<td>Exterior:</td>
</tr>
<tr>
<td></td>
<td>• Rigid mineral wool (formaldehyde-free if possible) – top pick</td>
<td>• Fiberboard (multiple types)</td>
</tr>
<tr>
<td></td>
<td>• Polyiso (also available in bonded OSB product)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rigid mineral wool (formaldehyde-free if possible)</td>
<td><strong>Interior:</strong></td>
</tr>
<tr>
<td></td>
<td>• Polyiso</td>
<td>• Fiberboard (multiple types)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cork</td>
</tr>
<tr>
<td>Insulation-Foundation</td>
<td>Interior foundation wall:</td>
<td>Interior foundation wall:</td>
</tr>
<tr>
<td></td>
<td>• Polyiso</td>
<td>• Various, depends on moisture</td>
</tr>
<tr>
<td></td>
<td>• Phenolic foam (e.g. Kooltherm)</td>
<td><strong>Exterior foundation wall:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Exterior foundation wall:</strong></td>
<td>• See Basic</td>
</tr>
<tr>
<td></td>
<td>• Rigid mineral wool</td>
<td><strong>Sub-slab:</strong></td>
</tr>
<tr>
<td></td>
<td>• EPS Type II or IX</td>
<td>• See Basic</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-slab:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rigid mineral wool (non-structural)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• EPS Type II or IX</td>
<td></td>
</tr>
<tr>
<td>Insulation-Attics</td>
<td>Flat:</td>
<td>Flat:</td>
</tr>
<tr>
<td></td>
<td>• Loose-fill cellulose</td>
<td>• See Basic</td>
</tr>
<tr>
<td></td>
<td>• Loose-fill fiberglass (new generation formulation)</td>
<td><strong>Sloped:</strong></td>
</tr>
<tr>
<td></td>
<td>• Open-cell spray polyurethane foam (where air sealing otherwise</td>
<td>• See Basic</td>
</tr>
<tr>
<td></td>
<td>difficult)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cotton/hemp/wool batts (grade 1)</td>
</tr>
<tr>
<td>Flooring</td>
<td>• Pre-finished engineered floors (look for NAF or ULEF; if you can't</td>
<td>• Pre-finished solid wood (prefer products that don't require adhesive)</td>
</tr>
<tr>
<td></td>
<td>those, then NAUF or California Phase 2 Compliant)</td>
<td>• Cork (non-adhesive, pre-finished)</td>
</tr>
<tr>
<td></td>
<td>• Polished concrete (or no-VOC finish)</td>
<td>• Natural unfinished stone (e.g. slate)</td>
</tr>
<tr>
<td></td>
<td>• Natural linoleum (e.g. Marmoleum), not sheet vinyl</td>
<td>• Earthen floors (low-VOC finish)</td>
</tr>
<tr>
<td></td>
<td>• Ceramic tile (made in USA only)</td>
<td>• True zero-VOC finishes (i.e. AFM SafeCoat, Rubio Monocoat)</td>
</tr>
</tbody>
</table>

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### Adhesives, sealants, and caulks

- Greenguard Gold-certified
- Low-VOC
- Water-based latex caulks and sealants wherever possible (e.g. Big Stretch)
- Solvent-free silicone caulks for wet or damp areas
- No biocides, petroleum solvents, ethylene glycol, methyl ethyl ketone (MEK), toluene, xylene, isocyanates, formaldehyde, phthalates, BPA

Avoid wherever possible (mechanical installation for items like flooring and countertops)

When used, zero-VOC choices, e.g. varieties by
- AFM Safecoat
- ChemLink
- Forbo
- Pro Clima

### Walls

[Use / let workers know about proper PPE]
- Drywall, but only with:
  - “Greenguard Gold” OR “UL Environment ISR 100” certification
  - Made in USA (meets sulfur requirements)
  - No biocides
  - No synthetic or pre-consumer recycled content gypsum (coal waste, may contain heavy metals such as mercury)
  - Paperless drywall (for mold-prone areas)
  - Use no-VOC and biocide-free, or hypo-allergenic joint compound; avoid premixed mud

- MgO board in place of drywall
- Earth or lime plaster systems
- Wood, cork paneling (pre-finished or safe finish, ensure proper air barrier)
- Recycled wallboard product

### Wall finishes

- Paint, but ONLY if:
  - Labeled for zero VOCs, AND
  - Green Seal-11 certified
  - Gypsum skin coat (safe source?)

- Paint, but ONLY if:
  - Declare-listed paints (ECOS, etc.)
  - Mineral paints (e.g. Romabio)
  - Clay or lime-based finish plasters or paints

### Cabinets and millwork

[Be wary of items with weaker certifications, such as NAUF (no added urea formaldehyde), and especially avoid standard formaldehyde resins (likely what you get with products that don’t have a certification)]

At minimum, look for:
- “NAF” (no added formaldehyde) OR “ULEF” (ultra-low emitting formaldehyde)
- If edge-banded, specify veneer rather than vinyl edge-banding
- Install with mechanical fasteners or use Greenguard Gold-certified adhesives

- Solid wood rather than composites, especially exposed surfaces (e.g. cabinet doors, fronts, shelves, and drawers)
- Install with mechanical fasteners or use Greenguard Gold-certified adhesives

### Plumbing

- Copper with post-2014 “lead-free” joint materials
- Polypropylene (PP) or PP-R** - heat-fusion joints
- ABS acceptable for drains
  - AVOID list: PVC, CPVC, PEX
- Choose fixtures 2014 or later, approved for use in United States

- Granite / natural stone (must use safe sealant product, i.e. AFM SafeCoat, or pre-finished with non-off-gassing sealant)
- Concrete (must use safe sealant product)
- Wood (use Greenguard Gold adhesives, safe wood sealant product such as mineral oil)

### Countertops

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