Flooring and Healthcare Outcomes:

An Evidence-Based Design Overview

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theflooringgroup

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ASHE™ Optimizing health care facilities

NIHD Nursing Institute for Healthcare Design
LEADERSHIP • EDUCATION • ADVOCACY

AMFP Association of Medical Facility Professionals

aahid American Academy of Healthcare Interior Designers

Learning Objectives

After completing this course, participants will be able to:

- Identify **3 types of healthcare outcomes** and the **effect** on those outcomes **by flooring solutions**
- Understand the difference between **empirical evidence** and **rational inference**.
- Evaluate **aspects of flooring** and integrated systems that **positively affect** desired outcomes
- Select the **proper flooring for a given application** using principles of evidence-based design

What are the Origins of Evidence-Based Design?

Evidence-Based Design is derived from Evidence-Based Medicine, which is a stringent, rigorous protocol that demands objective, repeatable data derived from clinical trials, peer review, and testing—in other words, **the medical intervention must have been scientifically PROVEN to work.**

How is Evidence-Based Design similar to Evidence-Based Medicine?

How is it Similar to Evidence-Based Medicine?

Evidence-Based Design is the process of basing decisions about the built environment on credible research to achieve the best possible outcomes.

The Center for Health Design

Evidence-Based Medicine

Evidence-Based Design is based on the same principles as Evidence-Based Medicine. Where verifiable, 'cause-and-effect' data is unavailable, EBD may also rely on rational inference in defining outcomes relating to human health and satisfaction among patients and staff alike.

History of EBD

600 BC – Ancient Greek healers oriented patient recovery areas to face the sun

1984 – Roger Ulrich, the ‘Father of EBD’, cited patient benefits of ‘natural views’

- Fewer pain meds required
- Shorter hospital stays
- Fewer negative evaluations

1996 Evidence-Based Medicine defined

2003 Evidence-Based Design defined

‘Gold Standard’ Impacts of EBD

EBD Primary Objective
Improve Outcomes and Raise Patient, Staff, Physician and Visitor Satisfaction through the Built Environment

Examples

Bronson Hospital (Kalamazoo, MI)

- Switching from semi-private to private rooms led to a demonstrable reduction in Healthcare-Associated Infections (HAI)

Peace Health (Oregon)

- Installing patient lifts led to a demonstrable reduction in staff injuries.

Balancing Empirical Data and Rational Inference

Where provable data is available:

- Evidence-Based Designers base decisions on credible research to achieve the best possible outcomes

Where gaps in the data exist:

- Evidence-Based Designers rely on client input and experience, and
- Use critical thinking techniques to draw rational inferences to guide design toward optimal solutions

Evidence-Based Design:

General Healthcare Interventions

- Views of Nature
- Hospital Aesthetic
- Acuity Adaptable Rooms
- Private vs. Semi-Private Rooms
- Reducing Patient Transfers
- Reduce Glare
- Nurse Station Configuration
- Headwall Position Relative to Bathroom
- Patient Lifts
- Use of Acoustic Materials
- ‘Green’ Cleaning
- Appropriate Lighting

What percentage of healthcare design professionals say they use evidence-based design?

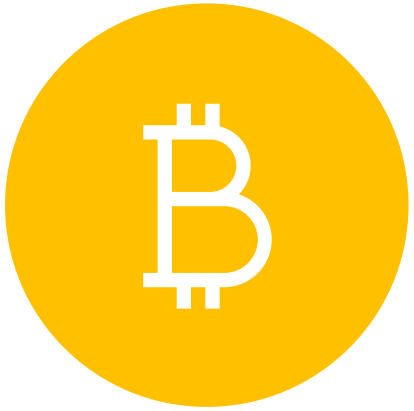
71%

The Military Health System has a complex evidence-based design checklist for developing world-class healthcare projects

Evidence-Based Design (EBD) evaluates **3 Types of Outcomes** that can be affected by the built environment

CLINICAL

OPERATIONAL



THE BUSINESS CASE - ROI

Evidence-Based Design

Flooring Interventions

1

Aesthetics

2

Durability

3

Reducing Complexity

4

Infection Control

5

Maintenance

6

Human Health Impacts

2

Durability

Durability

Load Ratings

Maintenance Protocols

Surface Density & Porosity

Weld Integrity

Lifecycle Costs

2

Durability

Load Ratings

- ASTM F970, a commonly used test for load ratings, is often modified modified by manufacturers due to limitations in the standard and to achieve more favorable results.
- As a result, PSI can be a confusing metric that doesn’t reflect a floor’s ability to handle real-world loads.
- Best determinant of durability and predicted performance is product and company history in a given application, and stakeholder feedback.
- Mockups / test floors are a valid vehicle for vetting products that have not been previously used, or feature new technology.

2

Durability

Maintenance Protocols

- Surface density and construction of product is largest determinant of overall durability and long-term performance
- Products requiring highly specialized cleaning equipment and protocols can negatively impact operational and business outcomes.
- Products with a durable, impermeable surface can be more easily cleaned with microfiber tools between scrubbings.

2

Durability

Surface Density & Porosity

- Flooring products with best-in-class density and impermeability resist staining from common healthcare chemicals
- Flooring products should also withstand deterioration from harsh cleaning compounds

CHEMICAL
Concentrated nitric acid
Ammonia
Toluene
Hydrochloric acid
Concentrated sulphuric acid
Ethyl acetate
Acetone
Concentrated acetic acid
Betadine
Tincture of iodine
Bouin's fluid
Hydrogen peroxide
Bleach
White spirit
Chloroform
Floor wax

2

Durability

Weld Integrity

Test measuring welding strength in accordance to EN 684:
Showing the strength (In Newtons of Force)
necessary to seprate 2 welded pieces of material

Results:

Vinyl:

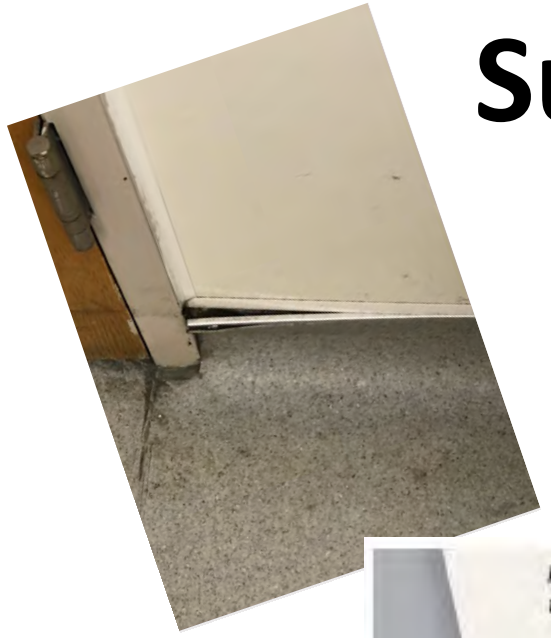
SV1	690 Newtons
SV2	590 Newtons
SV3	400 Newtons
SV4	380 Newtons
Rubber1	390 Newtons
Lino1	220 Newtons

- Seam weld integrity is one of the most important factors in sheet-good durability
- Some facilities use non-resilient floors like epoxy or terrazzo, sacrificing comfort, cleanability and repairability, stain resistance, Cost, Slip Resistance.

2

Durability

Integrated Systems, Durability, and Surface Contamination



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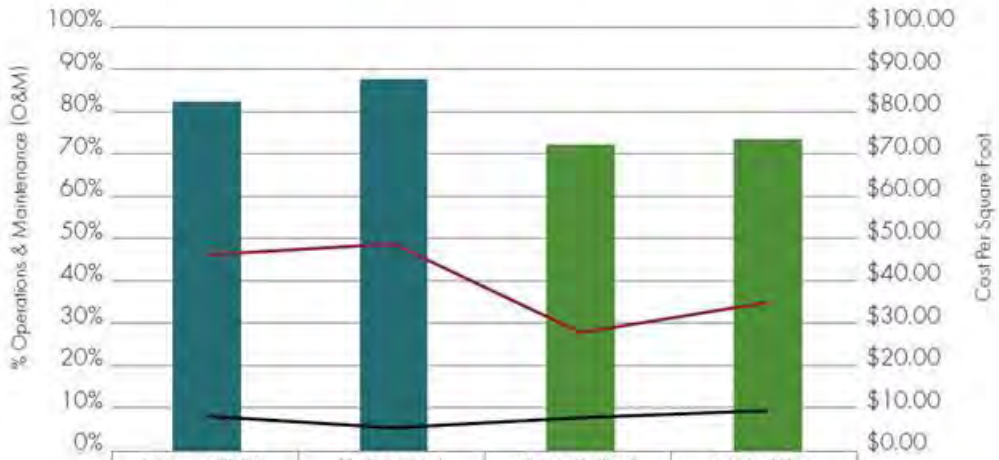
Durability

Lifecycle Costs

Real-time Case Study Data and Findings



	SHEET VINYL (factory applied coating failed at 18 months)	LINOLEUM (factory applied coating failed at 6 months)	SHEET VINYL (factory applied coating sustained to date)	PREMIUM RUBBER
UNIT	MED/SURG	MED/SURG	MED/SURG	MED/SURG
% O&M coated	82.80%	88.25%		
% O&M non-coated			72.20%	72.64%
LCC/sq. ft.	$47.64	$49.29	$28.87	$34.92
INITIAL COST/sq. ft.	$8.20	$5.79	$8.03	$9.56

- Lifecycle cost analyses provide points of comparison for Total Costs of Ownership of various flooring products
- *'This research has been published in the Journal of Hospital Administration, an international, open-access and peer-reviewed scientific journal published by Sciedu Press. Devoted to publishing research papers in the fields of managing practice and research in all branches of hospital administration.'*

Journal of Hospital Administration

3rd Party, Peer Reviewed, Published, data shows Sheet Vinyl Provides Best ROI

2

Durability

Clinical Outcomes

Key Points

- Surface materials, seams and joints should be non-porous, impermeable and compatible with the sanitizing methods outlined by the CDC. (HCD May 9, 2013)
- Flooring surfaces that don't require wax or coatings are in line with durability best practices. (EPA, 2007)
- Surface density and non-porosity of flooring materials makes them easier to clean and disinfect, improving patient health and clinical outcomes.
- Flooring durable enough to withstand heavy point and rolling loads in typical healthcare settings supports clinical initiatives not only in ORs, but in other areas of the hospital as well.
- Weld and seam integrity and strength is critical in maintaining infection control standards and inhibiting the growth of pathogens.
- Constant innovations in equipment and technology requires flooring that exceeds today's requirements and anticipates future needs.

2

Durability

Operational Outcomes

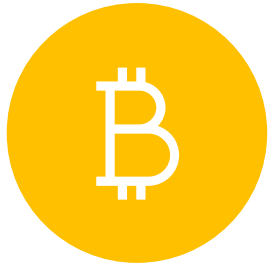
Key Points

- Best-in-class durability reduces time, effort and materials required to maintain optimal operations and facilitates greater efficiency in EVS procedures.
- Inferior materials require more time, effort and cost to maintain, repair and replace. Even a single seam break or bubble may involve multiple internal and external resources and disrupt clinical operations.
- Flooring durability in the healthcare environment can be assessed and predicted through references, product technical data, seam-strength tests and with on-site test installations.
- Surface density and impermeability are key drivers in durability, central to chemical and stain resistance and cleanability.
- Vendor healthcare experience and expertise insures appropriate match of flooring durability to usage and equipment requirements for each area of the hospital.
- Materials durability is a central consideration of all design interventions for operational efficiency.

2

Durability

The Business Case

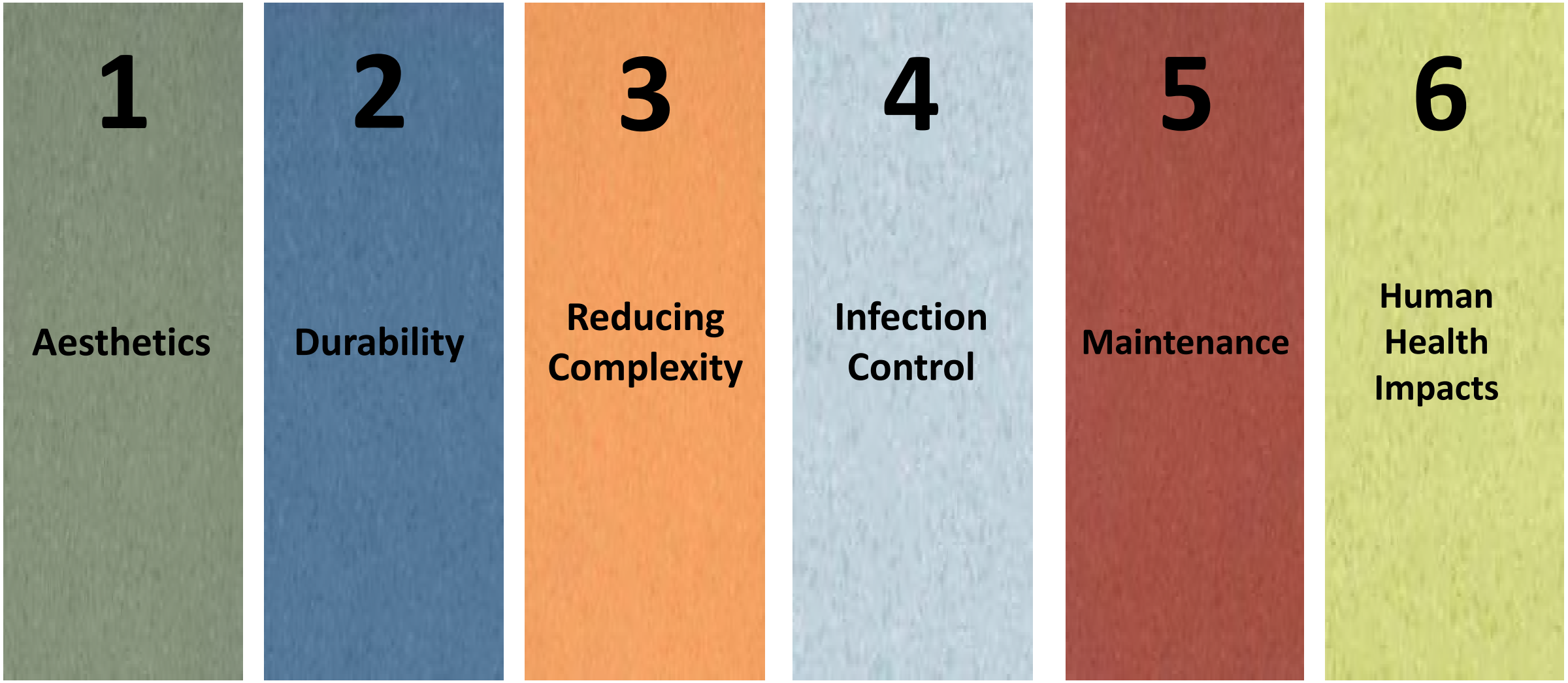


Key Points

- Evidence-Based Design interventions, by definition, require a return on investment (ROI). In other words, these design choices should pay for themselves over time
- Central to the business case is the need to balance initial investment vs. ongoing operational costs over the life of the product (Sadler et.al 2008)
- Lifecycle cost analyses can be used to assess costs of purchase, installation and maintenance over time.

Evidence-Based Design

Flooring Interventions



3

Reducing Complexity

Reducing Complexity

LEAN IPD

Simplifying Construction Processes

Moisture Solutions

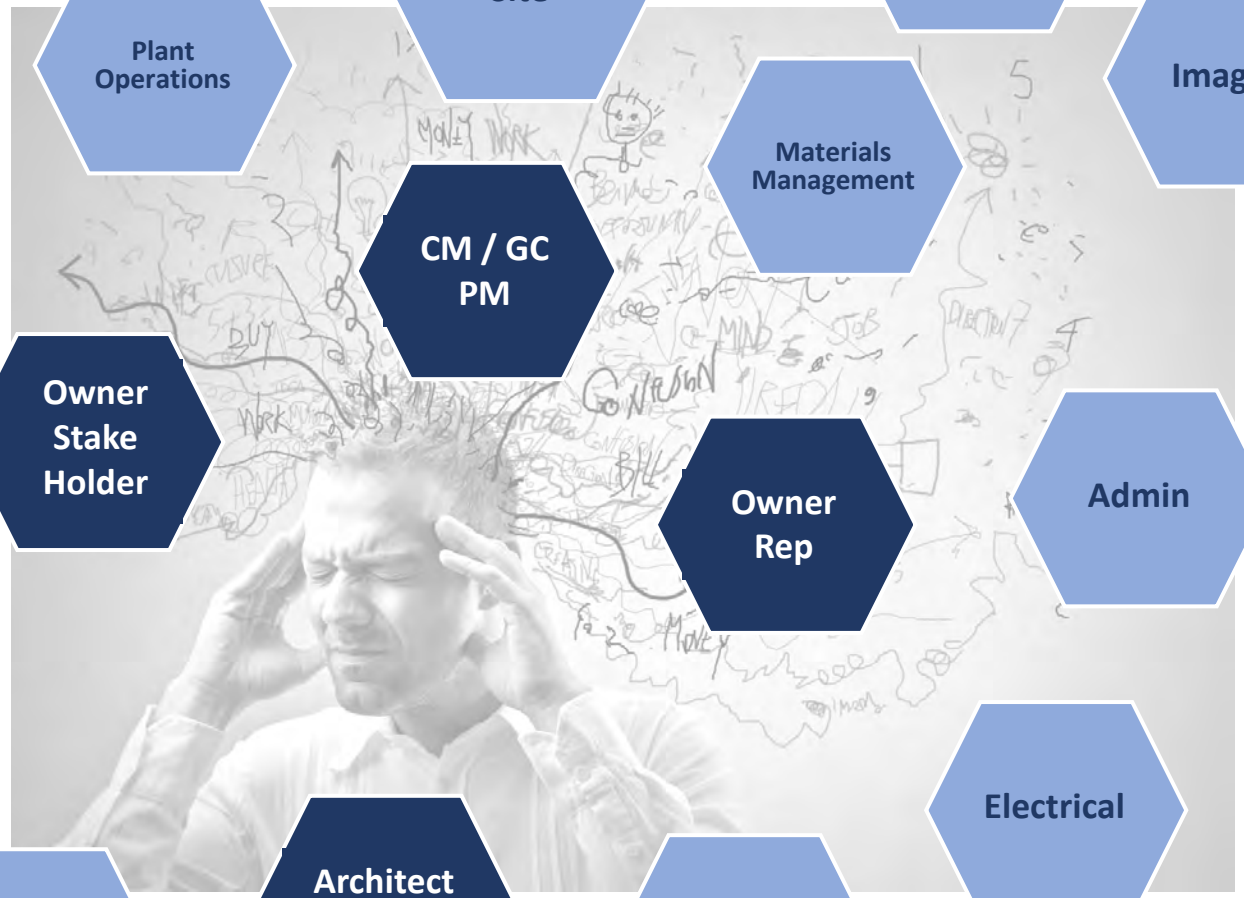
No-Downtime Solutions

Technical Solutions & Maintenance Protocols

3

Integrated Project Delivery (IPD)

Reducing Complexity

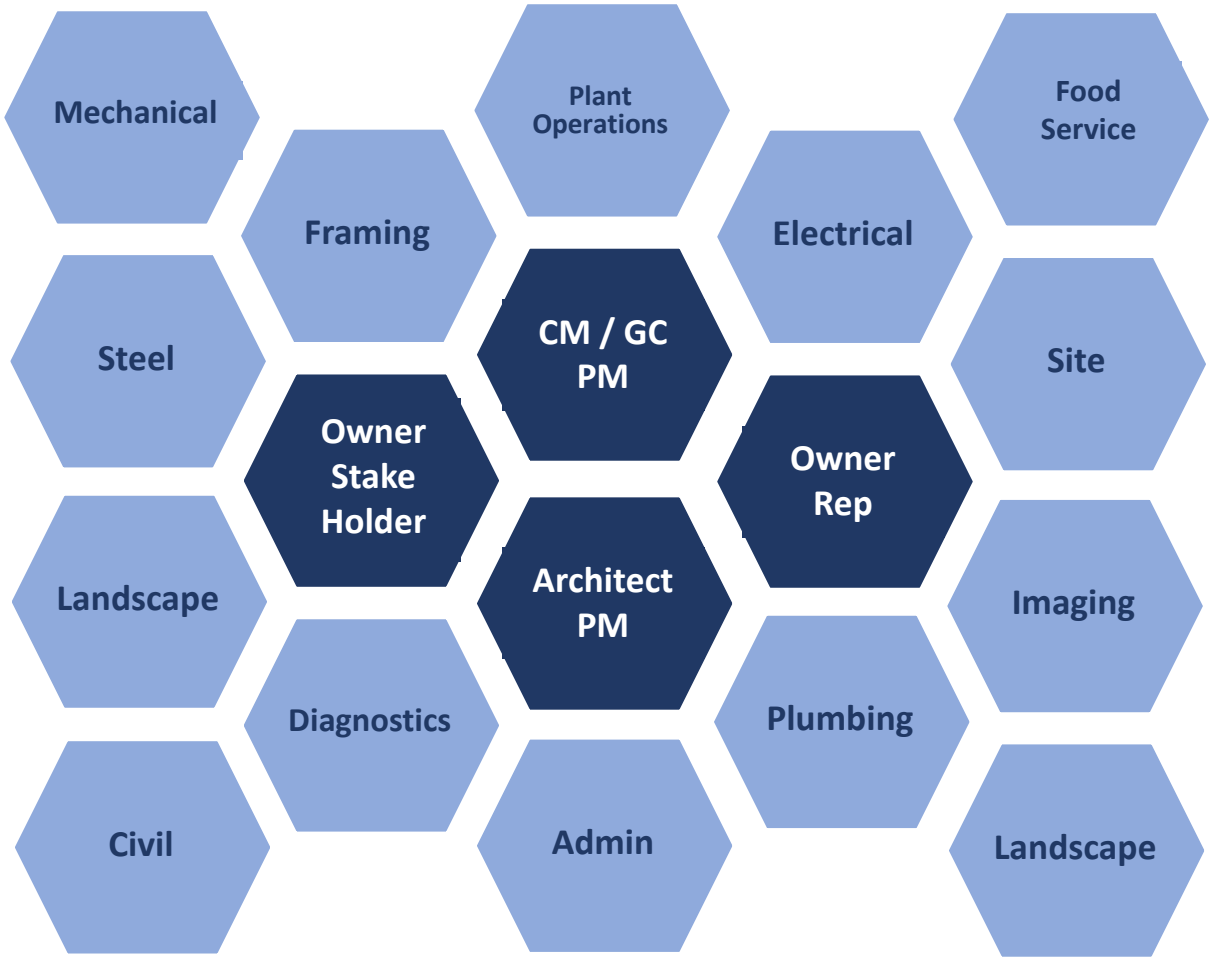


Framing
Mechanical
Steel
Landscape
Civil
Diagnostics
Architect PM
Landscape
Electrical
Plumbing
Admin
Imaging
Food Service
Site
Plant Operations
Materials Management
CM / GC PM
Owner Stake Holder
Owner Rep
?
?

3

Reducing Complexity

Integrated Project Delivery (IPD)



Lean IPD
Aligning Complex Construction Projects

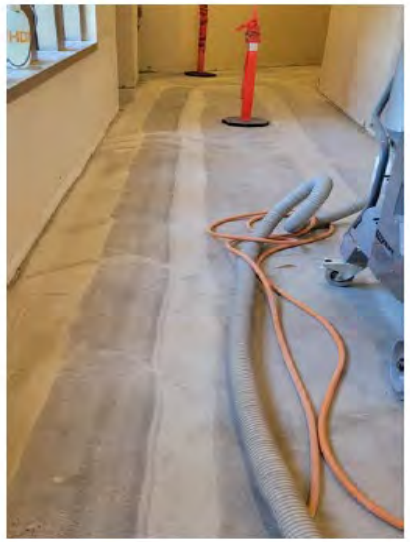
- Reducing cost and complexity
- Early collaboration and problem solving
- Avoids 11th-hour ‘collisions’

3

Reducing Complexity

On Thursday, April 13th, 2023, I visited the jobsite Texan Floor Service is currently working on the concrete compliant with ASTM F710.

I am aware that you also requested our spray adhesive supplier to be onsite for a demonstration make sure the installation is successful.



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Reducing Complexity

Simplifying Construction Processes

CASE STUDY

Resilient flooring manufacturer participating in IPD project used best practices for drying concrete

Avoided expensive mitigation

Saved customer $2-3 million and streamlined construction schedule

Best Practices to Promote Drying of Concrete

- Use moderately low water/cement ratio (.4 – .45 range) when drying time is critical
- Use under-slab vapor retarder (min. .01” thickness and permeance of .1y)
- If adding fly ash, reduce mix to under 25%
- Do not use waterproofing or damp-proofing admixtures
- Wet-cure method is preferred, with moisture-retaining cover. If chemical curing compounds are used, must be shot-blasted completely off concrete prior to installing flooring
- Light steel-trowel, porous finish is recommended—do not burnish
- Avoid re-wetting of slab (via onsite moisture or precipitation)
- Reduce relative humidity and monitor dew point (with climate controls in full-building enclosure)
- Lightweight concrete mix designs require longer to dry due to excess water in aggregate
- Consider industrial dessicant de-humidification equipment in fully enclosed areas
- Test for moisture per ASTM F2170, when building environment is stable and conditioned
- When moisture mitigation solution is required, consult with flooring manufacturer for proper procedures

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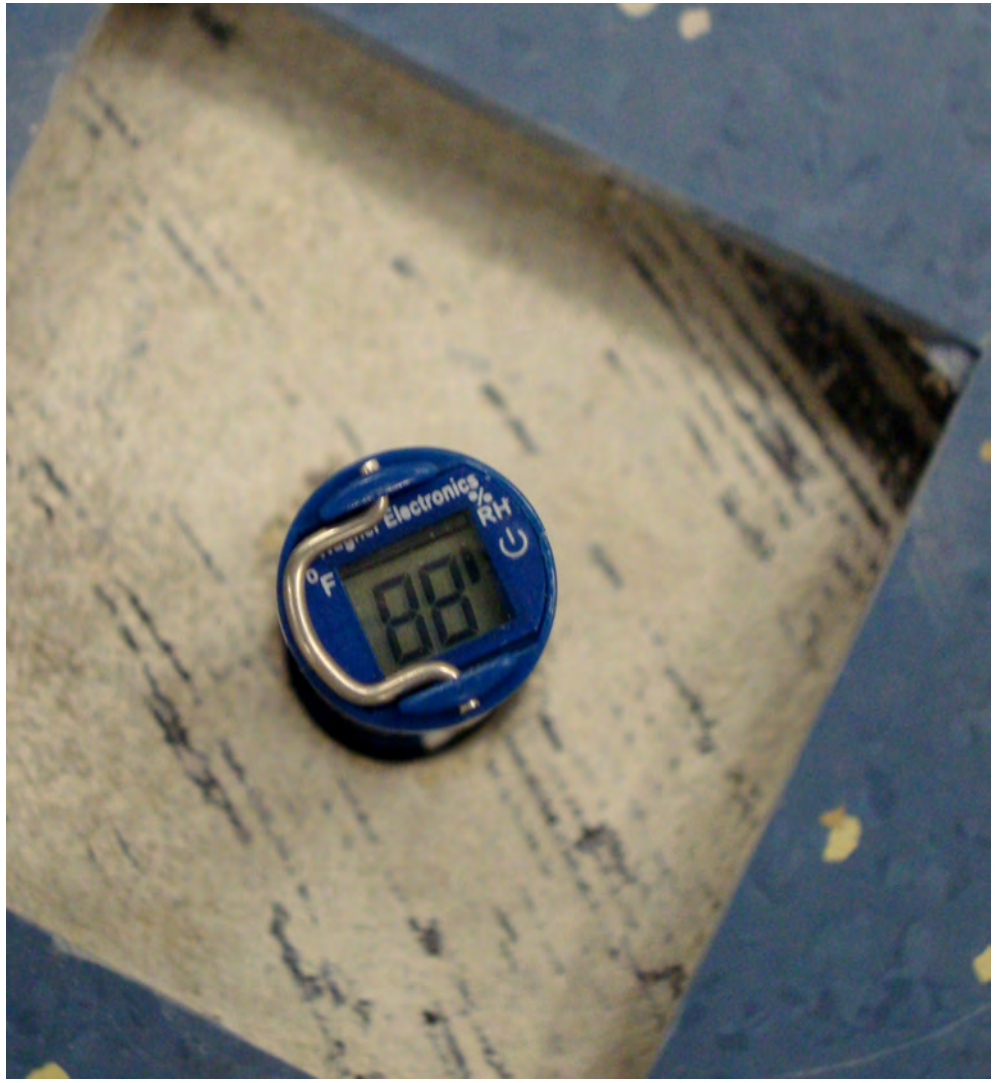
Reducing Complexity

Moisture Solutions



The Race to 100

- Industry searching for no-limit- (100RH) adhesive solutions for RH, PH, and MVER
- Optimal Solution to include:
  - Sole-source warranty that avoids 3rd-party additions
  - Field-applied adhesive with no product range limitations
  - no minimum order quantities
  - no lead-time issues
  - Cost @ .50 / sf - well below mitigation and infused or topic admixtures

3

Reducing Complexity

No-Downtime Solutions

- Key consideration in healthcare applications, particularly in ORs, elevators, occupied spaces
- Adhesive solutions must allow weekend replacement/repair that can be used immediately
- Replacement solutions must allow installation over existing, ‘problem’ sub-floors

3

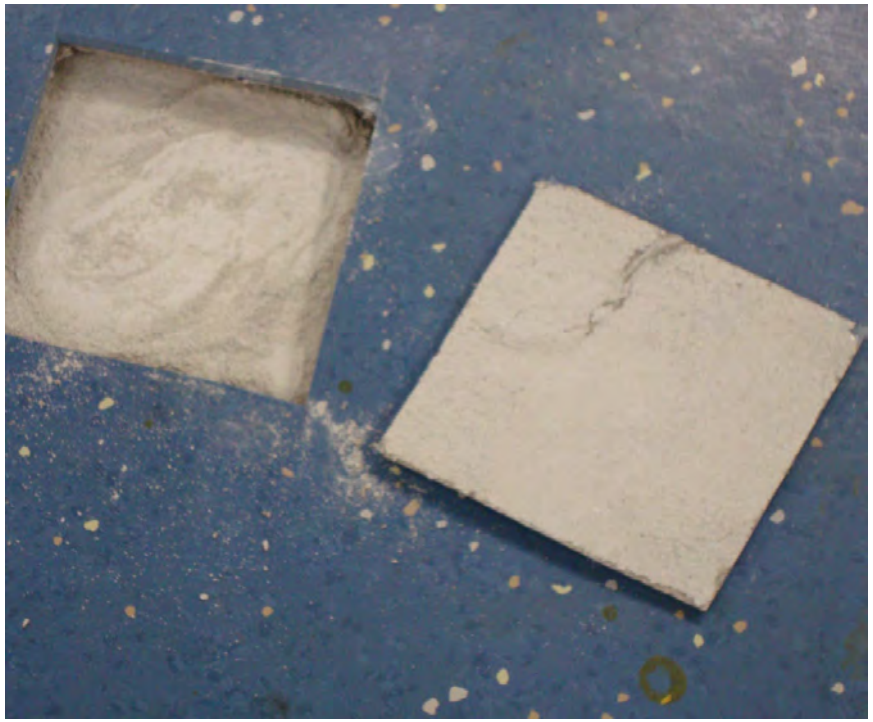
Reducing Complexity

No-Downtime Solutions

3

Reducing Complexity

Other Technical Challenges



- Subfloor Repair Failures
  - Improperly-installed patch or leveling compounds can degrade or crumble over time

3

Reducing Complexity

Other Technical Challenges

- Adhesive Displacement
  - Many resilient adhesives do not harden
  - “Hard-setting” or thin spray adhesives are recommended for high static and dynamic load areas

3

Reducing Complexity

ESD Floors In Healthcare

- You don't need ESD Flooring in any typical Healthcare Application

An ESD Floor used when ESD Footwear is not, renders the system ineffectual

These machines our non-ESD flooring is regularly installed under include:, as a few examples:

MRI

- Siemens Espree v2,
- Siemens Verio (3T),
- Siemens Aera,
- Siemens Vida (3T)
- Philips Achieva (1.5T).

CT

- GE HD750,
- Phillips Brilliance
- GE Revolution
- GE Lightspeed.

Vinyl floor is an **anti-static**. ... The reason for specifying **antistatic vinyl flooring** is to setup a special space, very often in commercial setup, that will be free of **static** shocks, or zaps. Thanks to the **anti-static** properties, **vinyl flooring** is perfect for any room or commercial area with large source of electricity.

3

Reducing Complexity

Maintenance Protocols

Green Cleaning

'The amount of VOCs emitted from a single waxing of a floor is comparable to the amount of VOCs emitted from the flooring itself over its entire lifetime.'

Dr. Greg Norris
Harvard School of Public Health

3

Reducing Complexity

Shine & Glare

3

Reducing Complexity

Shine & Glare

Increased shine (such as with frequently waxed floors) reveals sub-surface imperfections and can create glare, which can in turn increase the risk of falls and the perception of slipperiness. A matte finish creates a subtle, clean affect and requires less frequent maintenance.

3

Reducing Complexity

When Shine is Required by Customer

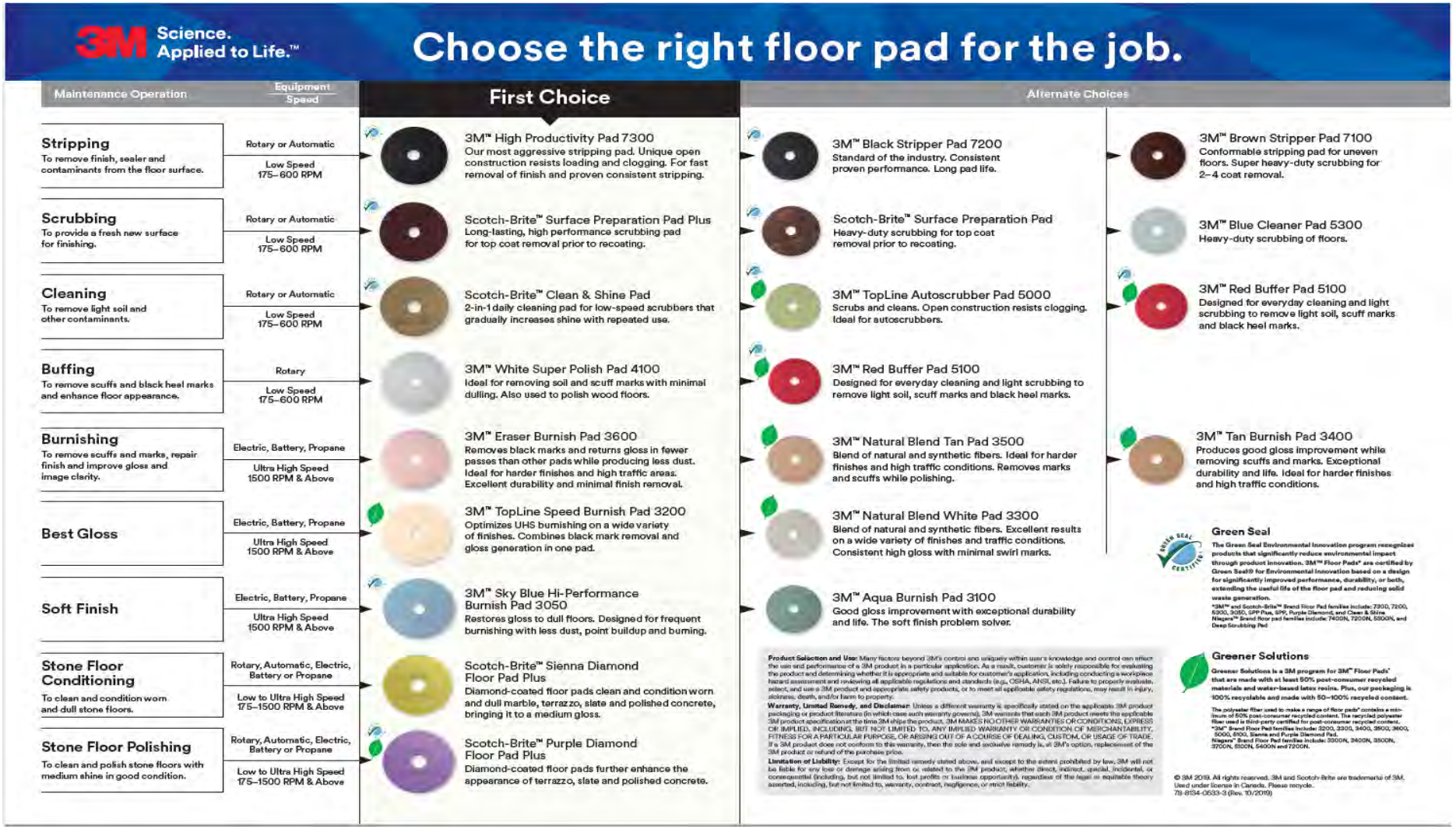
- Minimize cost and complexity
- Field applied – 2 coats mopped on
- No stripping
- Reversible
- Warranties remain intact

3

Reducing Complexity

Maintenance Protocols

Confusing and Complicated



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Maintenance Protocols

Reduced Cost and Complexity Optimize EVS Outcomes

Reducing Complexity

3

Reducing Complexity

Clinical Outcomes

Key Points

- Clinical outcomes can be affected by space disruption and contamination, noise, IAQ issues, and disruption of operations
- Products and systems that reduce complexity in installation, maintenance, repair, curing time, or preparation, also reduce disruption to clinical operations and potential contamination of occupied healthcare spaces.
- Floors that never need to be coated, waxed or stripped can positively affect clinical outcomes and improve indoor air quality (IAQ)

3

Reducing Complexity

Operational Outcomes

Key Points

- Flooring systems—including the flooring materials, adhesives, sub-floor/slab prep—can introduce or reduce complexity in the healthcare environment
- Balance between system versatility and flexibility
- Flooring features/elements can contribute to more efficient and collaborative LEAN / IPD initiatives
- Reduced downtime through simpler systems
- Retrofit solutions over existing substrate and installed flooring
- Moisture-control solutions reduce construction timetables and cost
- Manufacturer experience, expertise, and support in a complex environment.
- Product characteristics, adhesives, technical difficulty, moisture testing, welding, repair, maintenance can all reduce complexity

3

Reducing Complexity

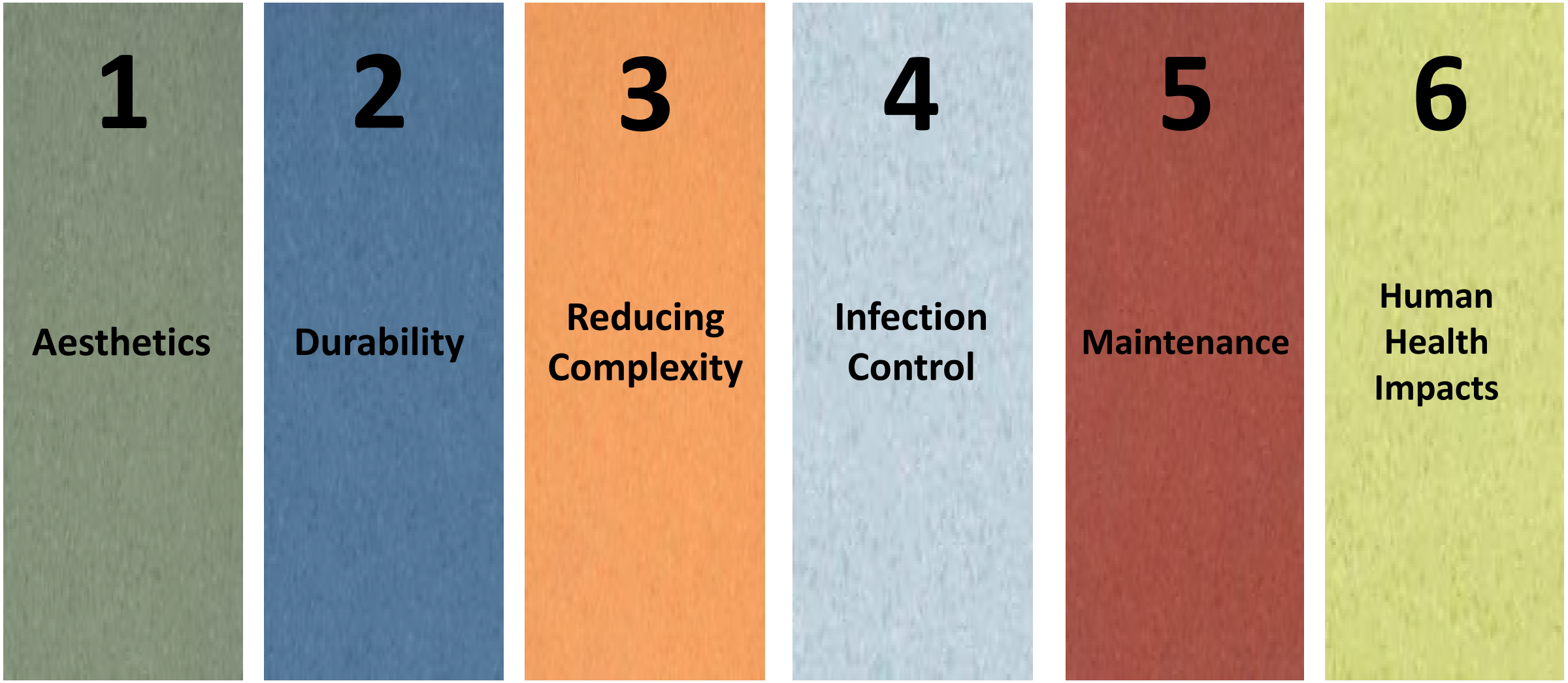
The Business Case

Key Points

- Case Study: Resilient flooring manufacturer participating in IPD initiative, used ‘best practices’ for drying concrete, with $2 million savings, streamlined construction schedule
- Balance initial cost of installation with lifetime cost of ownership
- Evaluating and reducing costs:
  - Through simplified installation methods
  - Limiting downtime
  - Limiting need for substrate preparation
  - Effective, simplified moisture mitigation solutions
  - Reliance on proven expertise of manufacturers heavily prioritizing healthcare applications

Evidence-Based Design

Flooring Interventions



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Infection Control

Infection Control

Minimizing Exposure

Flooring and Surface Contamination

ISO 22196 / 21702

Integrated Systems

Light Disinfection

4

Infection Control

Minimizing Exposure

- Surfaces with best-in-class durability perform better when subjected to stringent cleaning and disinfection equipment and processes

EPA **Product Performance Test Guidelines**

OCSPP 810.2200:

Disinfectants for Use on Environmental Surfaces

Guidance for Efficacy Testing

4

Infection Control

Minimizing Exposure

- “Indeed, there is a difference between Cleaning and Disinfection.”
- You always have to start with a clean surface. “Disinfectants don’t work if there’s a visibly dirty surface”

Karen Hoffman, RN, President APIC (Association for Professionals in Infection Control and Epidemiology

4

Infection Control

Flooring and Surface Contamination

- Floors are not considered a ‘touch surface’, but high-touch objects—such as blood pressure cuffs and call buttons—frequently come into contact with flooring surfaces, and could transfer pathogens
- There is no evidence that floorcovering of any type is a source of HAI (Gray 2010)
- Research suggests that properties of the floor can have far reaching impact on surface contamination (Hansen 2012)

4

Infection Control

ISO 22196

Measures antibacterial activity on plastics and other non-porous surfaces over a 24-hour period of time

A culture is injected onto the test surface, covered to prevent evaporation and then left for 24 hours.

After the test period, the surface is evaluated to determine the spread (if any) of the culture

ISO 22196 is a ‘pass-fail’ assessment that produces reproducible, quantitative and standardized results

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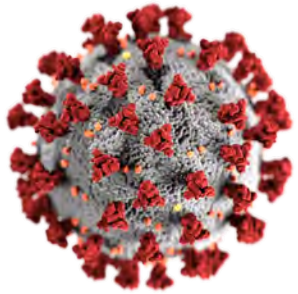
Infection Control

ISO 21702

The testing protocol measures the reduction of viral content at 90% humidity / 68° F

Quality, factory-applied, and permanent surface treatments have been demonstrated to reduction of percentage of infectious virus surviving on the surface.



Measures antiviral activity on plastics and other non-porous surfaces over a 24-hour period of time

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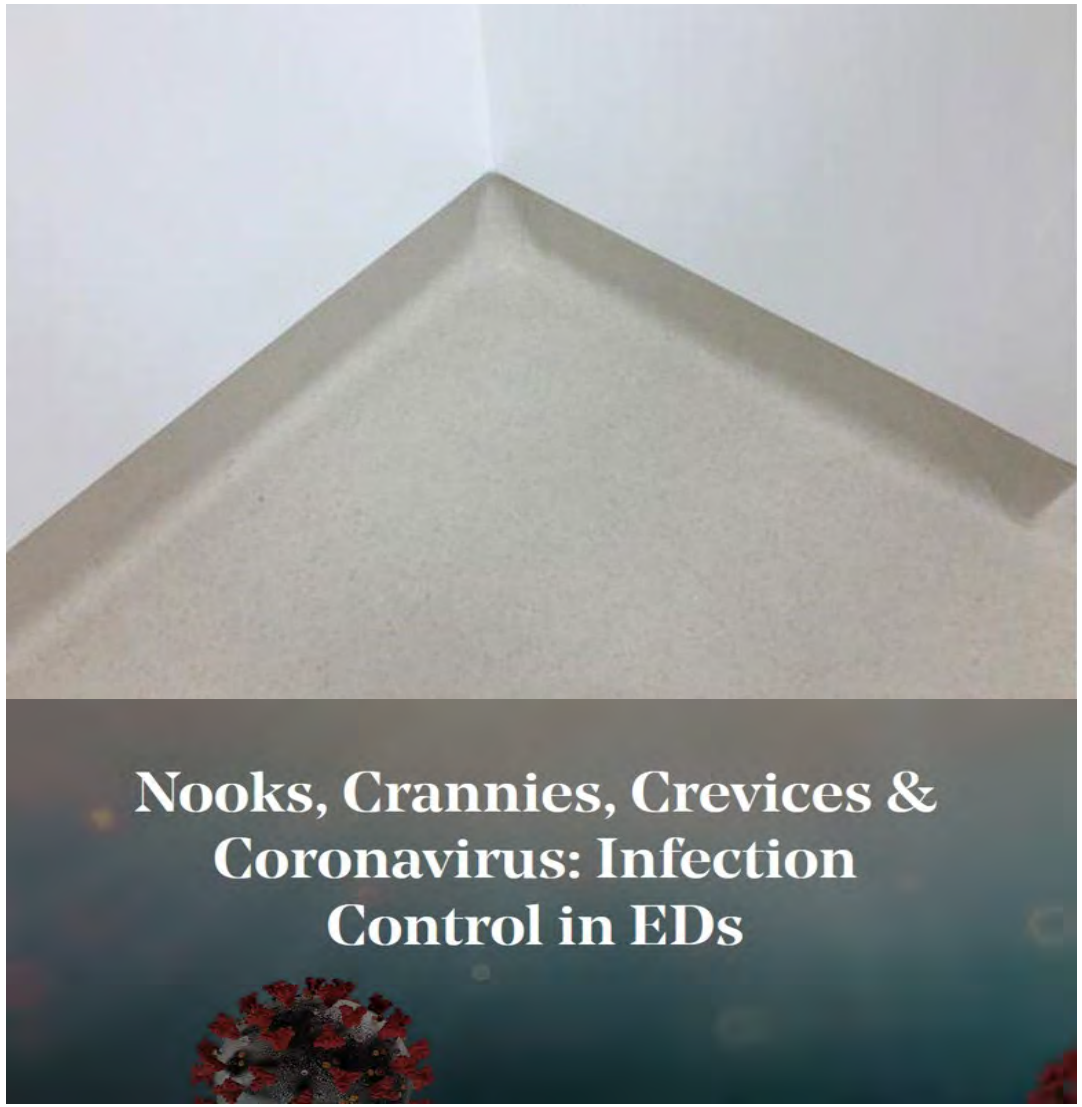
Infection Control

Integrated Systems



- Optimizes EVS productivity and infection-control outcomes
- Integrated systems reduce complexity in maintenance and repair
- ‘The corners of the room are rounded corners to further facilitate cleaning’

4

Infection Control

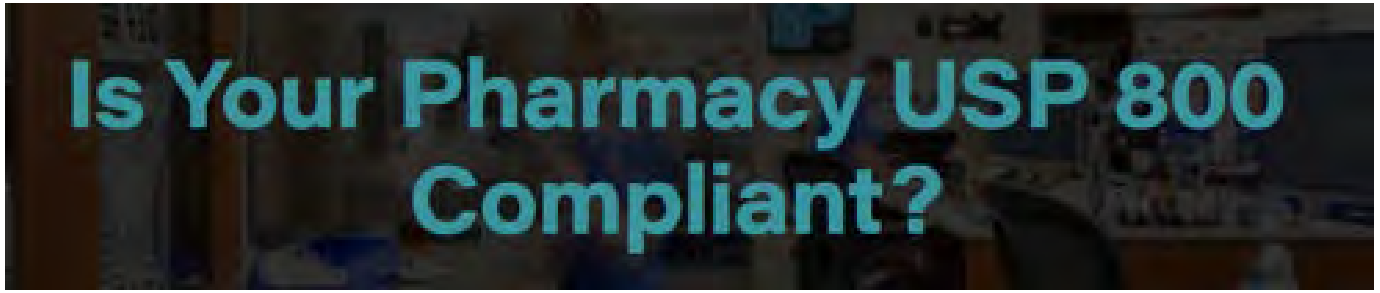
Integrated Systems and Surface Contamination

4

Infection Control

Integrated Systems

- USP 800 Guidelines govern ORs, compounding pharmacies, labs, behavioral-health units, ERs
- Flooring and wall panels are the same thickness, eliminates transitions/caps that create a ledge where dirt, mold and other bacteria can grow
- Requires ‘smooth, seamless and impervious finishes’



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Infection Control

Integrated Systems

4

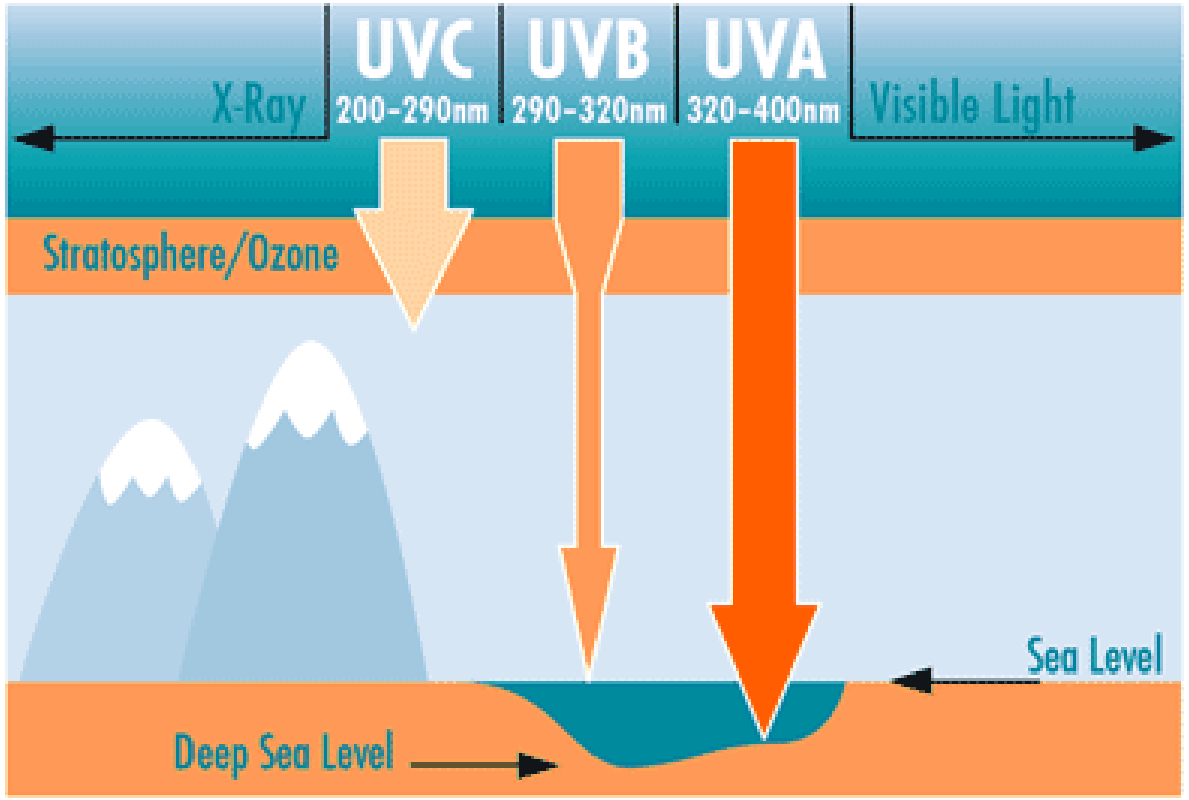
Infection Control

Integrated Systems

- Tested and certified for use in ISO 3-4, GMP Class A cleanrooms
- Rated for sterile applications, including isolation rooms where highly contagious conditions are treated / monitored
- H202 resistant
- Resistant to bio-contamination procedures
- Bacteriostatic against growth of micro-organisms

UV Light Disinfection

- Natural UVC rays don’t reach Earth’s surface
- All UVC used in healthcare applications is artificially produced
- Significant germicidal properties



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Infection Control

UV Light Disinfection

Research has noted that although UV light disinfection has proven an effective tool in infection control, a holistic program is necessary to reduce infection rates, including:

- Optimal environmental cleaning protocols
- Hand hygiene compliance
- Early identification of patient infection

'Although ultraviolet light (UV) has been proven to effectively destroy pathogenic bacterium (such as C Diff spores), its use alone may not be enough to reduce healthcare associate C Diff infection rates'

American Journal of Infection Control
Health Facilities Management, June 2020

4

Infection Control

Research In Progress

LED Continuous Light Disinfection

- University of New Mexico Comprehensive Cancer Center replaced traditional light bulbs in ORs with antibacterial LEDs for a Visible-Light Continuous Environmental Disinfection (CED) system
- Research indicates fixtures continuously kill harmful bacteria on high-risk surfaces
- Research program showing promise, but final data on effectiveness of infection control is pending

4

Infection Control

Clinical Outcomes

Key Points

- Time in a hospital increases the risk of HAIs (healthcare-associated infections). HAIs can have devastating emotional, financial, and medical effects and can even prove deadly
- No causal link has been established, but recent research raises the question: “Are Hospital Floors an Under-appreciated Reservoir for Transmission of Healthcare-Associated Pathogens?” (American Journal of Infection Control March 1 2017)
- Floors are not considered a ‘touch surface’, but high-touch objects—such as blood pressure cuffs and call buttons—were found to frequently come into contact with flooring surfaces, and could then result in transfer of pathogens to hands
- Consequently, flooring choices may have far greater impact on clinical outcomes than previously thought:
  - Research suggests that properties of the floor can have far reaching impact on surface contamination (Hansen 2012)
  - Testing and certifications designed to measure the likelihood of HAIs may see increased use, including ISO 22196, GMP Cleanroom certifications, H202, bio-decontamination procedures, and measurement of bacteriostatic properties
  - Integrated floor-and-wall systems featuring smooth, seamless, impervious finishes can limit the growth of harmful bacteria
  - Rounded floor-and-wall corner systems facilitate more thorough cleaning and disinfection and reduce the spread of pathogens and microbes

4

Infection Control

Operational Outcomes

Key Points

- Every healthcare design project is required to complete an Infection Control Risk Assessment (ICRA) addressing design aspects and mitigation recommendations, and surface materials must comply with sanitizing methods outlined in the 2003 recommendations by the CDC for cleaning of patient-care areas
- Recommendations for flooring include smooth, impermeable surfaces for floors (Healy, 2007) and surface joints should be kept at a minimum. (McDonald, 2010)
- Wider rolls = fewer seams
- Easy-to-clean, chemically resistant materials offer best opportunity to improve infection control.
- Approved Disinfectants are found in EPA List n - ://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19
- List n has not seen substantive change as a result of COVID 19 – i.e. it's a relatively easy germ to kill vs. HIV, Ebola, MRSA, C-Diff etc.
- Broken seams and cracked, brittle floors present infection-control risks and challenge operational efficiency
- Floors must be easily cleaned and disinfected with commonly available materials, and durable enough to handle new technology
- Floor-and-wall systems with seamless, consistent thickness reduce complexity and improve operational outcomes
- Rounded corners represent the most proactive approach to cleaning and infection control

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Infection Control

The Business Case

Key Points

- One out of every 20 hospitalized patients contracts an HAI costing between $35.7B and $45B annually (CDC 2010)
- Some HAI's are considered 'Never Events', not reimbursable by CMS
- Infection preventionists and epidemiologists are exerting increasing influence in healthcare design and operations; however, it is important to avoid over-estimating benefits and/or under-estimating staff time and costs in reducing HAIs (Perencevich, et al, 2007)
- While no direct business case has been made relative to flooring systems and ROI, anecdotal and empirical evidence suggests a direct link between outcomes and system integrity.
- Flooring products and systems that are more durable, yet more flexible and easier to install maximize the opportunity for desired ROI outcomes.
- Integrated systems that are easier to clean will optimize FTE operations
- Understanding industry testing and certification norms, such as ISO 22196 and ISO 3-4-5, can help optimize business outcomes for stakeholders and organizations

Flooring and Healthcare Outcomes:

An Evidence-Based Design Overview

Thank You!

Gerflor
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