

Sustainable Resilient Flooring Choices for Hospitals

Perceptions and Experiences of Users, Specifiers and Installers

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AUTHORS:
Jennifer DuBose
Amaya Labrador

Health Care Without Harm
Healthier Hospitals Initiative
UIC SCHOOL OF PUBLIC HEALTH
Georgia Institute of Technology

Health Care Without Harm has initiated a research collaborative coordinated by faculty of the University of Illinois at Chicago School of Public Health, with support from the Pioneer Portfolio of the Robert Wood Johnson Foundation, aimed at stimulating collaborative research around health and safety improvements in health care. The Research Collaborative is designed to increase the evidence base concerning the impacts of sustainable design, construction, organization, operations, and materials and chemicals choices in the health care sector on patient, worker and environmental safety.

This paper is the seventh in a series of papers in which the Collaborative provides research and analysis of factors influencing patient, worker and environmental safety and sustainability in the healthcare sector. The editors of this series are Peter Orris, MD, MPH and Susan Kaplan, JD.

COVER PHOTOS (left to right):

Photo courtesy of Carolyn Bates

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EXECUTIVE SUMMARY

Hospital stakeholders are increasingly recognizing the importance of sustainability and its implications for their building practices. One way that hospitals can green their buildings is by using more sustainable materials in their facilities. There has recently been a great deal of interest in finding sustainable resilient flooring solutions. Hospital flooring is a very important and visible part of the healthcare environment that can contribute to a positive experience when done well or can result in problems and negative impressions when done poorly. So, while hospitals want to use more sustainable flooring products, they are reluctant to use a product that does not have a long track record.

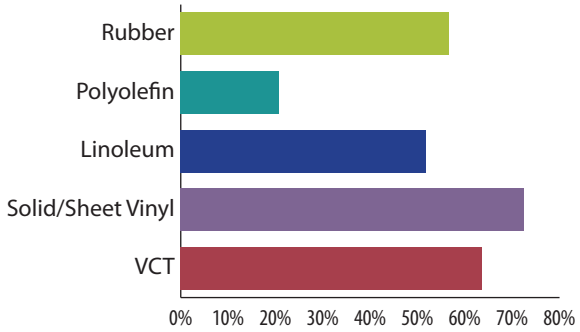
The objective of this study was to examine the recent experiences that architects, installers, facility managers and users have had with alternative, green resilient flooring materials in hospital settings. This research effort focused on specific resilient flooring materials, including rubber, polyolefin[1] and linoleum. Sharing the user experiences is expected to demystify these lesser-known products, identify key issues, and potentially lead to increased adoption.

The study builds on the Health Care Research Collaborative paper, "Resilient Flooring & Chemical Hazards: A Comparative Analysis of Vinyl and Other Alternatives for Health Care,"[2] researched and authored in 2009 by the Healthy Building Network (HBN), which inventoried the chemicals involved in four flooring material types (vinyl, linoleum, rubber and polyolefin) and characterized those chemicals using a chemical hazard-based framework. In the present study, we sought to hear directly from users about their perceptions and experiences. As such, the study used two methods for getting user feedback: an online survey of and a series of interviews with architects, flooring installers and facility managers.

The online survey was distributed to over 30,000 people through the *Green Guide for Health Care*™ and Practice Greenhealth networks in March 2010, and 689 people responded. Only 13% of the respondents were installers, and the rest were split between architects and hospital representatives. In addition to the survey, we interviewed many flooring stakeholders to develop six case studies of hospitals that have used rubber, polyolefin and linoleum flooring.

Over half of the survey respondents reported having specified, used or installed two of the more sustainable product offerings, rubber (56.7%) and linoleum (51.8%). We found that there was much less familiarity with polyolefin (20.7%). Across all survey respondents, we saw the most use of the two vinyl (less sustainable) products; sheet vinyl is the most commonly used product (72.5%), followed by vinyl composition tile (VCT) (63.6%).

Resilient Flooring Adoption Rates



From our research, we learned that four priority issues that went into flooring decisions for all of the user types were cleanability, aesthetics, durability and initial cost. More than the other groups, architects and designers were also interested in aesthetics and sustainability. Facility managers and users were overwhelmingly focused on the cleanability of flooring products, whereas installers were more likely to be concerned with initial and lifecycle cost, as well as durability.

Looking across the survey results and case study interviews, it appears that the term 'sustainability' means different things to the different stakeholders. Follow-up research should be conducted to understand which components of sustainability resonate with the different flooring stakeholders so that educational materials can be developed to address their information needs.

The overall message from the survey and case studies is that while vinyl flooring products are still being used by a majority of facilities, many hospital facility professionals view these products as less sustainable and are using alternative materials in many new projects and parts of the hospital. The success of a flooring installation depends on many factors, not just the material itself. Most importantly, the floor needs to be approached as a system, with all components of the system handled properly. This means selecting the right product for the right application, properly preparing the floor before installation, hiring skilled installers, and using recommended maintenance protocols to keep the floor looking its best. When all parts of the system are done correctly, rubber, linoleum and polyolefin flooring materials perform well and make excellent resilient flooring choices for hospitals.

It is also noteworthy that this research turned up a good deal of anecdotal evidence indicating that some of the more sustainable flooring materials also offered benefits for worker and patient health and safety, including increased comfort while standing and walking, reduced fatigue, reduced noise levels, and lessened negative health impacts from the use of harsh cleaners due to the lessened need for such products on rubber and other more sustainable types of flooring. Additionally, because rubber flooring is not slippery when wet, there may be safety improvements as a result, compared with other types of flooring. Given the potential significance of these impacts, follow-up research should be conducted to identify metrics for measuring these impacts, and to work with hospitals to measure them in a more systematic and quantitative manner.

I. INTRODUCTION

With increasing interest in sustainable building practices, new 'green' products are entering the marketplace and making their way into healthcare settings. As in any field, material innovation in hospital settings faces major challenges: the perception of 'green' products as being poorer performing, the 24/7 operations of hospital environments, lack of education around cleaning and maintenance protocol of these products and the slow building cycle of the healthcare industry. Furthermore, hospital administrators and facility managers are most comfortable with materials that they know and trust, fearing problems with an unfamiliar material that could disrupt their critical operations, which diminishes the opportunities for new materials to enter the market.

Some of the building materials that have been used widely in hospitals have known negative health impacts. Wanting to understand the potential health impacts of specific materials, the Health Care Research Collaborative initiated a study that evaluated the chemical hazards of different resilient flooring materials. The study found that some of the most widely used products (sheet vinyl and vinyl composition tile (VCT)) pose significant health risks and highlights the availability of safer alternatives such as linoleum, rubber and different petrochemical based products.

Health care facilities are increasingly concerned with avoiding the issues associated with harmful materials, and are looking at the alternatives. To better understand how many hospitals are using the different types of resilient flooring, the Research Collaborative conducted this follow-up study. The objective of this study was to understand the recent experiences that architects, installers, facility managers and users have had with alternative, green resilient flooring materials in hospital settings. This research effort focused on several resilient flooring materials, including rubber, rubber/cork, polyolefin[3] and linoleum. Sharing the user experiences is expected to demystify these lesser-known products, identify key issues, and potentially lead to increased adoption.

The research project was led by the Georgia Institute of Technology, with collaboration from *Green Guide for Health Care*™, Healthy Building Network and Practice Greenhealth. This project was contracted for by the Health Care Research Collaborative. The Research Collaborative was initiated by Health Care Without Harm, an international nonprofit coalition that promotes environmental responsibility in health care, and is coordinated by faculty of the University of Illinois at Chicago School of Public Health, with support from the Pioneer Portfolio of the Robert Wood Johnson Foundation.

Research Methodology

The study builds on the Health Care Research Collaborative paper, "Resilient Flooring & Chemical Hazards: A Comparative Analysis of Vinyl and Other Alternatives for Health Care,"[4] authored in 2009 by the Healthy Building Network (HBN), which inventoried the chemicals involved in four flooring material types (vinyl, linoleum, rubber and polyolefin) and characterized those chemicals using a chemical hazard-based framework. In the present study, we sought to hear directly from users about their perceptions and experiences. As such, the study used two methods for obtaining user feedback: an online survey of and a series of interviews with architects, installers and facility managers. The survey was administered first, and the results were used to select the interview subjects and develop the interview questions. Background research helped identify the key issues with resilient flooring materials and their installation prior to the development of the survey.

Background Research

Our preliminary research for developing the survey focused on the current adoption of these materials, marketing efforts and user perception as reflected in industry magazines such as *Health Facilities Management*, *Architectural Record* and *Environmental Design & Construction*. These articles provided us with an overall understanding of recurring issues, what people are talking about and what messages are being used to market these materials. We also looked for existing research on resilient flooring, and found few publications beyond the industry publications.

One of the most useful resources was the "Resilient Flooring & Chemical Hazards" study, which found vinyl to be the least preferred material because of its use and creation of persistent bioaccumulative toxicants (PBT). Linoleum, as the only non-petroleum based product, was the most sustainable. The other two materials, rubber and polyolefin, fall somewhere in the middle. Polyolefin is the preferred petroleum-based alternative, but limited production and lack of data made a full analysis difficult. Rubber showed some promise, with the potential for reformulation to eliminate the current environmental health issues associated with the polymer.

Another useful resource was an analysis of VCT, vinyl, carpet, rubber and linoleum flooring conducted by the Florida Hospital Office of Design in 1998 to look at the life cycle costs of those materials over a 15-year period. They found that the cost to maintain a floor can be many times more than the initial cost - for example, while VCT is typically the cheapest initially, the maintenance costs can be 9 to 15 times the installation cost. They found that rubber flooring had the lowest cost per square foot over the 15 years and allowed hospitals to turn over patient rooms more quickly because it did not require finishing. Their analysis focused on cost, cleanability, aesthetics, noise control, overall life-cycle decisions, seamless/installation/workability, and slip/fall issues. They found that the life cycle cost was impacted by the need to apply a finish to VCT and other vinyl products, but noted that no-finish vinyl products, which are increasingly being introduced, may be financially comparable to rubber[5].

"Vinyl flooring (both sheet and VCT) made from polyvinyl chloride (PVC) has the most pervasive presence of unavoidable persistent bioaccumulative toxicants (PBTs) in its life cycle of the four examined materials."

—"Resilient Flooring & Chemical Hazards: A comparative analysis of Vinyl and Other Alternatives for Health Care "

From the industry publications, we were able to get a sense of the benefits that are being marketed and the issues considered by the stakeholders when deciding upon flooring. Issues that were mentioned across the literature included aesthetic and visual aspects, acoustic control, infection control, cleaning and maintenance, slip resistance, stain resistance, environmental impact and cost[6]. The literature confirmed our belief that VCT has historically been the most popular flooring choice for hospitals[7].

Research Scope

This study focused on the more sustainable flooring alternatives, based on the chemical risk analysis as presented in "Resilient Flooring & Chemical Hazards", which include rubber, polyolefin and linoleum. Rubber/cork was also included in the survey as another sustainable alternative to vinyl flooring in order to see if it is widely used in the healthcare market. Furthermore, VCT and solid/sheet vinyl were included in the survey to help us understand how the more sustainable materials compared to them. As the current industry default, vinyl and VCT provide a benchmark against which we could measure the new materials.

The study effort and hence the report is largely focused on rubber, polyolefin and linoleum flooring. Through the survey, we learned that only 14% of our respondents were using rubber/cork, and as a result decided not to include the material in our case study research and have no findings regarding the material. In addition, reporting for the vinyl materials (VCT and solid/sheet vinyl) is restricted to the instances in which it provides a comparison and point of reference for the sustainable materials; they will not be analyzed by themselves.

Survey Design

The survey was developed by The Georgia Institute of Technology based on findings from the "Resilient Flooring & Chemical Hazards" report and information gathered during the background research. Drafts of the survey were shared with representatives from each of the project partners, who provided practical industry experience and helped determine which areas of inquiry needed more development and which could be bypassed. The final iteration of the survey was pilot tested in its online format by a group of industry professionals who provided feedback on the survey content, order of questions, and distribution of questions per pages in the online format. Based on the feedback received from pilot testers, the survey was expanded to include sections on VCT and solid/sheet vinyl flooring materials, numerous questions were refined and the attribute list and installation problem lists were revised.

Description of the Survey

The survey was divided into three tracks: the architect/specifier track, the installer track and the user/facility manager track. Survey respondents who did not identify themselves under one of these categories were routed to the most comprehensive track, the user/facility manager track.

The materials covered were rubber, rubber/cork, polyolefin, linoleum, VCT and solid/sheet vinyl. The same questions were asked for each material. One additional question was added to the polyolefin section, asking survey takers to identify the specific brands of polyolefin flooring they had used. The three tracks differed slightly with regards to the questions they contained. The primary differences included tailoring language to fit the targeted audience, the inclusion of profession-specific questions (e.g. for architects, asking the square footage of each material they've specified), and the inclusion of questions to the user/facility managers track intended to collect third-party user feedback.

A neutral attribute list was developed, to be used recurrently throughout the survey. Organized alphabetically, the list included the items in the sidebar in addition to an 'other' option, with a blank field for respondents to input their own values.

This list was used for both positive and negative questions for first-hand knowledge/perceptions and to ask about feedback received from staff, patients or family members. (*"When thinking about [rubber, polyolefin, linoleum, etc] what do you consider to be the most (positive/negative) attributes?"* and *"Have staff, patients or family members commented about any of the following issues as (benefits/problems) due to the [rubber, polyolefin, linoleum, etc] flooring?"*)

Attribute List

- Acoustics
- Aesthetics
- Antimicrobial properties
- Cleanability
- Comfort underfoot
- Durability
- Infection control
- Initial cost
- Installation requirements
- Life cycle cost
- Odor
- Product quality
- Repairability
- Rolling resistance
- Safety
- Stain resistance
- Sustainability

We also included specific questions about installation challenges because the previous research team received a lot of anecdotal evidence suggesting the greener materials involve more difficulty with installation. We wanted to verify this as well as understand the specific problems better.

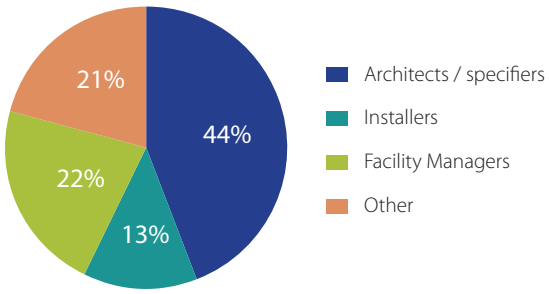
The full survey is available in the Appendix to this report.

Survey Distribution

After obtaining Institutional Review Board (IRB) approval, the survey was administered electronically through the SurveyMonkey website, and was distributed to the public via the partners' mailing lists. At the time the survey was distributed, the Practice Greenhealth email list had approximately 4,700 subscribers, and *Green Guide for Health Care*™ had over 27,000 subscribers. We encouraged recipients to forward the survey link to anyone they thought might be appropriate, so the respondents may have come from outside these two organizations. The survey was available for two weeks, from March 8 to March 22, 2010.

The survey was started by 753 people, and we received 315 complete responses, a 41.8% completion rate. "Completion" refers to a survey taker reaching the end of the survey, although partial responses were also taken into account. The survey results were screened for survey takers who identified themselves as manufacturers, distributors or somehow associated or paid by a flooring manufacturer. These responses were purged in light of a possible bias. After the purge, the survey results contained 689 started surveys and 294 (42.7% completion rate) completed surveys.

Figure 1: Respondents by Type



Survey respondents were classified by type and routed to one of three survey tracks: architect /specifier, installer and user/manager. Survey takers who identified themselves as 'other' were routed to the user/facility manager track, as it was the most comprehensive. After purging respondents with a possible bias, the respondent pool breaks down as follows: 44% classified themselves as architects or interior designers, 13% as installers, 22% as facilities manager or environmental services, and 21% as other. Those classified as 'other' include project managers, users (physicians, nurses), engineers, sustainability managers and consultants, to name a few. See Figure 1. In the report we have grouped all the date from facility managers and others together and refer to them collectively as 'users'.

Because only 87 people identified themselves as installers, we did not have as robust of a data set for installers as we did for the other categories. Consequently, for some of the analysis we were not able to draw meaningful conclusions about installers as a separate group. In all instances we specify whether the data reflect all users or just select user groups.

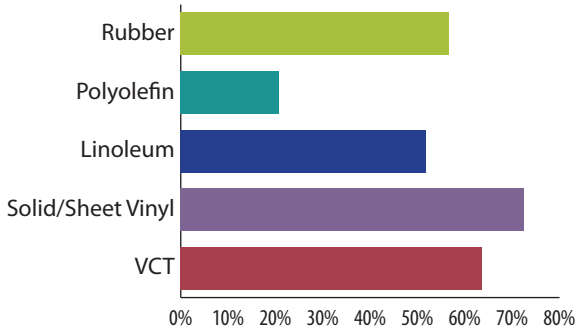
Case Studies

Potential leads for the case studies were collected from the survey results, along with industry contacts provided by the partner representatives. For each facility selected for a case study, an effort was made to contact a wide range of professionals involved with the project in order to provide a complete study. Among the individuals contacted were architects, project managers, facility managers, installers, environmental services and nurses. While we concentrated our efforts on developing in depth case studies on one material per hospital, we have included more abbreviated case studies when a hospital had information to share about additional materials. Case studies were developed for rubber, polyolefin and linoleum.

II. OVERALL FINDINGS

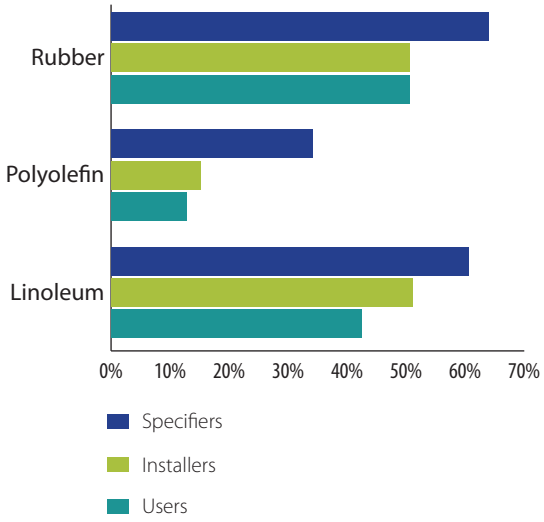
Although rubber, linoleum and polyolefin flooring materials have been increasingly featured in media and magazines, it was important to better understand the adoption rates within the healthcare industry compared with the use of the traditional vinyl products. From all survey respondents, we saw the greatest use of the two vinyl products. Sheet vinyl is the most commonly used product (73%), followed by VCT (64%). This finding is consistent with our preliminary research, which found that VCT has the lowest first cost, followed by sheet vinyl, and that both products have a long history of use in healthcare. Over half of the respondents reported having specified, used or installed each of the two newer product offerings, rubber (57%) and linoleum (52%). The survey found that there was much less familiarity with polyolefin (21%) and even less with rubber/cork flooring (14%). Because of the low adoption rate for rubber/cork, the material was not included in our case study research and no further results are reported in this paper. See Figure 2 for the adoption rates of all the flooring materials for all the survey respondents.

Figure 2: Resilient Flooring Adoption Rates



Out of the three respondent types (specifiers, installer and facility manager/other), the survey takers who answered the facility manager/other survey track were more likely to not know whether they had any particular material installed. For example, 16% did not know if they had rubber flooring installed, as opposed to 2% of architects and 4% of installers. This holds true for all the other materials as well.

Figure 3: Resilient Flooring Adoption Rates by Material and Stakeholder Type



If we break down the adoption rates by respondent type, we see that architects had higher adoption rates for all materials, see Figure 3. While architects may have had several healthcare clients throughout the years with diverse flooring needs, facility managers are typically responsible for one institution with a limited palette of flooring materials and installers tend to specialize in material.

Figure 4: Resilient Flooring Square Footage by Material

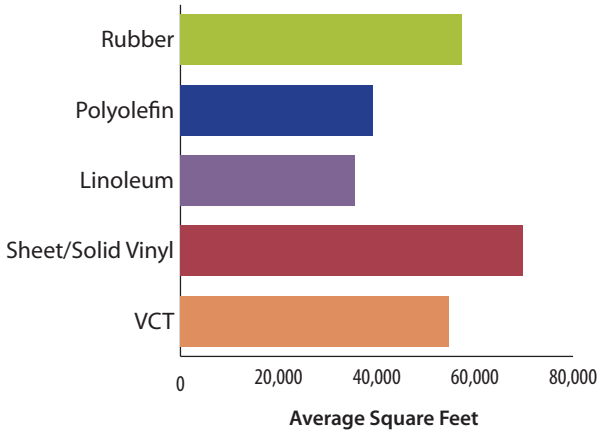
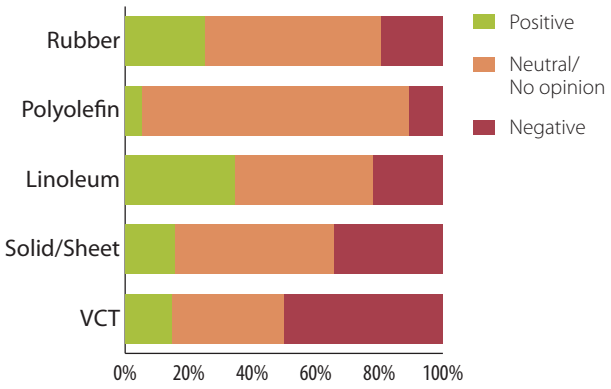


Figure 5: Perception of Resilient Flooring Materials by People that Have NOT Used It Before



Survey responders who classified themselves as architects/specifiers were asked to quantify the average amount of each resilient flooring material they had used per project. About half of respondents were not able to specify an amount, marking the "Don't Know" option. From the results collected, we found that solid/sheet vinyl was used to cover the largest amount of floor space, see Figure 4. Interestingly, rubber surpassed VCT in square feet, which could be a reflection of an industry trend. Alternately, the results could have been swayed by targeted marketing of the survey to early-adopters, reflecting a trend in these users, but not the industry as a whole.

The selection and specification for any material in a project will depend, more often than not, on the architect's, specifier's, or client's perception of a product's properties and performance. Such perceptions can be influenced by previous experience, marketing efforts, research studies, or anecdotal information from peers, among other things. We asked our survey takers who had not specified one of the materials in the past five years whether they had a positive, negative or neutral opinion of the flooring material in order to understand the perceptions that will influence future use of the materials. We also gave them the option to select "no opinion."

Figure 5 shows the opinions of all the survey respondents regarding the materials that they have not used recently. Linoleum and rubber are both perceived positively by many of the people surveyed (35% and 25% respectively). Results indicate that people are not generally familiar with polyolefin; 84% of respondents said they were neutral or had no opinion about the product, and only 5% had a positive impression of the material. Both vinyl floor covering products got the most negative ratings from people who are not using the materials, with 50% of people having a negative opinion of VCT and 34% for solid and sheet vinyl. It seems reasonable to conclude that this perception is driven by the negative environmental image of the products and an understanding of the health risks highlighted in the "Resilient Flooring & Chemical Hazards" report.

Positive and Negative Attributes

Survey respondents were asked to select the top three positive and negative attributes for each material that they had used. When we looked at the benefits and negatives selected by all the respondents, some patterns began to appear. Looking at both the benefits and negative attributes that were selected by all stakeholder types across all the material options gives us a good indication of the issues that are important to people when making flooring decisions; these were cleanability, aesthetics, durability and initial cost. By looking at the data divided up by respondent types, we can see that each is concerned with different issues. This in turn may drive these players to arrive at different decisions when presented with the same facts about flooring products. In the sections below, we present the attributes most commonly selected by each of the different stakeholder groups across all materials. The figures list the percentage of people in that group that selected a specific attribute as one of the top three attributes for any of the materials they had used. For example, in Figure 6 we see that over 30% of specifiers selected 'cleanability' as a positive attribute for one of the flooring materials. In each figure, we provide the five most common responses for that stakeholder group. The purpose of these figures is not to identify their impressions of specific materials (that will be covered in a later section), but to demonstrate that architects, installers and facility managers are concerned about different issues.

Specifiers

Architects and designers selected cleanability, aesthetics and sustainability often as both positive and negative issues related to resilient flooring options. Notably, they were the only group to select sustainability as one of their most important positive or negative attributes. Sustainability was selected by architects as both a positive attribute for rubber, polyolefin and linoleum and as a negative attribute for VCT and sheet/solid vinyl, but it was not a major issue for installers or users.

Figure 6: Specifiers' Most Commonly Selected Positive Attributes

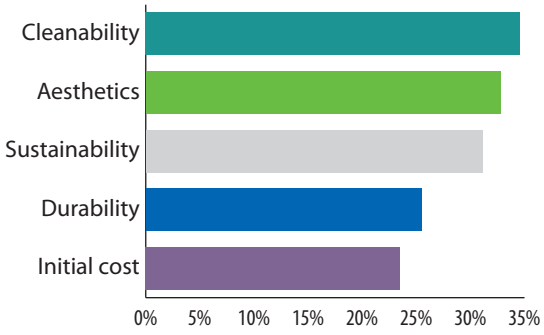
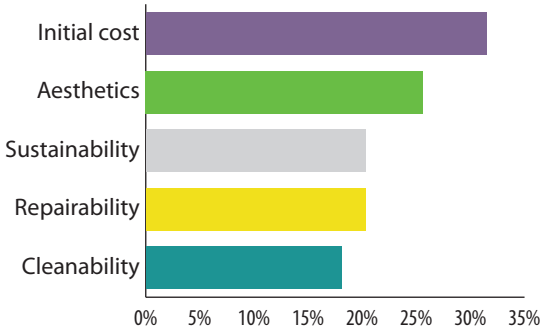


Figure 7: Specifiers' Most Commonly Selected Negative Attributes



Installers

We see a very different set of issues when we look at the responses from installers. The issues of concern for installers are initial and lifecycle cost as well as durability and cleanability. Interestingly, many installers selected 'installation requirements,' but only as a negative attribute, suggesting that installation only becomes an important consideration when it is a problem. Installers do not indicate that sustainability or aesthetics are important attributes to them, even though these were significant issues for the specifiers.

Figure 8: Installers' Most Commonly Selected Positive Attributes

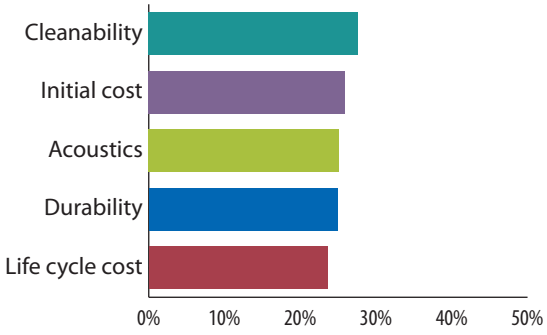


Figure 9: Installers' Most Commonly Selected Negative Attributes

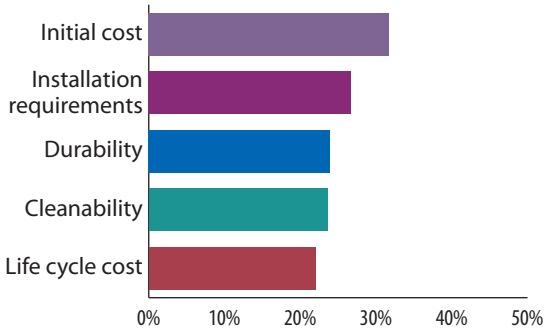


Figure 10: Users' Most Commonly Selected Positive Attributes

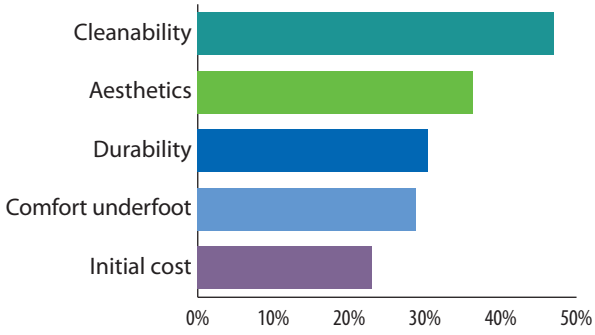
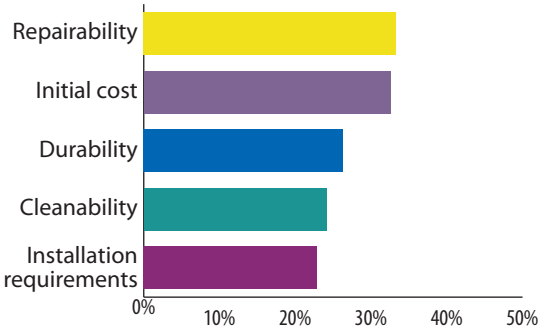


Figure 11: Users' Most Commonly Selected Negative Attributes



Users

For facility managers and users, cleanability was overwhelming important, selected by 47% as a positive attribute and by 24% as a negative attribute for one of the materials. Initial cost and durability also showed up on both the positive and negative lists for facility managers, indicating their importance in decision making. One third of facility managers selected repairability as a significant problem and 22% selected installation requirements as a negative attribute.

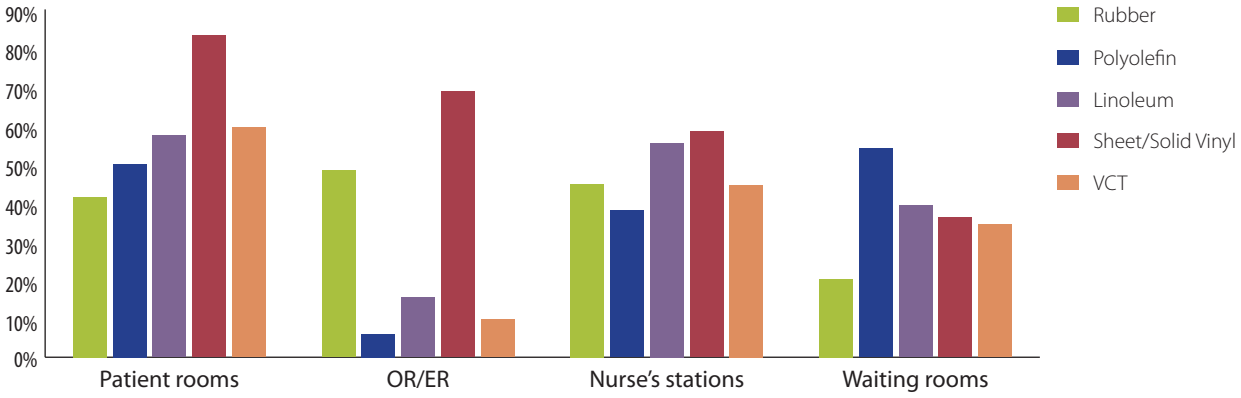
There are several overall conclusions that can be drawn from these figures. All the groups surveyed were concerned about the initial cost, cleanability and durability of materials. It is not surprising to see that the groups showed concern with different aspects of flooring, considering that each is involved with flooring during different phases of its life cycle.

Applications

Although all the materials covered are grouped together into the category of resilient flooring, they have different properties and performance characteristics that make each more appropriate for specific applications and not others. In order to investigate the appropriate applications for the various flooring products trends, we asked survey takers where in the facility they had specified or used each material. Figure 12 shows the percentage of architects and facility managers who have used a flooring material in the specified hospital space.

The survey results show that there is a lot of overlap, although we can see some definite trends among the materials. For emergency departments and operating rooms, the tile products (polyolefin and VCT) were used less often, with sheet vinyl taking the lead and rubber in second place. While rubber has been used in all the spaces listed, it is used significantly less than other materials in lobbies and waiting rooms. All the resilient flooring materials are used in patient rooms, but sheet vinyl is by far the most commonly used flooring for that space type. The case study interviews confirmed the results from the survey.

Figure 12: Resilient Flooring Use by Space



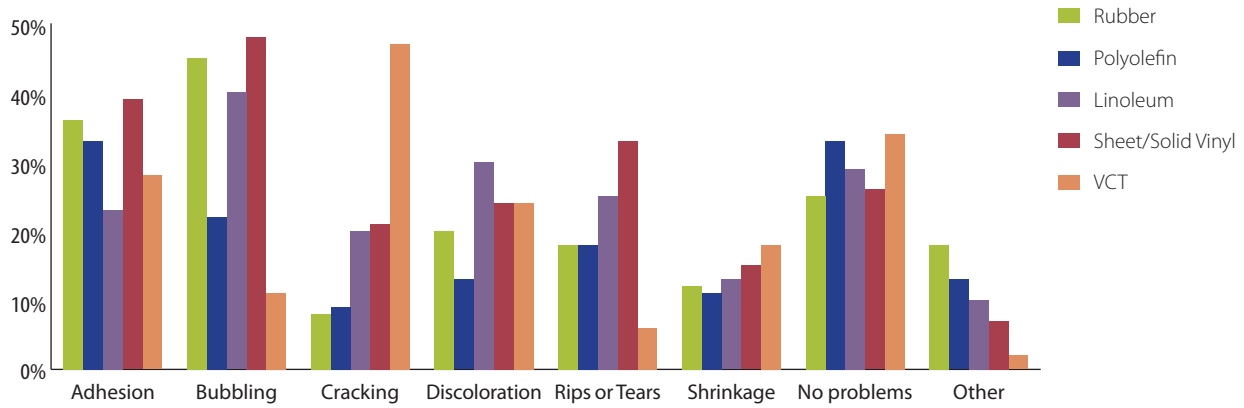
Installation

Newer flooring materials are often accused of being difficult to install and prone to installation problems. To learn whether this was true and to determine the nature of the problems, we asked our respondents to specify, for each material, whether they'd had specific installation problems. We learned that installation-related problems occur with all the different resilient flooring types. Figure 13 shows the percentage of respondents who reported specific problems for each material. Bubbling was indicated as a problem for all sheet goods, showing up more strongly for solid/sheet vinyl (48%) than for rubber (45%) or linoleum (40%). Adhesion was the second most common problem, and again it was reported at higher rates for sheet vinyl (39%) than for rubber (36%), polyolefin (33%) or linoleum (23%). Cracking, discoloration and rips and tears were also among the top chosen installation problems across material types. We included rolling and warping in the list of response options, but fewer than 10% of respondents chose either of these options, so they are not included in the figure.We also provided respondents with the option to tell us about other installation problems beyond the list that we included. Problems with the quality of welded seams and peaking at seams were mentioned for rubber, linoleum and sheet vinyl. Several additional issues were brought up for rubber flooring, including squeaking, scuffing and difficulty with installing cove base. For linoleum there were several comments about indentations or grooves left from equipment.

Although problems with installation may be attributed to specific flooring types, adhesives or the installer, the overall trend is that all materials, including the vinyl ones, are experiencing installation problems. From the case study interviews we learned that the incidence of flooring failures is generally not due to properties of the materials, but result from a combination of factors that have converged at the same time that these materials have become more commonplace in the market. Speeding up the construction cycle has resulted in compressed schedules which do not always allow adequate time for the slab to cure prior to flooring installation. The adoption of new formulations of concrete, particularly lightweight or porous formulations and those including fly ash, has also resulted in slow curing slabs or surfaces that do not react well with adhesives[8]. Another factor that has affected floor installation is the shift to low-VOC adhesives. These adhesives are better for the health of the installers and occupants of the space, but they are also more temperamental to work with when compared to old adhesives. The low-VOC adhesives can work as well as the adhesives they replaced, but they require more planning and skill on the part of the installers, who have to schedule their work around the open time for the adhesives.

A consistent message we heard during all the case study interviews was that flooring should be approached as a system, which includes the subfloor. All the components of this system have to work together for a successful installation. There need to be clear specifications about the subfloor, such as the concrete mixture and time to acclimatize the building before the floors are installed, and the general contractor should be held account-

Figure 13: All Resilient Floors Experience Installation Problems



able for meeting those specifications. Additionally, it is vitally important to hire a skilled flooring contractor with experience installing the specified floor material. Installers need to use the adhesives that are recommended by the flooring manufacturer and meet all the installation recommendations, such as moisture content of the slab, and abide by the recommended delay before having rolling traffic or point loads on the floor.

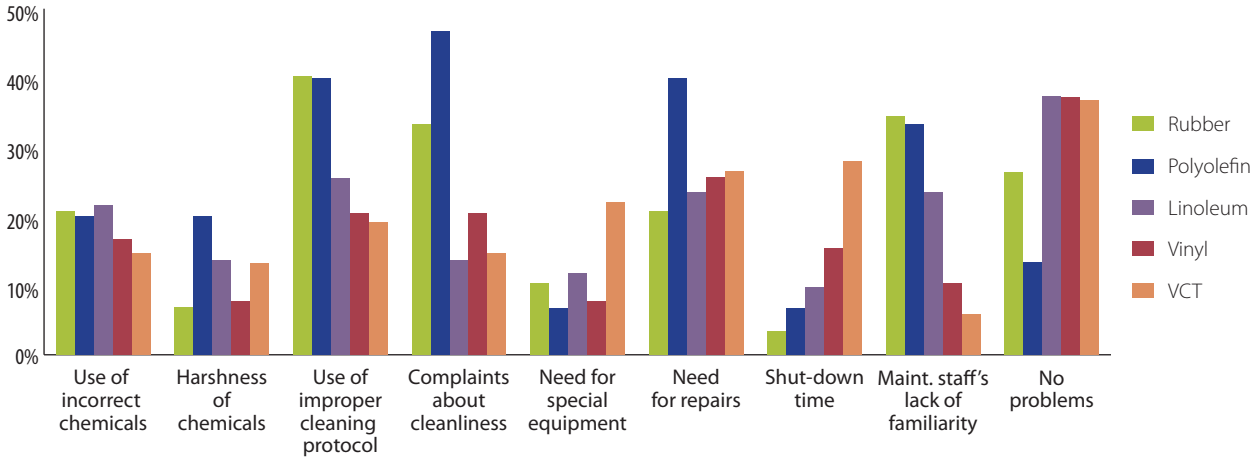
Installation is Critical

Kaiser Permanente has invested a lot of time in the past several years evaluating resilient flooring alternatives and they have had their share of problems with flooring materials. Because they wanted to develop system-wide standards for flooring and did not want to replicate problems in future installations, Kaiser Permanente hired an independent flooring consultant to investigate their flooring problems to determine the root causes and develop standards to avoid these problems. The investigation found that all the flooring failures were related to preparation and installation, and not the flooring products themselves. To avoid repeating these problems, they developed Flooring Installation and Maintenance Guidelines with standard procedures for preparing the subfloor and managing the installation.

Maintenance

The environmental services personnel who were interviewed for the case studies were very enthusiastic about the cleaning protocols for rubber, linoleum and polyolefin when compared with VCT and sheet vinyl. They were unanimous in their understanding that stripping and waxing of VCT and vinyl is a time-consuming process that takes up a lot of their staff time and often has to be scheduled overnight to minimize the disruption to patients and staff through noxious odors from the stripper as well as having to shut down areas during the process. While the interviewees were clear that rubber, linoleum and polyolefin required less staff time to keep clean, the survey results tell a more ambivalent story. Two-thirds of all facility managers surveyed responded that the three materials of interest either had no impact on their workload or they didn't know what the impact was. Based on the feedback from the case study interviews, reduced cleaning requirements is a very important factor in the decision to use the non-vinyl resilient flooring materials. Flooring manufacturers are introducing sheet and solid vinyl tiles that come pre-finished and do not require stripping and waxing. The introduction of these products may erode some of the advantages that rubber, polyolefin and linoleum currently hold.

Figure 14: Lack of Familiarity Results in Improper Cleaning



Metrics Collected by Survey Respondents

- Flooring analysis validated by benchmarking.
- Comparison of initial costs
- Evaluation of time and equipment needed to clean
- Ease of rolling heavy stretchers
- Life cycle costing
- Resilience to chemical spills
- O&M costs
- Life cycle costing
- Comparison of off gassing
- Field visits to talk to other owners
- Pilot testing with small installations

We also provided a specific list of maintenance problems in the survey for users and asked them to select all of the problems they had experienced with each of the materials they had used. The full results are provided in Figure 14. In keeping with the case study comments about the cleaning requirements for VCT, the survey shows more people reporting problems with shut-down time for VCT. Other notable results are that polyolefin stands out, with more needed repairs and complaints about cleanliness. We did see greater incidence of using the wrong cleaning protocol for the three non-vinyl products, which seems to go hand-in-hand with the higher reports of maintenance staff's lack of familiarity with the products.

Health and Safety Impacts

Based on the previous research effort examining the chemical hazards from flooring materials, we wanted to learn if hospitals were tracking the impact of their flooring choices on the health of staff and visitors. We also wanted to know if hospitals had tracked data about injuries such as falls from slippery floors or joint and back problems for staff due to the flooring material. In the survey, we asked the facility managers if they had collected any metrics or data specific to the different flooring materials that they had used and asked them to describe that data.

In the survey, we had 30 distinct respondents report that they had collected data or metrics about a resilient flooring material. Unfortunately, few of the responses indicated that hospitals are collecting data on health or safety impacts. The data that respondents are collecting is about initial cost and life cycle costs. One person reported that they were measuring the ease of rolling heavy stretchers over rubber flooring. A different person stated that they had also looked at rolling resistance of sheet/solid vinyl.

However, while none of these hospitals were making an effort to track or measure health or safety outcomes *per se*, we did hear a number of anecdotes about health and safety impacts during the case study interviews that indicate that flooring choices do have impacts related to health and safety – and they may be very significant. These relate in particular to statements about sustainable resilient flooring choices being more comfortable to stand and walk on, especially for nurses; reducing noise levels; and reducing the need for harsh cleaning chemicals that may cause workers to feel ill and even have to leave the hospital in the middle of a shift. For example, one hospital said that a nurse who worked there routinely had to go home for the day when the floors were being stripped because of the smell. As another example, several case study interviewees said they found rubber floors more comfortable underfoot, which is a big consideration in operating rooms. Yet another person said they had looked at off gassing for sheet/solid vinyl – although we did not determine the implications of off gassing for health or safety. Additionally, the section on

rubber floors, below, notes that rubber floors, unlike some other types, are not slippery when wet – which could have significant safety implications in terms of potentially reduced slips, trips and falls.

Given the potential importance of these impacts – nurses may walk many miles in the course of a shift and suffer muscle strain or fatigue as a result; hospitals tend to be noisy environments, which can increase stress and lead to negative health and safety impacts; and cleaning chemicals may cause a variety of health impacts – this study indicates that they are worthy of further investigation. Perhaps this information can be used to help identify more specific health and safety metrics related to flooring, and to work with hospitals to study such impacts of different flooring choices in a more quantifiable way.

Sustainability

We also wanted to understand whether or not a commitment to sustainability was driving a change in material choices. Since we did not directly ask people how important sustainability was to them or the hospital, we had to find a surrogate measure for a commitment to sustainability, and a way to analyze those people's responses. To do so, we divided up the survey responses into two groups: The "Green" group was all of the specifiers and users who identified sustainability as a positive attribute for one of the sustainable resilient flooring materials, and the "Neutral" group was all of the architects and facility managers who did NOT select sustainability as a positive attribute for those materials. We did not include installers in this analysis.

When we compared the Green and Neutral groups on their past use of sheet/solid vinyl and VCT, we did not see a big or consistent difference between them. In fact, contrary to what we might expect, we saw greater usage rates for VCT among the Green group; 75% of the Green specifiers had specified VCT in the last 5 years, compared with 66% of the Neutral specifiers, and the rate of use for VCT among Green users was 63% compared with 54% of Neutral users.

On the other hand, we did see a slight difference between these two groups of respondents regarding their likelihood of using the vinyl products in the future. In Table 1, we have combined the responses from the specifiers and users who have used vinyl and VCT to compare the likelihood of future use of the two vinyl products for the Green and Neutral groups. The table provides the percentages of these respondents who have previously used the products. In the table, we see that fewer of the Green respondents anticipate using sheet vinyl or VCT in the future. There is a smaller difference between the two groups in the number who report they are clear that they will not use the products in the future. Despite these differences, the bottom line is that both groups are overwhelming likely to use sheet vinyl and VCT in the future regardless of the importance they placed on sustainability.

Table 1: Green Specifiers and Users Less Certain About Future Use of Vinyl Flooring

Sheet Vinyl	**"Green" Group**	**"Neutral" Group**
Definitely/most likely	70	76
Maybe	22	18
Not likely/definitely not	8	7
VCT		
Definitely/most likely	59	74
Maybe	29	18
Not likely/definitely not	12	8

We asked specifiers who had not used a material in the past five years, as well as those who had, about their future use of those materials. For users, we only asked this question of those who had used a material in the past five years. The rationale for this was that we felt specifiers would have more opportunities to specify different materials in the future, whereas users will not necessarily have those opportunities, and may not be knowledgeable about materials that they had not used previously. This additional data from the specifiers provided us with further information to interpret.

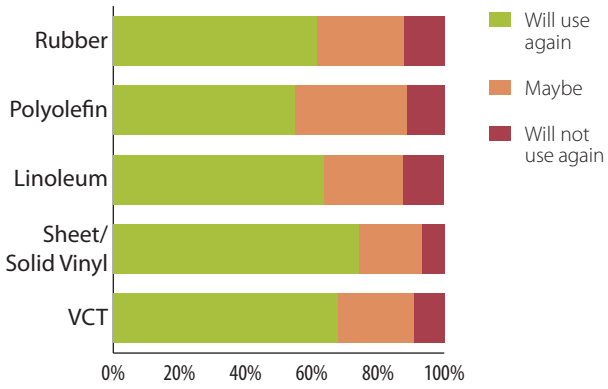
In Table 2 we have presented the responses from the specifiers, broken out by the Green and Neutral groups, as well as separating out those who had and had not specified the material in the past five years. When the data was organized in this way, we saw an interesting trend. While the data for the specifiers who had used one of the vinyl products in the past five years was similar to the data we saw for users, the data for those specifiers who had NOT used either of the vinyl products was drastically different – they were overwhelmingly clear that they were not planning to use those products in the future. We can conclude from this that previous use of sheet/solid vinyl and VCT is much more predictive of future use of those products than is one's stated interest in sustainability. It is possible that the people who feel most strongly about avoiding vinyl based products changed their behavior previously and therefore have not used them in the past five years. Alternatively, this group of specifiers prefers other flooring materials for reasons other than sustainability. Our survey did not capture sufficient information to allow us to reach a conclusion on this question.

Table 2: Specifiers That Have Not Used Vinyl Flooring Recently Not Likely to Change Their Minds

	"Green" Architects		"Neutral" Architects	
Sheet Vinyl	**NO recent use**	**Recent use**	**NO recent use**	**Recent use**
Definitely/ most likely	7	72	12	82
Maybe	14	19	38	15
Not likely/ definitely not	79	9	50	4
VCT				
Definitely/ most likely	5	59	8	79
Maybe	9	27	28	13
Not likely/ definitely not	87	14	64	9

Future Use

Figure 15: Experienced Stakeholders Expect to Continue Using All of the Resilient Flooring Options



The intention to use a product in the future is an important indicator of how well these flooring products have performed in hospitals and whether or not they will continue to grow their share of the market. In the survey we asked people that had used a material how likely they were to use it again. Response options were 'definitely',' most likely', 'maybe', 'not likely' and 'definitely not'. We grouped the answers on the two ends of the spectrum to make the data easier to interpret. What we can see in Figure 15 is that over 85% of people who have used the three green alternatives are open to using them in the future, and over 50% of those people will most likely use rubber, polyolefin and linoleum again. Respondents also indicated that they were likely to use sheet/solid vinyl and VCT in the future. This is consistent with our analysis in the sustainability section that found that people that had used the vinyl products in the last five years were likely to continue using them in the future. The important message is that architects, installers and facility managers who have experience with rubber, polyolefin and linoleum were pleased enough with their experience to use these products again in the future. This should be reassuring to hospital stakeholders considering using one of these materials in a project.

III. RUBBER

Use

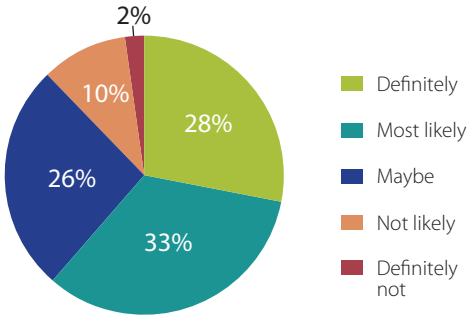
The survey results show that rubber is the most widely used of the resilient flooring alternatives to vinyl, with 62% of respondents saying they had used rubber in a hospital project in the past 5 years. Rubber has been used for many years in stairwells, where maintenance is difficult, and is increasingly being used in other, more public spaces such as hallways, patient rooms and nurse's stations. Many hospitals are also using sheet rubber floors in their operating rooms, where they appreciate the comfort underfoot for physicians who might be standing for a long time, in addition to ease of maintenance, which reduces the need to have the room closed down.

When we asked specifiers and facility managers who had used rubber flooring whether or not they expected to use it again in the future, 61% of them answered definitely or most likely. See Figure 16 for a combined summary of the responses from architects and users. We also asked architects who had not used rubber how likely they were to specify rubber in the future, to get a sense of any trends. A full quarter of these architects said they were definitely or most likely going to specify rubber in future projects, and 53% responded that they might specify rubber in the future.

Areas Where Rubber is Commonly Used

- Hallways
- Stairs/stairwells
- Operating rooms
- Nurses' stations
- Patient rooms

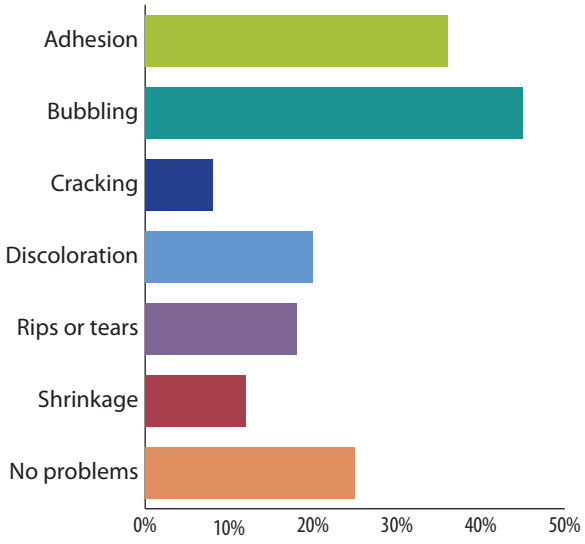
Figure 16: Continued Use of Rubber Very Likely



Installation and Maintenance

As we expected from the previous research project's case studies, bubbling was the most widely reported installation problem, experienced by 45% of all respondents. Adhesion was also a common problem, experienced by 36% of respondents. People interviewed for the case studies and background research did not report having major problems with bubbling or adhesion. It was universally felt that any problems experienced with rubber flooring installation were common to all resilient flooring materials and were more due to surface preparation and newer adhesives than something inherent in the rubber flooring.

Figure 17: Bubbling and Adhesion are Biggest Installation Issues for Rubber



A recommendation from the case studies for avoiding installation problems was to specify the appropriate thickness of the product. Several people commented that they found three millimeters to be just the right degree of thickness to minimize any telegraphing of subfloor blemishes without being so cushiony that it makes it difficult to push equipment. While rubber floors can be walked on 48 hours after installation, they cannot accommodate rolling loads until 72 hours post installation.

In terms of maintenance, many facilities are using an automatic scrubber to clean and buff their rubber floors. The auto scrubber applies water and cleaning solution to the floor via a scrubbing pad and then squeegees the water off the floor, leaving a clean, dry floor in about the same amount of time it takes to mop. This process is much less disruptive than stripping and waxing because patients and staff can work around the equipment and there is no need to clear out or close the area. Being able to clean the floor while an area is occupied gives increased flexibility and reduces disruption to clinical work. Floors can be cleaned more frequently and during daytime hours, eliminating the need for more expensive night time crew work. Despite the consistent message from the interviews that rubber floors deliver big benefits to the maintenance staff, facility managers were more ambivalent on the survey. Over 65% of users said rubber floors had no impact on the maintenance staff's workload or they didn't know what the impact was; the remaining respondents were roughly split between 'increased' and 'decreased' workload.

While manufacturers provide an option to apply a finish to rubber flooring, it isn't necessary. Dartmouth Hitchcock Medical Center chooses not to use a finish on their rubber floors, and hospital staff reported that through autoscrubbing they have been able to bring out the natural sheen of the floor. The downside of not using a finish is that unfinished rubber shows more scuff marks during the natural maturation process; finishes can reduce the appearance of the scuff marks, but at the cost of slowing the maturing process.

Some of the lessons learned during the course of this research are that while the cleaning protocol is simple, difficulties can arise if maintenance staff are not familiar with the product and try to wax the floor as though it were vinyl. Survey respondents indicated that they had received complaints about the cleanliness of the floor, but this was not corroborated in the case study interviews. Interviewees said that they did not have many complaints from clinicians or others about the cleanliness of the floors and that while they had received a few comments about the matte finish, people were satisfied when they were told that the floor is not supposed to be shiny.

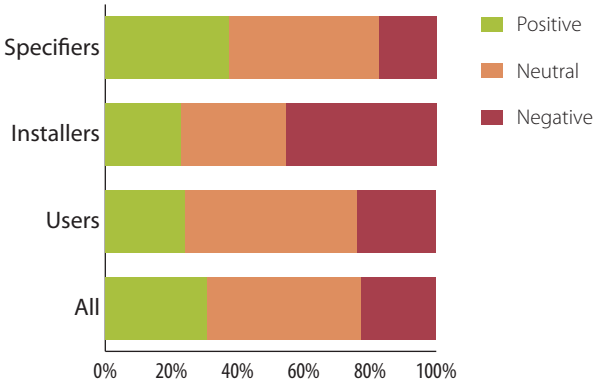
Users Most Common Maintenance Issues with Rubber

- Improper cleaning protocol (40%)
- Maintenance staff's lack of familiarity/ knowledge (35%)
- Complaints about cleanliness (33%)

Perception

The overall opinion of rubber was quite high, with the vast majority of respondents satisfied with the product and reporting that it met their performance expectations. In fact, 61% of all people who had experience with rubber flooring reported that they would definitely or most likely use rubber flooring again in the future. When we asked architects if rubber met their performance expectations, 75% responded yes. They also reported that 65% of their clients were satisfied with the rubber flooring they had specified. We also wanted to understand how people who had not used a material thought about that material to learn about the possible barriers to adoption. People who had not used rubber flooring in the past five years were asked to explain why, through free response. The most commonly given response was that rubber floors are too expensive. We also asked these people to tell us whether or not their overall opinion or perception of the material was positive. These results are provided in Figure 18 and show that specifiers are much more positive about rubber than the other stakeholders and installers have a stronger negative sentiment to the material. The reason for this difference is not clear from the current study, but it should be investigated further.

Figure 18: Non-Users' Perceptions of Rubber Vary by Stakeholder Type



Benefits

The people interviewed for the case studies had mostly positive experiences to report about rubber flooring, and some of the clinical and maintenance staff had glowing praise for rubber flooring. Several people commented that they wished they had rubber flooring in more parts of the hospital. The clinical staff most frequently commented on how comfortable it is to walk and stand on for long periods of time. Some mentioned that it made the spaces where it was installed feel quieter. The environmental services staff interviewed were very happy with the ease of care for the product, particularly when compared with stripping and waxing vinyl floors.

Most commonly selected positive attributes of rubber from all survey respondents who had used rubber floors in the past five years:

- Comfort Underfoot (47%)
- Acoustics (41%)
- Sustainability (33%)
- Cleanability (33%)

Challenges

The most significant downside to rubber flooring is the initial cost, which can be higher than the vinyl products hospitals may be accustomed to. Initial cost was identified by 55% of the survey respondents as a negative attribute, and this was supported by the case study interviews. The look of the product and limited styles available were also mentioned as negative attributes in the survey and case study interviews. While odor was identified as a negative attribute of rubber by 25% of survey respondents, none of the people interviewed brought up the issue of smell without being prompted and no one reported that they had received complaints from staff or patients about the odor; their only comments were to acknowledge that the floor had a rubber smell to it for a few weeks after installation.

Most commonly selected negative attributes of rubber from all survey respondents who had used rubber floors in the past 5 years:

- Initial Cost (55%)
- Aesthetics (39%)
- Installation requirements (29%)
- Odor (25%)

CASE STUDY

Dartmouth Hitchcock Medical Center Finds Rubber Floors Comfortable and Quiet

When the Dartmouth Hitchcock Medical Center was looking for new flooring alternatives, they decided to test out a variety of flooring materials, including Mondo rubber and Forbo linoleum, in their Patient Safety Training Center (PSTC). The institution was looking to move away from the vinyl-based floors that dominated their facilities and wanted to reduce the use of harsh chemicals required to strip and wax those floors. Their decision to move ahead with the rubber product was influenced in part by the response they received from the PSTC staff and housekeeping during a pilot test. A poll designed to collect opinions and thoughts about the different flooring materials showed a staff rating for rubber of five out of five points. Staff also offered direct praise for rubber: "We love this flooring! It is very comfortable to work on, we have had red food coloring on it for over an hour and it didn't stain." The housekeeping staff also rated the rubber floor highly (four out of five for the tiles and three out of five for sheet rubber), but noted that it was difficult to mop.

In May 2008, when it came time to renovate a space to create an 8-bed Intermediate Care Unit, Dartmouth Hitchcock decided to outfit the entire 4,000 square feet unit with Mondo rubber sheet flooring with welded seams. Staff of the ICU requested rubber because they had heard good things about rubber flooring in terms of comfort and acoustics. Before making the final decision, the Center brought in the vendor, Mondo, to talk with clinicians and housekeeping staff to make sure they understood that the floor would not be as shiny as they were accustomed to with VCT.

As was expected, there was some initial resistance from those who thought the rubber floor didn't look clean because of the lack of shine. However, over time the rubber floor has matured and become shinier, developing a natural luster as a result of auto scrubbing. As the material matures, the floor requires less scrubbing. One nurse in particular prefers the lower gloss floor because the rubber floor does not produce glare which can exacerbate her migraines. In addition, the Center had previously received complaints that waxed vinyl floors were too shiny and looked slippery. Staff find the cleaning of the floor to be much less disruptive than the cleaning process for VCT (where areas needed to be off-limits for cleaning), as well as having a less noxious smell. Cleaning staff uses a small auto scrubber that allows them to maneuver around in the patient rooms and occupied areas. Perhaps the most challenging procedure change they have faced has been getting the cleaning staff to use the auto scrubber for discharge cleaning instead of mopping. The auto scrubber provides better results, whereas wet mopping alone can result in a film residue left on the surface. The resistance to using the auto scrubber for discharge was likely just because it was a change in process and required the staff to retrieve the equipment when needed; it has not proven to be a big issue.

Photo courtesy of Lavallee Brensinger Architects

continued ▶

The staff is also very happy because they find the rubber floor more comfortable underfoot; work mats are no longer needed in areas where they stand for long periods of time, and the rubber floors are not slippery when wet, another safety improvement. They have also commented on and really appreciate the quietness of the floor material.

Photo courtesy of Lavallee Brensinger Architects

Based on their previous successes in the Intermediate Care Unit and the Patient Safety Training Center, Dartmouth Hitchcock decided to use rubber flooring on 30,000 square feet of their new 40,000 square foot Outpatient Surgery Center. The new facility, which opened in June 2010, has rubber in all the patient prep areas, recovery rooms, operating rooms, circulation areas around the ORs, locker rooms, and staff corridors. The decision to use rubber was driven by the ability to keep the floor looking good without the use of a finish, unlike vinyl floors. Floors in operating rooms have to withstand a lot of abuse, and chemicals such as Betadine® can leave difficult to clean stains. The maintenance staff felt that rubber floors would be a good choice for this area since Betadine® doesn't stain rubber and it would be easy to keep the floor clean and looking good with just regular auto scrubbing.

Proper installation is a critical component to having an attractive rubber floor. There have been some challenges in their new Outpatient Surgery Center, with irregular sized gaps developing between the individual tiles. They are not sure what caused this problem, but speculate that it could be a result of the epoxy that was used in the installation instead of the contact adhesive that was used in the PSTC. An epoxy adhesive was chosen because the heavy wheeled traffic anticipated in the OR suites requires a more durable adhesive, but the epoxy had a long open time and the tiles may have shifted due to foot traffic before the adhesive cured. To resolve the matter, they had to go back and weld the seams in all the patient care areas. Initially the welded seams looked good, but over time they have found that the seams are harder to clean. In the future they plan to use sheet rubber, or explore alternate adhesive options, to avoid this problem. Dartmouth has not experienced any bubbling problems in any of their rubber installations.

While rubber flooring costs more initially than other options such as sheet vinyl or VCT, Dartmouth Hitchcock Medical Center feels that they will recoup this initial cost through savings on maintenance, particularly through the elimination of the stripping and waxing protocol. They also feel that the rubber floor is more durable and expect it to last longer than vinyl flooring. ■

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Karen Pushee, Nurse Manager, Intermediate Special Care Unit, Dartmouth Hitchcock Medical Center

Dave Stiger, Director of Project Management, Dartmouth Hitchcock Medical Center

Jay Welenc, Operations Manager – Housekeeping, Dartmouth Hitchcock Medical Center

CASE STUDY

Rubber Flooring is Part of Gundersen Lutheran Medical Center's Interior Standards

In 2006, Gundersen Lutheran set out to define interior standards for their approximately 3 million square feet of facilities. The move was designed to ensure that the money being spent on construction projects was delivering value, especially with regards to their organizational goal of sustainability. One of the first things they tackled was their flooring specifications, since they were using a variety of flooring materials throughout their facilities. They undertook the creation of a material standard to achieve three goals: 1) reduce the number of materials used; 2) reduce the life cycle costs to the system; and 3) improve their sustainability impact. An internal team led by the project manager conducted research on the materials they were already using, the cost of those materials, how they were holding up, recycled content, the expected life cycle, acoustical qualities and maintenance specifications. Then, they installed a number of the flooring alternatives in their environmental services department and had their insurance provider test the coefficient of friction for the different surfaces to reduce the risk of slips and falls.

Although Gundersen Lutheran had previously used a lot of VCT, as a healthcare organization they have a strong commitment to sustainability and wanted to minimize their use of vinyl. In addition to the unsustainable aspects, VCT did not offer them the proper aesthetics and provided no cushion underfoot, although one of the biggest reasons for the shift away from VCT was the expense and down time involved in stripping and waxing the floors. As a result of their flooring analysis, they adopted Nora rubber and Stratica polyolefin, in addition to Collins and Aikman carpet, VCT and sheet vinyl for limited applications. Sheet vinyl is still used in patient rooms to achieve the look they want with a seamless installation for infection control and at a reasonable cost.

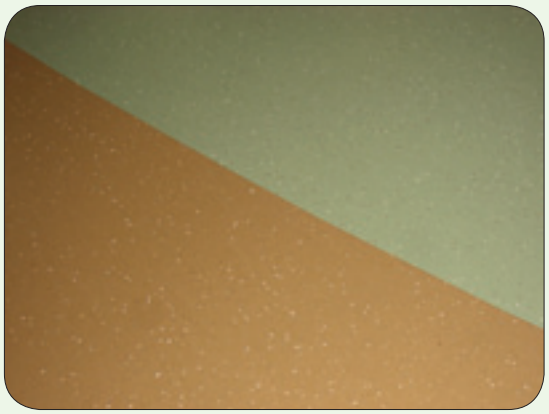


Photo Courtesy of Gundersen Lutheran

Gundersen Lutheran's main hospital in La Crosse has installed approximately 3,000 square feet of rubber flooring in the ICU, nurses' stations, and in the trauma and emergency department. They experienced some staining and discoloration problems in the initial installation in the emergency department, which was due to a previous formulation of Nora rubber flooring. They have not had any issues with subsequent installations, and although Nora offered to replace the defective product, the hospital chose not to have the flooring replaced because it would disrupt operations. During installation of the rubber flooring, they found that the two-part epoxy has a strong smell and dries rapidly, requiring quick response on the installer's part. One solution was to use smaller quantities; they found that 1-gallon containers of the epoxy worked better than 5-gallon containers because it did not require them to work as large an area at one time. Despite these drawbacks, the epoxy provides better results than the adhesive. Another lesson is that it is important to give adhesives time to dry before subjecting the floor to traffic. If carts or equipment are rolled over the floor before the adhesive hardens, they can leave grooves in the floor that collect dirt.

continued ▶

The design team likes that the rubber product is available in sheet goods, which facilitates applications that require a seamless floor. It is comfortable, quiet and helps with fatigue, so they have decided to use it in all areas where staff members are likely to be standing for long periods of time. The staff has also commented that the floor is comfortable and that it masks the sound from footsteps and equipment compared with other floors. Rubber is the institution's standard product for certain patient care areas, exam rooms, clean and soiled rooms, nurses' stations and break rooms. They have also decided to incorporate rubber flooring in all the corridors of the 400,000 square foot hospital addition that is currently being designed for the La Crosse campus. While other organizations have chosen to use rubber flooring in the operating rooms, the physicians at Gundersen Lutheran were very partial to the vinyl safety flooring that they are used to, so the specification for those areas was not changed. They are also using a sheet vinyl product as their standard for inpatient rooms.

The environmental services department posts cleaning and maintenance instructions for the various materials they have installed in their facilities on an internal website. They also provided training to their staff when rubber and Stratica were initially installed. For general maintenance of the floor, they have been using a mop with Hydrox®, bringing out an autoscrubber only for tough stains. A finish is not applied to the floors, and the Medical Center is happy with the reduced maintenance requirements. Gundersen Lutheran Medical Center has benefited from the lower maintenance requirements of Stratica polyolefin and Nora rubber flooring. According to the Director of Construction Engineering, since they made these products part of their interior standards, the institution has added a significant amount of square footage without increasing the number of full time equivalent staff to maintain those floors. ■

Acknowledgments:

Theresa Besse, Interior Designer, Gundersen Lutheran Health System

Carla Brott, Clinical Manager for Post-partum and Nursery, Gundersen Lutheran Health System

Paul Heath, Supervisor for Environmental Service Group, Gundersen Lutheran Health System

Kari Houser, Director, Construction Engineering and Project Management, Gundersen Lutheran Health System

CASE STUDY

Northern Michigan Regional Hospital Tries Rubber Flooring in the Operating Room

Northern Michigan Regional Hospital is a 228-bed facility located in Petoskey, Michigan, built in 1977. Originally, the hospital had VCT installed in most of the patient spaces and used sheet vinyl in the operating rooms. As they have renovated the facilities, they have successfully incorporated some newer and more environmentally friendly flooring materials such as rubber and Stratica. Northern Michigan is an environmental leader, as demonstrated by their 2008, 2009 and 2010 Environmental Leadership Awards from Practice Greenhealth. Although they look for ways to reduce their environmental impact through material selection, they still use VCT as one of their standard flooring materials. They have also recently installed a no-wax sheet vinyl product that may become one of their standard materials.

In 2009, Northern Michigan Regional Hospital renovated one of their 550-square-foot operating room suites and decided to replace the old sheet vinyl with Estrie's Duramed rubber flooring. As part of the decision process, they marked up a sample of flooring with different stains and asked for feedback from the housekeeping staff on how well it cleaned up. Housekeeping was impressed that all of the stains, with the exception of the surgical marker, were easily removed from the rubber flooring.

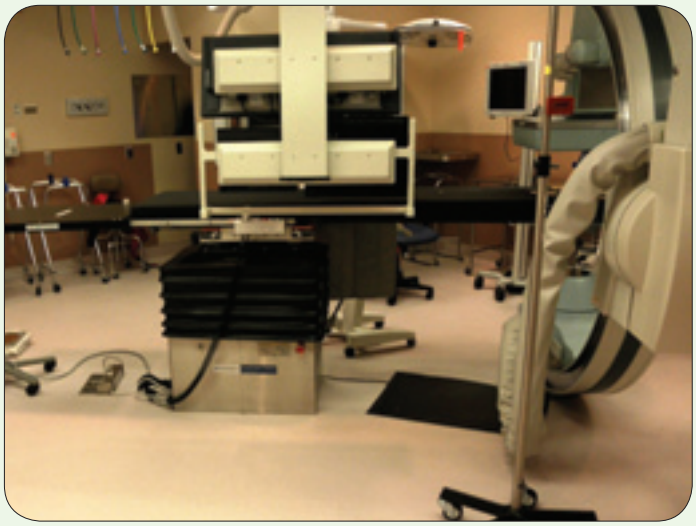


Photo courtesy of Northern Regional Hospital

The feedback from the users on the rubber flooring has all been positive, including nurse feedback that the flooring is more comfortable. The facilities department likes the rubber for its durability, since renovating an operating room can be very disruptive. Another advantage appreciated by the institution is the reduced maintenance requirements of rubber compared to the strip and wax protocol that is required for most sheet vinyl and VCT. Their standard protocol for cleaning the rubber floor is a wet mop, which reduces the amount of time that the OR needs to be shut down for cleaning. Occasionally, the auto scrubber is used on stubborn stains such as Betadine®. The maintenance requirements are so simple that the staff didn't require any special training; the most challenging aspect is to remind the staff that they *don't* need to strip and wax the floor. Even with this reduced maintenance, the rubber floor looks great and is developing a natural luster. Based on their experience in the single operating room, the facility coordinator for Northern Michigan Regional Hospital anticipates that they will use rubber in future operating room applications that call for a sheet product. ■

Acknowledgments:

Diane Moore, Afternoon Supervisor, Environmental Services Dept., Northern Michigan Regional Hospital

Gary Rellinger, Facility Coordinator, Northern Michigan Regional Hospital

IV. POLYOLEFIN

Use

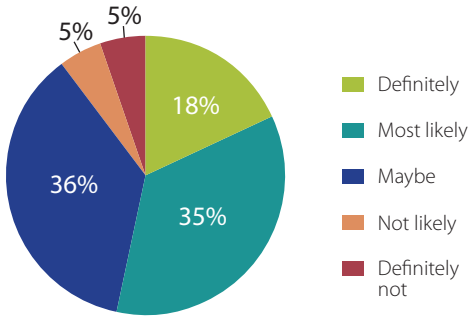
Another non-vinyl tile product in the resilient flooring category is a material called polyolefin, the most widely know example of which is Stratica. During the design of the survey, we tried to describe the product in a way that would ensure people knew which material we were referring to without always referring to brand names. We ended up using the following description: "Polyolefin polymer flooring is often made from mixtures of polyethylene and polypropylene. Examples include Stratica by Amtico, Lifeline by Upofloor, WELS by Ceres and FreiFloor by Allstate." We asked respondents to give us the name of the products they had used, and in the end, 37 out of the 40 people who listed a brand name had used Stratica and 2 people had used WELS.

The survey revealed low rates of adoption for polyolefin when compared with linoleum, vinyl and rubber, with only 27% of all participants reporting that they had used it within the past five years in a hospital. A skip logic problem was discovered early in the distribution of the survey, affecting questions related to polyolefin. The problem caused survey takers on the architect track who had not used rubber/cork to bypass the polyolefin questions; we estimate that approximately 80 people were not asked if they had used polyolefin. The analysis employs percentages as opposed to absolute numbers in order to minimize the effects of the skip logic problem, but it does mean that we had fewer overall respondents to weigh in on their perceptions about polyolefin.

Areas Where Polyolefin is Commonly Used

- Hallways
- Waiting rooms
- Patient rooms
- Lobby
- Nurse's stations

Figure 19: Continued Use of Polyolefin Very Likely



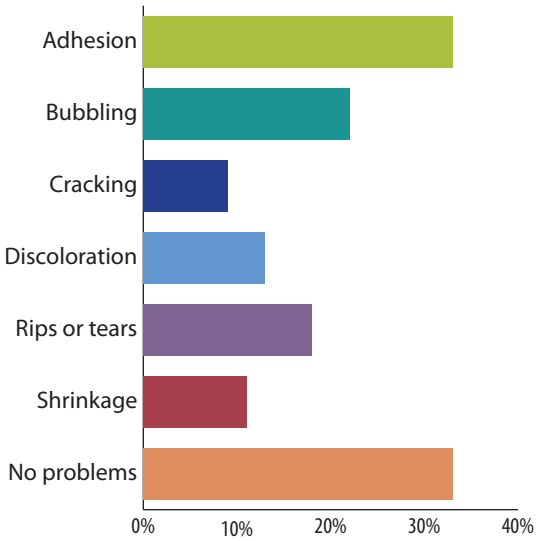
From the case study interviews, we learned that polyolefin is most often used in high visibility public spaces or patient areas. The product comes in wood or stone patterns, so it is often chosen for aesthetic reasons, where a warm or homelike look is desired. For example, Gundersen Lutheran is using Stratica in high traffic, high visibility areas such as elevator lobbies, and Mass General uses the product in their Special Care Nursery and NICU. The responses to the survey also support this finding, revealing that polyolefin is most often used in hallways, waiting rooms, patient rooms, lobbies and nurse's stations. In the survey, 68% of architects and facility managers reported using it in hallways, and about half of the respondents used it in waiting rooms, patient rooms and lobbies. The product is generally used in limited areas due to the cost premium compared with other products. It is not used in clinical or treatment spaces because it is a tile product and cannot be installed seamlessly.

Of the specifiers and users who had used polyolefin in the last five years, 53% reported that they most likely or will definitely use the product again in the future. Only 11% said they were not likely or would definitely not use polyolefin again.

Installation and Maintenance

During the case study interviews, people spoke mostly about adhesion problems, and a third of the survey respondents reported having adhesion problems with polyolefin as well. Mass General had poor adhesion in the installation of their polyolefin floor that caused some tiles to pop up. They felt that the product requires more skill to install than VCT and suggest looking for installers with prior experience working with polyolefin. The Allina Hospital system had a lot of problems with tiles popping up and concluded that it was caused by the quick set adhesive that they used for their renovation projects. While 22% of the people surveyed said that bubbling was a problem, it was not brought up during the interviews. As a tile or plank product, it is unclear how polyolefin products can bubble; it is possible that the survey results are skewed by some survey participants confusing polyolefin with other flooring products. It should also be noted that a third of the people surveyed reported having no installation problems with polyolefin.

Figure 20: Adhesion Most Common Installation Problem with Polyolefin



The hospital staff interviewed for the case studies all commented that one of the things they liked about polyolefin is the ease of maintenance. Since cleaning it takes less time, it is less disruptive to the clinical work flow than the VCT flooring that it typically replaced. All three of the facilities sampled are cleaning the polyolefin floors with a dry mop followed by a wet mop with a mild cleaner. They only reported using an auto scrubber to clean selected high traffic areas. The product comes pre-finished, but one of the facilities interviewed said they are applying finish to the polyolefin occasionally to increase the shine and reduce the visibility of scuff marks. Despite the consistent message from the case studies, only 27% of the facility managers surveyed reported that polyolefin had reduced their workload and 67% either did not know or thought the impact on their workload was neutral.

Users Most Common Maintenance Issues with Polyolefin

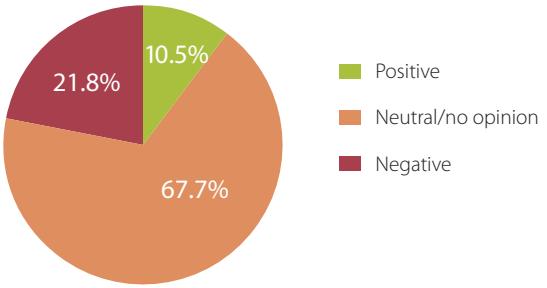
- Complaints about cleanliness (47%)
- Need for repairs (40%)
- Use of improper cleaning protocol (40%)

Perception

Over half of the people who have experience with polyolefin flooring reported that they would be 'likely to use' it again. People who have not used the product before overwhelming stated that they had 'no opinion' about the product. This is further supported by the open-ended responses, in which people indicated that they were unfamiliar with the product. Of the 71 specifiers who gave additional information about why they had not used polyolefin before, 31 stated that they had not heard of the product or did not have enough information about it.

We asked architects if polyolefin met their performance expectations, and 69% said yes; they also reported that 81% of their clients were satisfied with the material. Of the survey respondents who had not used polyolefin in the last five years, 84% said they had either a neutral or no opinion about polyolefin - see Figure 21. Whereas only 11% had a negative opinion, the smallest percentage to have a negative opinion of a flooring material that they hadn't used, polyolefin also had the lowest percentage of non-users with a positive opinion about the material (5%); it appears that the product is simply not well-known and low usage rates are due to lack of knowledge about the product, not because of any specific perceptions about it.

Figure 21: Opinion of Non-Users for Polyolefin is Largely Neutral



Benefits

In both the survey and the case study interviews, we overwhelming heard that people chose polyolefin because of the look it provides. When users want to create a warm look, they like products that simulate wood and stone. The other benefit that was touted by almost half of the survey participants and all of the interviewees is the ease of cleaning polyolefin floors. Sustainability is also an important benefit, since polyolefin is a vinyl-free material and does not necessitate the use of harsh chemicals to keep it clean.

Most commonly selected positive attributes of polyolefin from all survey respondents who had used polyolefin floors in the past 5 years:

- Aesthetics (74%)
- Cleanability (47%)
- Sustainability (28%)
- Durability (25%)

Challenges

Polyolefin often competes with vinyl tile or plank products, and can cost more per square foot to purchase. Over half of the survey respondents said that initial cost of the product was a drawback. Cost was also the reason that all of the hospital systems interviewed had chosen to limit the use of polyolefin to high profile public areas. The survey responses show that installation requirements was another negative, and one of the case studies found that installation of polyolefin requires more skill.

Most commonly selected negative attributes of polyolefin from all survey respondents who had used polyolefin floors in the past 5 years:

- Initial cost (55%)
- Repairability (32%)
- Installation requirements (29%)
- Durability (27%)

CASE STUDY

Aesthetics Drive Gundersen Lutheran Medical Center to Polyolefin

Gundersen Lutheran Medical Center installed between 2,000-3,000 square feet of Stratica in the hallways of the post-partum unit and in elevator lobbies of the Main Hospital in La Crosse, Wisconsin in 2007. They selected Stratica because of its non-institutional aesthetic and because they felt it was more sustainable than the similarly styled vinyl alternatives. The fact that it was PVC-free and could be cleaned with mild cleaners was also attractive. The Stratica comes pre-finished, so the maintenance protocol is simply to dry and wet mop with a mild soap and water solution. Areas with more traffic are auto scrubbed. The nurse manager in the post-partum unit is pleased with the new Stratica flooring, in part because the cleaning regime is more user friendly than the previous floor. They used to have carpet in this area, and the smell from the carpet cleaning process was so bad that one staff member would routinely get headaches and have to leave on days when it was cleaned. While the Stratica is not very shiny, the staff got used to the matte finish and like how it looks.

Photo Courtesy of Gundersen Lutheran

The Medical Center chose Stratica as their standard product for high traffic public areas that don't require sealed seams, such as high traffic corridors, elevator lobbies and elevator cabs. One thing they learned during installation is that it is important to make sure that the seams are tight - otherwise they collect and show dirt. Although aesthetics was a main driver for the selection of Stratica, the interior design team is frustrated by the limited variety of colors and patterns available. Another drawback reported was that the floor can be somewhat slippery when wet or when sand collects on it in the winter months. Despite this, there have not been any falls attributed to the flooring. ■

Acknowledgments:

Theresa Besse, Interior Designer, Gundersen Lutheran Health System

Carla Brott, Clinical Manager for Post-partum and Nursery, Gundersen Lutheran Health System

Paul Heath, Supervisor for Environmental Service Group, Gundersen Lutheran Health System

Kari Houser, Director, Construction Engineering and Project Management, Gundersen Lutheran Health System

CASE STUDY

Mass General Chooses Polyolefin for High Impact Areas

Photo courtesy of MGH Planning and Construction Office

In 2006, Mass General performed a complete renovation of their Newborn Infant Care Unit to create a comforting environment for the families of critically ill infants. Part of their design strategy was to select interior finishes that made the space more home-like. For the flooring, they wanted a material that looked like wood, and were very happy with the Stratica that had been used for four years in their Special Care Nursery. The decision was made to install Stratica in all the public areas of the unit, including the patient rooms, waiting rooms, main lobby, main corridor, and the nurse station - adding up to approximately 75% of the 12,000 square foot unit. For the non-public spaces, they decided to use a PVC-free vinyl tile floor.

The nurses have been happy with the Stratica flooring in the NICU and are pleased with the way it looks. Some of the nurses commented that the floor feels softer under foot than VCT. While the floor does not have the same high shine finish that the clinicians are accustomed to, there have not been any complaints about cleanliness. Clinicians were involved in the decision to use the Stratica and were informed about the matte finish during those design discussions. Both the clinical and maintenance staff have been pleased with the new cleaning protocol, which no longer requires them to shut down an area to strip and wax the floors. The Assistant Director of Environmental Services reports that the daily maintenance is "quick and easy, you're in and out and it looks good." Their daily cleaning protocol for Stratica is to dry mop the area first to remove dirt followed with a wet microfiber mop that dispenses fresh cleaning solution automatically. A couple of times a year they scrub the floors and apply Wiwax finish, which doesn't require stripping or buffing, but gives the floor a protective finish with a little shine. In the corridors, they use the auto scrubber daily, which is quicker than the strip and wax protocol they follow for VCT.

While they are happy with the Stratica in both settings, they are more satisfied with the look of the floor in the NICU because of a couple of design-related decisions. In the NICU they used a darker color, based on feedback from the staff in the Special Care Nursery, and find that it doesn't show scuff marks as much as the lighter color does. In addition, they specified random length planks, which produces a more organic look.

continued ▶

The installation experienced some problems with the adhesive bleeding through the seams and tiles popping up, which necessitated having the floor repaired during occupancy. One of the lessons learned is that it is important to hire a quality installation contractor who is knowledgeable about the specific material and adhesive requirements. The preparation of the subfloor is also very important. They felt that Stratica requires a more specialized installation when compared to VCT, so it is best to hire a contractor who has prior experience with the material. Another strategy they recommend to improve the likelihood of success is to require the general contractor to oversee the flooring installation.

Mass General is conducting their own internal analysis of materials to help them select products that are more sustainable in terms of their impact on the environment, people who work around the materials and the maintenance staff. The research has involved benchmarking against similar organizations and gathering specification data from product manufacturers. Durability of the materials and maintenance requirements are also important considerations. Although they are trying to eliminate PVC on their campus, they do not have an official policy mandate on the issue. Stratica will continue to be used in small scale, high impact areas such as a new waiting room for the Pediatric Endoscopy unit and in the parent lounges at the Ronald McDonald House. ■

Acknowledgments:

Tom Connors, Independent Flooring

Jim Guiry, Senior Construction Manager, Mass General Hospital

Dorothy Haney, Project Manager, NICU, Mass General Hospital

Steve Mikula, Construction Manager, NICU project, Mass General Hospital

Julianne Savarese, MGH Planning and Construction, Mass General Hospital

Peggy Settle, Nurse Manager in NICU, Mass General Hospital

Richard Turgeon, Assistant Director of Environmental Services, Mass General Hospital

CASE STUDY

Northern Michigan Regional Hospital Enjoys Reduced Maintenance of Polyolefin

Photo courtesy of Northern Regional Hospital

Northern Michigan Regional Hospital is a 228-bed facility located in Petoskey, Michigan, originally built in 1977. The hospital had VCT installed in most of the patient spaces and used sheet vinyl in the operating rooms. As they have renovated the facilities, they have successfully incorporated some newer and more environmental friendly flooring materials such as rubber and Stratica polyolefin.

Northern Michigan Regional Hospital replaced VCT floors with Stratica in three nuclear medicine treatment rooms and in a retail space. Altogether, the installation encompasses about 2,000 square feet of Stratica, which have been in place since 2008. The decision to use Stratica in these spaces was primarily motivated by the reduced maintenance requirements and the 'soft' aesthetic of the material. The Stratica does not require a finish or to be stripped and waxed and can be cleaned with regular mopping. The reduced maintenance is particularly important to the staff in the nuclear medicine areas because the equipment is sensitive to disruption. When they had a VCT floor, they worried about the cleaning staff bumping into their equipment, splashing wax on it or leaving something uplugged – this happened once and caused a delay in patient treatments waiting for the equipment to warm up. The staff have been happy with the look of the floors and are pleased with the reduced maintenance requirements. Kristen Hasse, a team leader in the nuclear medicine department, said: "I wish we could have this flooring in all our rooms." They will be using Stratica in future renovations, particularly in procedure rooms and patient support areas where they want a softer look. ■

Acknowledgments:

Kristen Hasse, Nuclear Medicine Technologist and Team Leader of Nuclear Medicine Department, Northern Michigan Regional Hospital

Diane Moore, Afternoon Supervisor, Environmental Services Dept., Northern Michigan Regional Hospital

Gary Rellinger, Facility Coordinator, Northern Michigan Regional Hospital

V. LINOLEUM

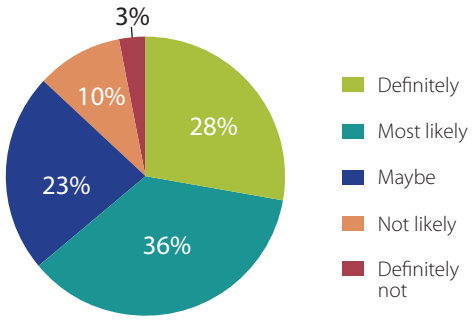
Use

Linoleum is gaining renewed interest among healthcare facilities concerned about their impact on the environment and wanting to provide a healthy space for users. The survey found that 57% of architects, installers and facility managers have used linoleum in their hospital projects in the past five years, and 64% of specifiers and users report that they are most likely or definitely will use linoleum on future projects (see Figure 22).

Areas Where Linoleum is Commonly Used

- Hallways
- Waiting rooms
- Patient rooms
- Lobby
- Nurse's stations

Figure 22: Continued Use of Linoleum Very Likely



"Linoleum is still a controversial product for patient rooms, exam rooms or clinic corridors. While some manufacturers say it is suitable for these areas, some health systems limit its use."

—Dellinger 2008

Linoleum is generally being used in public spaces, such as hallways, nurse's stations and waiting rooms, in addition to patient rooms. There is some concern about where linoleum can be used successfully. Despite the fact that it is a seamless floor, it is not being used in treatment or operating rooms; nor is it recommended for these areas by the manufacturers. Different reasons were given for why it isn't being used in these spaces. Several people spoke about the need to use harsh chemicals to clean these areas for infection control and felt those chemicals would damage the linoleum. Other people mentioned that due to the jute backing on linoleum, it is more susceptible to moisture problems and cannot be flooded with water during cleaning. Additionally, linoleum is susceptible to staining by iodine.

Installation and Maintenance

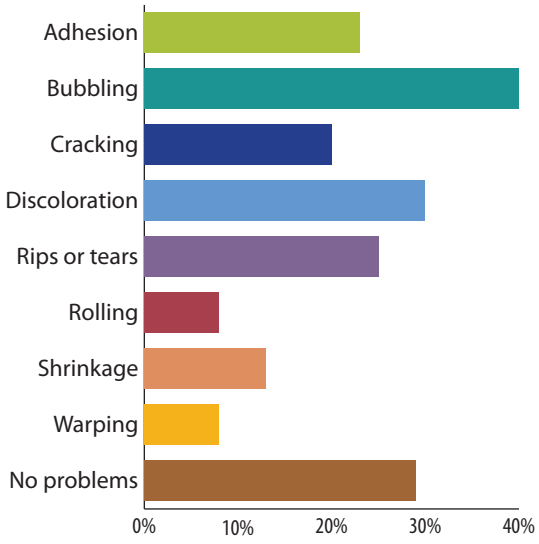
As a sheet good, the most commonly reported installation problem for linoleum in the survey was bubbling; this was not mentioned by any of the case study interviewees, so we do not have any lessons learned to report. Discoloration was identified as a problem by 30% of the survey respondents. There was a case of linoleum becoming temporarily discolored at Rumford Hospital, but they understood that this was a temporary condition caused by light exposure.

Linoleum cannot withstand heavy traffic or point loads for 72 hours after installation. Some of the facility managers interviewed mentioned that this is difficult to achieve, particularly in renovation projects, and as a result has limited their use of the flooring.

While shrinkage was only identified by 13% of the survey respondents, one interviewee mentioned that linoleum is not as flexible as vinyl, and there can be shrinkage and stretching of the material after installation that needs to be accommodated. Because linoleum can be a little tricky to install, it is particularly important to hire experienced installers.

Another issue with installation or design can be the location of the welded seams, which create a vulnerable spot in the floor and which some people find unattractive. The survey did not provide 'seams' as an option for the question about installation problems, but it was mentioned by several of the case study participants. One hospital told us about a seam in a patient room coming apart, breaking the integrity of the floor. They had to close off this patient room for a week while the floor was repaired. One way to avoid this problem is to use larger pieces and be strategic about where the seams occur. Another option to address the aesthetic issue is to add a design element such as a shape or block of a different color so that the seam is anticipated. Seams require skill to be done well, which is another reason why it is important to hire installers who have previous experience working with linoleum.

Figure 23: Bubbling Most Common Installation Problem for Linoleum



Linoleum comes in sheets and tiles, and is often prefinished in the factory. Prefinished products are ready for use immediately after installation and do not require any initial finish application. Linoleum can be damaged if cleaned with harsh chemicals, making it incompatible with some hospitals' cleaning regime. Typical maintenance is to use a mild combination cleaner and finish product to both clean and add a little protective shine to the floor. A neutral ph stripper is used before applying the new finish. Many of the facilities we spoke with are choosing to apply a finish to their linoleum, to increase the shine, to make it easier to keep clean and increase stain resistance. Manufacturers recommend using a finish, and suggest that several layers of finish be used to achieve a high shine.

As the linoleum oxides over time, it becomes stronger and harder. Many people commented that they felt it was a more durable material than vinyl and expect it to hold up longer in high traffic situations. Overall, more than a third of the facility managers surveyed reported that they had no maintenance problems with linoleum. The next most commonly problem reported was use of the wrong cleaning protocol. Dartmouth Hitchcock Medical Center reported that a section of linoleum flooring had been mistakenly waxed, and now the area looks dull because harsh strippers cannot be used to remove the wax buildup.

Users Most Common Maintenance Issues with Linoleum

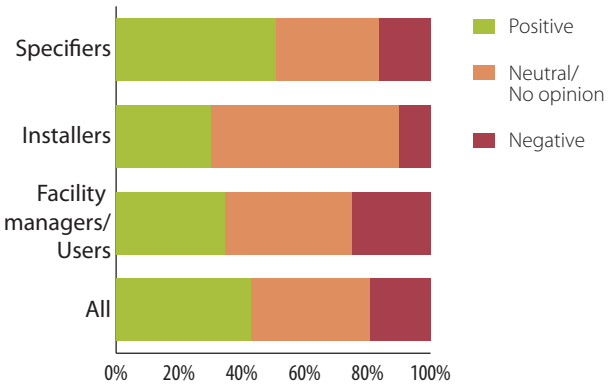
- No problems (37%)
- Use of improper cleaning protocol (26%)
- Need for repairs (24%)
- Maintenance's staff lack of familiarity/ knowledge (24%)

Even though reducing maintenance staff workload was cited as major benefit from the people interviewed for the case studies, the survey respondents were a bit more ambivalent. In the survey, 69% said linoleum had no impact or they didn't know what the impact on workload was, and the rest were essentially split between increased and decreased workload.

Perception

Among people who have not used linoleum in the past five years, 37% had a positive perception of the material; 47% of specifiers had a positive perception of linoleum. A third of the facility managers that had not used linoleum before had a negative opinion, more than the specifiers and installers - see Figure 24. When the respondents were asked to provide the reason why they had not used linoleum in the past five years, the most common answers related to performance and price. The performance issues that were mentioned included not holding up to cleaners required for infection control and concerns about being too porous to be used in wet areas.

Figure 24: Facility Managers Most Negative Among Non-users of Linoleum



Benefits

The environmental advantages of linoleum are fairly well known; 61% of survey respondents selected sustainability as an important benefit for linoleum, compared to 33% of people that selected sustainability for rubber flooring. During case study interviews, people highlighted the reduced maintenance requirements as a benefit of linoleum, in addition to the product being composed of all natural materials. They also commented that not only is the maintenance easier to perform, but it uses less harsh chemicals, so it does not disturb staff and patients.

Most commonly selected positive attributes of linoleum from all survey respondents who had used it in the past 5 years:

- Sustainability (61%)
- Aesthetics (46%)
- Cleanability (37%)
- Durability (21%)

Challenges

There is no strong consensus about the problems or challenges with linoleum. About a quarter of the survey respondents identified infection control, product quality, initial cost, and repairability as negative attributes. Compare this to the results for rubber and polyolefin, where there was more convergence around initial cost for both products. During the case studies and in the free response section of the survey, there were numerous comments made about linoleum being inappropriate for wet areas. There were also a few people who felt that linoleum is not as durable as vinyl, but there were far more people who felt it was more durable.

Most commonly selected negative attributes of linoleum from all survey respondents who had used it in the past five years:

- Infection control (27%)
- Product quality (26%)
- Initial cost (25%)
- Repairability (25%)

CASE STUDY

Mercy Hospital Finds Linoleum Looks Great With Little Effort

Mercy Health Partners has been using linoleum in their hospital system since 1999. In 2003, they opened a new Emergency Department at the Mercy Campus in Muskegon, Michigan, where they installed Marmoleum in the public corridors and patient rooms of the 24,000-square-foot department. Using linoleum in this project was proposed by the designers, who were enthusiastic about the product's color and design options. The design team discussed the idea of using linoleum with the environmental services staff, since they were reluctant to use an unfamiliar material. Environmental services were used to VCT and were not sure how the linoleum would hold up. The vendor assured them that it was not difficult to maintain, and they visited local schools where it was installed to see how the product was working.

The staff has been very happy with the decision to have linoleum in the corridors because it is a durable product that holds up better to heavy traffic than vinyl. Based on its performance to date, they expect it to look better for longer, which is important since some of their floors end up being in place for over 40 years. The environmental services staff is very happy with linoleum because the cleaning requirements are much easier compared to VCT or carpet, which they were using previously.

Their cleaning procedure in the halls is daily cleaning with the auto scrubber and burnishing the floor two times a week. Once a year, a new coat of finish is applied. The patient rooms are mopped on a daily basis. They do a thorough cleaning with a more aggressive pad on the auto scrubber every month, and depending on the condition of the floor, they burnish or apply another coat of finish. They found that the cleaning staff were putting finish on the floors too often, rather than burnishing the floors, because applying finish is easier and guarantees a shiny floor. Burnishing is more difficult, and if the floor still does not look good afterwards, then they would have to go back and apply another coat of finish. They have been working on educating their staff on the downsides of building up too much finish, and now if the staff is in doubt about whether a room needs to be burnished or finished they ask the supervisor to assess it. In one room, they had to follow the restoration procedure to correct for improper maintenance, and the floor came out looking great.

Environmental services feel like they get a cleaner looking floor with less effort compared to VCT and report that the floor looks like new after they burnish it. They simply follow the manufacturer's instructions for cleaning the floor and feel that this has cut in half their cleaning time when compared to cleaning VCT. Another advantage is that the cleaning protocol does not require strong chemicals, eliminating the problem that they have in other parts of the hospital where nurses go home sick when they strip the VCT floors. Overall, environmental services staff feel that linoleum provides a better look with less maintenance.

The emergency department staff have not noticed any impact on comfort underfoot, noise or slips and falls. In general, they feel the floor is attractive, and they added that the corridors look better than the patient rooms. They did recognize that cleaning crews might not have enough time in the patient rooms to do a deep cleaning since the rooms are often occupied.

Mercy has had some trouble with the seams. A seam failed in one of the patient rooms and moisture got under the linoleum, causing it to lift up. The affected patient room had to be shut down for a week while the linoleum was replaced. They also had some spots where the floor bubbled initially, but these areas were repaired and look fine now. Due to the length and width of linoleum rolls, many seams are required. Inexperienced installers sometimes do a poor job with the seams, so it is important to get an

continued ▶

experienced installer. To address this issue, Mercy has begun requiring their installers to show proof that they are trained in linoleum installation, and ask for references from previous jobs. When possible, they suggest visiting previous installations to look at the quality. They also had problems with poor quality field cuts for curved designs, so now they pay a premium for water jet cuts to make sure it is done well.

Overall, Mercy has been happy with linoleum floors and plans to use them in the future. Because linoleum requires 72 hours to cure after installation before it can be walked on or withstand rolling loads, it is not a good product for renovation projects in occupied spaces and has limited Mercy's ability to specify the product. ■

Acknowledgments:

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James Roberge, Senior Director of Facilities Services, Mercy Health Partners

Lee Ann TenCate, Director Environmental Services, Mercy Health Partners

CASE STUDY

Linoleum Reduces Maintenance Costs for Rumford Hospital

Photo courtesy of Carolyn Bates

Rumford is a 25-bed critical access hospital in rural Maine, whose emergency department and main entrance were renovated in 2006. The architect in charge of renovation, Freeman French Freeman, recommended linoleum for 2,100 square feet of corridor and waiting room flooring in the emergency department and other renovated spaces. The recommendation was based on anticipated reductions in maintenance requirements, since stripping and waxing the old VCT was a burden for this small hospital. The institution was very receptive to materials that would reduce their maintenance requirements and save money over the long run. The higher upfront cost of linoleum was offset by the savings from maintenance and the fact that it is a more durable floor that will not have to be replaced as often. Another benefit of linoleum was the lack of harsh chemicals needed for the cleaning and maintenance. During the decision making process, the architect provided the client with an article that compared the life cycle costs of linoleum, and the Forbo representative was on hand to answer questions. Once the product was selected, Forbo provided the hospital staff with training on the proper maintenance protocols for the product.

Pleased with the performance of the product and finding the maintenance to be easier, Rumford decided to use more Marmoleum in 2008 for an addition project that added private patient rooms to

continued ▶

the first floor, and a pharmacy, operating room and administrative offices to the ground floor[9]. The new wing has linoleum in the hallways and staff spaces; the patient rooms have a Green Guard certified sheet vinyl that doesn't require stripping and waxing. The linoleum's durability is appropriate for high traffic areas, while the vinyl provides the aesthetic desired for the patient rooms.

The regular maintenance routine for the linoleum is to dry and wet mop the floor daily, with a thorough cleaning with the shower scrubber approximately once a week. During the winter, use of the shower scrubber may be needed on a daily basis. About every four months, a finish is applied to the linoleum to give it shine and make it easier to keep clean. Unlike wax, the finish never needs to be stripped off since it either wears off with traffic or is removed with the shower scrubber and doesn't require an area to be closed off for the application. The cleaners and finish for the Marmoleum do not have a strong or offensive smell and the floor can be cleaned while clinicians and patients are in the area. They once had an area of the hospital with VCT that they couldn't strip and wax for six months because there was a patient with respiratory issues and it was too cold to open windows for sufficient ventilation.

The environmental services department is aware that stripping or waxing the linoleum would ruin the product and eliminate the maintenance advantages. As a precaution, they have educated their staff on the maintenance requirements of linoleum and constantly correct staff who talk about 'waxing' the linoleum floor that they are not waxed, but rather finished.

The participation of vendors was also crucial in the process; they helped the hospital understand how to work with the linoleum, in particular with the phenomenon called ambering. In this process, the product will discolor when protected from light, which frequently occurs in winter when portions of the floor are hidden by walk off mats employed to catch the sand that is brought in on shoes. Because of the education provided by the vendor, the institution understood early on that this is a temporary condition of the floor, and that it corrects itself when exposed to light.

Despite the hospital's success with linoleum, VCT was used in parts of the new wing as a way to decrease the initial cost of the project. To minimize the impact on maintenance, the VCT was placed in low traffic areas where it wouldn't require frequent attention and where the maintenance could easily be done during off peak times, such as the pharmacy and conference rooms. They also used sheet vinyl in this project for patient rooms, since the wood aesthetic they desired wasn't available in linoleum.

Photo courtesy of Carolyn Bates

Acknowledgments:

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Tracy Milledge, Coordinator for Environmental Services, Rumford Hospital

Jesse Robbins, Architect, Freeman French Freeman

Doug West, Facilities Manager , Rumford Hospital

VI. RECOMMENDED STEPS FOR FLOORING SUCCESS

One of the main purposes of this research effort was to capture lessons learned from people who had used rubber, polyolefin and linoleum in order to share them with other hospital design stakeholders. From the case study interviews, we gleaned some lessons that should help you succeed with your resilient flooring choices.

1. **Determine the needs:** Before making a decision on what material to use, talk to the end users and find out what their needs are - for example, the performance requirements for the space, the ability for maintenance to get in and have access for cleaning, and the look that they want. See Table 3 for a quick guide to which materials help meet specific goals.
2. **Touch and test samples:** Obtain samples that people can see and feel and, if possible, install a small area of multiple types of flooring for users to evaluate. Put some of your tougher staining substances on the product and let them sit for an hour before cleaning to evaluate stain resistance.
3. **Do your research:** Get the manufacturer to provide references for other hospitals that have used the product in a similar application. Call those other hospitals and get feedback from clinicians, environmental services and the facility manager. Go and visit, if possible, to see the floor firsthand. Ask your insurance company to test the coefficient of friction for the material when it is dry, wet and when freshly finished to see if the product will provide you with a safe environment.
4. **Make an inclusive decision:** Narrow the selection down based on the information and feedback gathered in the previous steps. Involve select, key people from the affected departments in the final decision.
5. **Ensure a quality installation:** Set clear guidelines for preparation of the subfloor to create the conditions needed for the specified flooring material. Check the qualifications and experience of the installer and verify references and feedback from the other projects they have done. Allow adequate time in the construction schedule for acclimatizing the building before installation. After installation, allow the required amount of time before permitting traffic into the area.
6. **Inform the stakeholders:** Make sure environmental services staff are trained in the proper maintenance procedures and have the appropriate equipment and supplies. Educate the clinical staff about the flooring choice and what they should expect in terms of the cleaning protocol.
7. **Measure the results:** Check in with the environmental services department and clinical staff to document their impressions of the floor after several months in service. Track any impacts such as comfort, acoustics, falls or reduced maintenance costs that were anticipated.
8. **Institutionalize the findings:** Based on the performance of the flooring material, make changes to the system standards and procedures so that other facilities or future projects in the same system can benefit from your experience.

Table 3: Flooring Selection Guide: Which Materials Can Best Help Meet Specific Goals

Aesthetics	Downtime	Comfort Underfoot	Initial Cost	Infection control	Life cycle cost	Sustainability	Health
Polyolefin	Rubber Polyolefin	Rubber Linoleum	VCT Sheet Vinyl	Rubber Linoleum	Linoleum Rubber Polyolefin	Linoleum	Linoleum

VII. CONCLUSION

Hospital flooring is a very important and visible aspect of the healthcare environment. It can contribute to a positive experience when done well, or can result in problems and negative impressions when done poorly. The willingness of so many people to complete the online survey and to share their stories with us during phone interviews attests to how much interest there is in the topic. Hospital personnel feel that flooring is critical to making a good impression on visitors and do not want to take any chances when specifying flooring, since the costs from flooring failures are high. Hospital floors have to withstand heavy traffic and are expected to look attractive for many years. Problems with flooring materials not adhering to the floor can result in tripping hazards, creating an unsafe environment. Making repairs or replacing a bad floor is not always feasible given the fact that hospitals are open around the clock.

There are multiple decision drivers for flooring selection, and they vary by stakeholder type. Of the many factors that go into a flooring decision, the priority issues that were identified in our research were cleanability, aesthetics, durability and initial cost. A review of the survey data by respondent type revealed that architects, installers and facility managers are concerned with different issues, which may drive these players to different decisions when presented with the same information about flooring products. Architects and specifiers most often spoke about a product's cleanability, aesthetics and sustainability. Installers were more likely to be concerned with initial and lifecycle cost, as well as durability and cleanability. For facility managers and users, cleanability was overwhelming important, though initial cost and durability also showed up as important considerations for them. It is important to keep these perspectives in mind when communicating the advantages of new resilient flooring options to the different stakeholder groups.

While sustainability is on the minds of many people in health care design, it is interesting to note that it was predominantly architects that spoke about sustainability as a factor in flooring specification. The growing awareness of sustainability as important to health care may be influencing decision making, but it does not appear to be driving flooring decisions to products with the best overall sustainability rating. This may be a result of the complexity of both sustainability and the built environment.

The term sustainability may be used differently by health care stakeholders than it is by sustainable material advocates. During the research, we learned that important drivers were operating costs, durability and patient and staff safety, which may be how hospitals frame sustainability, rather than focusing on the upstream and downstream impacts. As we analyzed the survey results and talked to different stakeholders, we came to understand that sustainability is of growing importance to healthcare, but it means different things to the various people involved in making healthcare facility decisions. People talked about worker health and safety, and about making the hospital environment more pleasant. While architects were more likely to select 'sustainability' as an attribute, this doesn't mean that it was not important to installers, facility managers and other users. When talking to people for the case studies, many different aspects of sustainability came up, although people didn't always frame it in terms of sustainability. Sustainability around resilient flooring includes consideration of the following:

- Indoor air quality from cleaning chemicals
- Cleaning procedures and back injury
- Working with harsh chemicals
- Risks of slip and falls
- Cost of ongoing maintenance
- Worker comfort
- Noise reduction

It is also difficult to determine whether or not hospitals are making sustainable flooring choices, because there are no clear winners. There are conflicting messages in the marketplace and tradeoffs between different aspects of sustainability such as energy consumption, health impacts and recycled content that make it impossible to choose a truly sustainable flooring product. The overall message from the survey and case studies is that while vinyl flooring products are still being used by a majority of facilities, many hospital facility professionals view these products as unsustainable and are using alternative materials in many new projects and parts of the hospital.

Perhaps the most important conclusion that we can draw from our research is that rubber, linoleum and polyolefin have been successfully used in hospitals and are good resilient flooring options for those environments. Over 85% of the people surveyed who had previously used the three green alternatives are open to using them in the future, and over 50% of those people will *most likely* use rubber, polyolefin and linoleum again. The success of a flooring installation depends on many factors, not just the material itself. To be successful, the floor needs to be approached as a system, with all components of the system handled properly. This means selecting the right product for the right application, properly preparing the floor before installation, hiring skilled installers, and using recommended maintenance protocols to keep the floor looking its best. When all parts of the system are done correctly, rubber, linoleum and polyolefin flooring materials perform well and make excellent choices for hospitals.

Limitations and Future Research Needs

While we learned a great deal about the perceptions and experiences stakeholders have had with resilient flooring materials in hospitals, there are some limitations to our research that leave some questions unexplored. There was little participation in the survey by installers. Only 87 out of 689 people that started the survey were installers, and at least 10 of those installers indicated that they only install ceramic tile. This suggests that we were not able to tap into enough installers and perhaps did not reach the right group of installers. Since installation was identified as a critical element in a successful resilient flooring project, it would be very useful to get feedback from installers and give them an opportunity to speak to the challenges and keys to success. Future research into resilient flooring should focus on getting installers involved in the conversation.

The research findings also suggest that there is not a shared understanding of sustainability in the flooring community. We did not provide a definition of sustainability in the survey or during the case study interviews. As a result, it is difficult to interpret the results. Sustainability is a complex concept that encompasses many issues. Instead of providing a standard definition of sustainability, it would be useful to explore what the term means to the different hospital design professionals. Follow-up research could then be conducted to understand which components of sustainability resonate with the different flooring stakeholders.

Additionally, it would be valuable to further clarify metrics, or ways to measure, how different flooring choices impact staff and patient safety and health. Based on anecdotal evidence collected in this study, and identified in the paragraphs on sustainability above, such impacts may include improved worker and patient comfort; reduced fatigue; reduced risk of slips, trips and falls; reduced perception of noise; and reduced symptoms or impacts from the use of, or reduction in use of, harsh cleaning chemicals. Such impacts are potentially very significant in the health care environment, where workers and patients may be exposed to health or safety risks as a result of exposure to cleaning chemicals correlated with asthma and other illnesses, a noisy atmosphere, and hard flooring surfaces. It would therefore be valuable to identify the most relevant metrics for measuring these impacts, and then undertake a study to collect such data in a systematic and quantitative manner at hospitals that are installing these types of flooring.

A. APPENDIX

The survey on the next page was developed based on background research and feedback from pilot testers. It was designed with 3 tracks tailoring the questions slightly to capture input from specifiers, installers and flooring users. The first question determined which set of questions was most appropriate for the particular respondent to route them to questions relevant to their role. Respondents that selected 'other' were routed to the user or facility manager set of questions as this was the most comprehensive set of questions. The survey then asked a series of questions about all of the materials (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) that a respondent had used.

A list of flooring attributes was developed to describe possible positive and negative attributes. The attribute list was intentional kept neutral in order to avoid biasing answers. The attributes were organized in alphabetical order, with the exception of 'none' and 'other' which were listed last. At every point in the survey where we say "Attribute List" we had the following list of options:

- Acoustics
- Aesthetics
- Antimicrobial properties
- Cleanability
- Comfort underfoot
- Durability
- Infection control
- Initial cost
- Installation requirements
- Life cycle cost
- Odor
- Product quality
- Repairability
- Rolling resistance
- Safety
- Stain resistance
- Sustainability
- None
- Other

The survey was administered electronically through the SurveyMonkey website, and was distributed via the Practice Greenhealth and *Green Guide for Health Care*™ email lists, reaching over 30,000 people. The survey was available for two weeks, from March 8 to March 22, 2010. The respondents could be anonymous or could voluntarily provide their contact information if they were willing to be contacted for a follow-up interview or case study.

To avoid duplicating questions asked of all the respondent tracks, the questions below are coded according to the tracks (S = Specifiers, I = Installers, and U = Users). If a question is not marked with the code for a specific track that indicates that the question was not included in that track. Where the wording of the question varies, the different questions are grouped together and labeled, with the response options following the group of questions. Survey ▶

SURVEY

1. (S,I,U) In order to direct you to the most appropriate set of questions, please select the answer below that best describes your role related to hospital flooring materials.

   ☐ Architect or Interior Designer [SPECIFIERS TRACK]

   ☐ Flooring Installer or Contractor [INSTALLERS TRACK]

   ☐ Facility Manager or Environmental Services [USERS TRACK]

   ☐ Other (please specify) [USERS TRACK]

Question 2 was repeated for each material, and based on the answer respondents were either given the abbreviated or detailed questions for that material before moving on to the next material.

2. (S)Have you specified (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring for a hospital application in the past 5 years?

   (I)Have you installed (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring in a hospital in the past 5 years?

   (U)Has your hospital system installed (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring in the past 5 years?

   ☐ Yes [QUESTIONS 5 THROUGH 24, THEN BACK TO 2 FOR NEXT MATERIAL]

   ☐ No [QUESTIONS 3 AND 4, THEN BACK TO 2 FOR NEXT MATERIAL]

   ☐ Don't Know [QUESTIONS 3 AND 4, THEN BACK TO 2 FOR NEXT MATERIAL]

3. (S,I,U) Your opinion or perception of (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring is generally:

   ☐ Positive

   ☐ Neutral

   ☐ Negative

   ☐ No opinion

   (S)Please explain why you haven't specified it:

   _____

   (I)Please explain why you haven't installed it:

   _____

   (U)Please explain why your institution hasn't used it:

   _____

4. (S)How likely are you to specify (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring in the future?

   (I)How likely are you to install (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring in the future?

   ☐ Definitely

   ☐ Most likely

   ☐ Maybe

   ☐ Not likely

   ☐ Definitely not

5. (S,I)In the typical project where you specified (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) what was the approximate total square footage of (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl)?

   _____

   ☐ Don't know

6. (S)In which spaces have you specified (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring? Choose all that apply:

   (U)Where in your facility do you have (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring? Choose all that apply:

   ☐ Lobby

   ☐ Patient rooms

   ☐ Hallways

   ☐ Operating rooms/Emergency rooms

   ☐ Nurse's stations

   ☐ Waiting rooms

   ☐ Stairs/Stairwells

   ☐ Other (please specify)

7. (S, I, U)Please list the brands or manufacturers of POLYOLEFIN flooring you have used: *Question only included for Polyolefin*

8. (U)If the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring was installed as part of a renovation project, did it replace VCT or sheet/solid vinyl flooring?

   ☐ yes

   ☐ no

   ☐ don't know

   ☐ not applicable

9. (S, I, U)When thinking about (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl), what do you consider to be the most *positive* attributes? Please rank the top three:

   (Asked to Select 3 from the Full Attribute List Provided on page 47)

10. (S, I, U)When thinking about (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl), what do you consider to be the most negative attributes? Please rank the top three:

    (Asked to Select 3 from the Full Attribute List Provided on page 47)

11. (S, I, U)Have you experienced any of the following problems with (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring? Choose all that apply:

    ☐ Adhesion

    ☐ Bubbling

    ☐ Cracking

    ☐ Discoloration

    ☐ Rips and Tears

    ☐ Rolling

    ☐ Shrinkage

    ☐ Warping

    ☐ No problems

    ☐ Other (Please specify)

12. (S, I, U)If you experienced any problems with (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl), were they able to be resolved to result in a successful installation?

    ☐ Yes

    ☐ No

    ☐ Don't Know

    ☐ No problems

13. (S)Overall, has (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring met your expectations in terms of performance?

    ☐ Yes

    ☐ No

    ☐ Don't Know

14. (S)Overall, have your clients been satisfied with the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring?

    ☐ Yes

    ☐ No

    ☐ Don't Know

15. (S, U)Have staff, patients or family members commented about any of the following issues as BENEFITS due to the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring? Choose all that apply:

    (Asked to Select 3 from the Full Attribute List Provided on page 47)

16. (S, U)Have staff, patients or family members commented about any of the following issues as PROBLEMS due to the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring? Choose all that apply:

    (Asked to Select 3 from the Full Attribute List Provided on page 47)

17. (U)Did you conduct any educational or marketing efforts to promote the integration of the new (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring material?

    ☐ Yes

    ☐ No

    ☐ Don't Know

18. (U)Have you collected any metrics or data about the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring? (Satisfaction, cost, benefits, etc)

    ☐ Yes

    ☐ No

    ☐ Don't Know

19. (U)To your knowledge, have any of the following been issues with maintenance of the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring? Choose all that apply:

    ☐ Use of incorrect chemicals

    ☐ Harshness of chemicals

    ☐ Use of improper cleaning protocol

    ☐ Need for special equipment

    ☐ Need for repairs

    ☐ Shut-down time

    ☐ Maintenance staff's lack of familiarity/knowledge

    ☐ Complaints about cleanliness

    ☐ No problems

    ☐ Other (Please specify)

20. (U)To your knowledge, has the maintenance staff had to take/establish training sessions in order to deal with the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring?

    ☐ Yes

    ☐ No

    ☐ Don't Know

21. (U)To your knowledge, has the (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring had any impact on the maintenance staff's workload?

    ☐ Increased the workload

    ☐ Decreased the workload

    ☐ No impact on workload

    ☐ Don't know

22. (S)How likely are you to specify (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring in future projects?

    ☐ Definitely

    ☐ Most likely

    ☐ Maybe

    ☐ Not likely

    ☐ Definitely not

23. (I)How likely are you to continue installing (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring in future projects?

_____

24. (U)How likely are you to continue using (rubber, rubber/cork, polyolefin, linoleum, VCT, sheet/solid vinyl) flooring in future projects?

- ☐ Definitely
- ☐ Most likely
- ☐ Maybe
- ☐ Not likely
- ☐ Definitely not

The Following Questions Were Only Asked Once Per Survey

25. (S)In approximately what percentage of your hospital projects in the past 5 years have you specified rubber, rubber/cork, polyolefin or linoleum flooring?

(I)In approximately what percentage of your hospital projects in the past 5 years have you installed rubber, rubber/cork, polyolefin or linoleum flooring?

(U)Approximately what percentage of your hospital flooring surfaces are rubber, rubber/cork, polyolefin or linoleum?

- ☐ 0%-25%
- ☐ 26% - 50%
- ☐ 51%-75%
- ☐ 76%-100%
- ☐ Don't Know

26. (S)Aside from rubber, rubber/cork, polyolefin, linoleum, VCT and sheet vinyl, have you specified any of the following flooring materials in a hospital application in the past 5 years?

(I)Aside from rubber, rubber/cork, polyolefin, linoleum, VCT and sheet vinyl, have you installed any of the following flooring materials in a hospital application in the past 5 years?

(U)Aside from rubber, rubber/cork, polyolefin, linoleum, VCT and sheet vinyl, has your hospital system installed any of the following flooring materials in a hospital application in the past 5 years?

- ☐ Concrete
- ☐ Terrazzo
- ☐ Cork
- ☐ Ceramic Tile
- ☐ Carpet
- ☐ Wood
- ☐ None
- ☐ Other (please specify)

27. (S, I, U)If you have additional comments to share about your experiences with resilient flooring materials, please write them below:

_____

_____

_____

_____

_____

28. (S, I, U)As part of this HCWH Research Collaborative funded project, the Research Team will be conducting a series of in-depth interviews and case studies. If you authorize the team to contact you, please submit your contact information below; this is strictly voluntary. Your survey responses will always be kept confidential and will not be attributed to you in any reports.

Name _____

Organization _____

_____

Position _____

E-mail address _____

_____

Phone _____

REFERENCES

1 Polyolefin polymer flooring is often made from mixtures of polyethylene and polypropylene. Examples include Stratica by Amtico, Lifeline by Upofloor, WELS by Ceres and FreiFloor by Allstate.

2 "Resilient Flooring & Chemical Hazards: A comparative analysis of Vinyl and Other Alternatives for Health Care" is available at www.noharm.org/us_canada/reports/researchcollaborative.php

3 Polyolefin polymer flooring is often made from mixtures of polyethylene and polypropylene. Examples include Stratica by Amtico, Lifeline by Upofloor, WELS by Ceres and FreiFloor by Allstate.

4 "Resilient Flooring & Chemical Hazards: A comparative analysis of Vinyl and Other Alternatives for Health Care" is available at www.noharm.org/us_canada/reports/researchcollaborative.php

5 Barnes, S. (1998). Life-Cycle Benefits of Flooring Surfaces in Health Care.

6 Malick, P. (2007). Big Choices Under Foot. *Health Facilities Management*, *20*(8), 33-37.

Dellinger, B. A. (2008). Floor Show. *Health Facilities Management*, *21*(8), 25-28.

7 Eagle, A. (2008). Fantastic Flooring. *Health Facilities Management*, *21*(6), 24-28.

Malick, P. (2007). Big Choices Under Foot. *Health Facilities Management*, *20*(8), 33-37.

8 Imhoff, Bill. "The Fly in the Concrete: Coal Fly Ash in Cement Bring Green Value – and flooring challenges," PlantServices.com, accessed October 7, 2010 at http://www.plantservices.com/articles/2010/05FlyAshConcrete.html?page=1

9 http://www.rumfordhospital.org/about-history.html accessed 4/24/10

Health Care Without Harm (www.noharm.org)
Healthier Hospitals Initiative (www.healthierhospitals.org)
12355 Sunrise Valley Dr., Suite 680
Reston, VA 20191

Environmental and Occupational Health Sciences
University of Illinois at Chicago School of Public Health
835 S. Wolcott, Suite E-144, MC 684
Chicago, IL 60612

Georgia Institute of Technology
College of Architecture (www.coa.gatech.edu)
245 4th St. NW
Atlanta, GA 30332-0155