



“Greening the Dental Clinic”

Pursuit of Sustainability at the University of Michigan School of Dentistry

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Developing recommendations to help dental clinics transform patient care and achieve sustainability through cultural, operational, and infrastructural changes while stewarding our environment.



DOW SUSTAINABILITY FELLOWS
UNIVERSITY OF MICHIGAN

TABLE OF CONTENTS

EXECUTIVE SUMMARY	i
1. Literature Review	i
2. Case Study of the University of Michigan School of Dentistry (UMSOD) Student Clinics.....	i
3. “Greening the Dental Clinic” Toolkit.....	ii
Conclusions	iii
I. INTRODUCTION.....	1
II. LITERATURE REVIEW	2
Defining Sustainability	2
Environmental Sustainability in Health Care	3
The Field of Dentistry: Changing Demographics and Opportunities for Sustainability	3
Greening the Dental Clinic: Conceptual Framework	5
III. UNIVERSITY OF MICHIGAN SCHOOL OF DENTISTRY (UMSOD) – CASE STUDY	7
UM Dental Clinic Redesign	7
Background on the UMSOD Student Dental Appointment Format	7
Pre-Survey	8
Educational Intervention.....	8
Post-Survey and Analysis	9
Outcomes and Impact	10
IV. “GREENING THE DENTAL CLINIC” TOOLKIT.....	12
Lessons from “Greening the OR”	12
DOMAIN 1: Organizational Development	13
DOMAIN 2a: Waste Reduction and Prevention	18
DOMAIN 2b: Mandatory Waste Reduction and Regulation.....	20
DOMAIN 3: Environmentally Preferred Purchasing	22
DOMAIN 4: Built Environment.....	24
V. LOOKING TO THE FUTURE	30
VI. CONCLUSION	34
APPENDIX A: Biophilic Design Patterns & Biological Responses	A1
APPENDIX B: Biophilic Design Attributes and Pattern Descriptions.....	B1
APPENDIX C: Greening the Dental Clinic Toolkit.....	C1
APPENDIX D: Unpacking the Toolkit.....	D1

EXECUTIVE SUMMARY

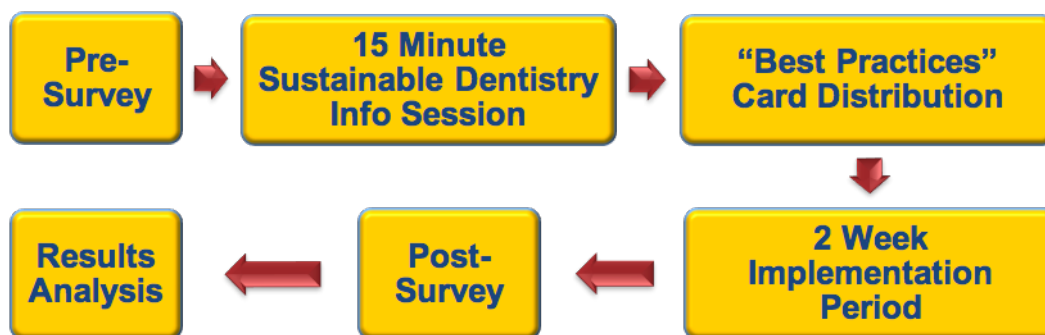
Our Dow Masters project addresses the dearth of research on sustainability within the field of dentistry and includes three separate components: a general literature review; a case study of the University of Michigan School of Dentistry (UMSOD) dental clinics; and the design of an online toolkit for dental providers.

1. Literature Review

Our team reviewed data on the current state of the dental profession in the United States including sustainability regulations, demographics and case studies of successful sustainability initiatives. Key findings included:

- Minimal federal or state-level regulation exists governing the environmental impact of dentistry. The only relevant EPA document is a non-binding Memorandum of Understanding jointly released with the American Dental Association in 1998, primarily addressing the disposal of amalgam waste.
- Community dental clinics are shifting to more open-air, standardized models rather than single-owner proprietors.
- Dental professionals of the baby boom generation are retiring and being replaced with young graduates, shifting the profession to a younger demographic.
- All examples of successful sustainable dental clinics represent ad hoc solutions to sustainability rather than an organized effort across the profession

2. Case Study of the University of Michigan School of Dentistry (UMSOD) Student Clinics



The UMSOD has secured funding and initiated the process of redesigning the student clinics. We have partnered with the dental school to provide specific recommendations on minimizing the environmental impact of the current clinics, as well as how to incorporate sustainable design into the future renovation. In order to assess current student attitudes toward sustainability as well as individual

student waste generation in the clinic setting, we implemented a case study as illustrated in the figure above. We obtained results from 142 third year UMSOD students through the following process:

- a. A *pre-survey* assessed current attitudes toward sustainability and waste generation in the clinic
- b. An *information session* provided students with simple suggestions to minimize waste generation in the clinic. Each student was provided with a “*Best Practices*” card to remind them how to improve their environmental impact in the clinic without compromising patient care.
- c. After a *two-week trial* of implementing the suggested changes in the clinic, students completed a second *post-survey* to assess any potential changes in their attitudes, materials usage and waste generation.

Our case study demonstrated noticeable changes in material usage levels by surveyed students across four key categories: gloves, masks, paper sheets, and protective blue tape. Study opinions were also documented, indicating that 74% of students believe that environmental sustainability was important to them personally and a large majority believed that environmental sustainability could be incorporated to higher levels in the UMSOD clinic. However, a number of students indicated some concern regarding increased time constraints by incorporating sustainable practices into their preparation and cleanup processes.

3. “Greening the Dental Clinic” Toolkit

Organizational Development	
<input type="checkbox"/>	Identify potential partners and build a “Green Team” specific to the Dental Clinic
<input type="checkbox"/>	Train staff on use and collection of reusable materials
<input type="checkbox"/>	Track improvements and recognize successes
Waste Reduction and Prevention	
<input type="checkbox"/>	Conduct a waste audit to identify largest sources of waste
<input type="checkbox"/>	Implement processes for recycling as much as possible
<input type="checkbox"/>	Utilize reusable materials whenever/wherever possible (i.e. stainless steel suction tips/air water syringe tips, washable bibs, reusable protective eyewear)
Environmentally Preferred Purchasing	
<input type="checkbox"/>	Use digital dentistry systems to reduce waste
<input type="checkbox"/>	Use non-toxic autoclaves and instrument/surface disinfectants
<input type="checkbox"/>	Use interactive patient education tools to enhance dental experience to expand patient base over

	time
Built Environment	
<input type="checkbox"/>	Utilize lighting occupancy sensors to reduce energy use in unoccupied rooms
<input type="checkbox"/>	Employ LED lighting to reduce energy use
<input type="checkbox"/>	Incorporate natural design elements like plants, artwork, or structural elements
<input type="checkbox"/>	Employ ceiling fans to circulate air, reduce energy use and improve occupant comfort

Taken together, the general literature review and the UMSOD case study enabled us to develop recommendations for dental clinics seeking to incorporate sustainability into their mission and daily workflow. In order to distribute these recommendations in an accessible format, we developed a *Greening the Dental Clinic Toolkit*, using Practice Greenhealth’s “Greening the OR” toolkit as a model. A small excerpt of the toolkit is pictured above. Our recommendations were broken down into the following four categories:

- a. *Organizational Development* - developing the work atmosphere and stated values of the dental clinic to foster environmental sustainability among both employees and patients
- b. *Waste Prevention* – incorporation of reusable materials and minimization of waste generation
- c. *Environmentally Preferred Purchasing (EPP)* – selection of products used in the daily workflow of the clinic based on complete life cycle analyses with minimal environmental impact
- d. *Built Environment* – design of infrastructure and energy usage

Conclusions

Although sustainability is a largely untouched topic within dentistry with minimal literature or regulations addressing this issue, the shifting demographics of the field provide an opportunity for implementing systemic change. Dental providers seeking to incorporate sustainability into their daily practice can utilize the *Greening the Dental Clinic toolkit* as a resource and starting point for transformational change in their workplace.

I. INTRODUCTION

Our Dow Masters project encompasses three components that address the dearth of research on sustainability in the dental literature. Despite the increasing recognition and implementation of sustainable practices across the corporate sector and the visibility of environmental issues in the news over the past decade, sustainability has yet to become a priority in the fields of healthcare and dentistry within the United States. Furthermore, the overwhelming majority of U.S. health-related research pertains to hospital systems and operating rooms, while the awareness surrounding sustainability in dentistry is almost nonexistent. Thus, the first component of our project is a literature review that assesses current attitudes towards sustainability within the national and global dentistry community. The review also includes data on average material usage within dental clinics and shifting demographics in the field.

The second component of our project is a case study of third year dental students at the University of Michigan School of Dentistry (UMSOD), which evaluates the current state of sustainability within the school's dental clinic and the students' attitudes toward incorporating new practices to improve the clinic's environmental impact.

Taken together, the results of our literature review and UMSOD case study suggest that shifting demographics and attitudes within the dental industry may be increasingly conducive to incorporating sustainable practices and products into the operations of the average dental clinic. However, clinicians have few formal resources available to them discussing how to implement sustainable practices. The third component of our project addresses this need. Our "Greening the Dental Clinic toolkit", modeled off the "Greening the Operating Room (OR)" movement launched by Practice Greenhealth, is a practical resource for dental clinicians looking to "go green". The OR is a useful model because, like operating rooms, dental clinics are relatively uniform in their setup and materials usage within a single institution, enabling uniform implementation of cost-saving, "green" changes.

Ultimately, the three components of this Dow Masters project included our literature review, UMSOD case study, and comprehensive toolkit will inform the growing discussion on sustainability in healthcare and provide a useful starting point for dental students, educational institutions, and clinics interested in integrating sustainability into dental care.

II. LITERATURE REVIEW

Defining Sustainability

The first challenge in conceptualizing the scope of this project is defining “sustainability.” When the term arises in the context of healthcare, it typically refers to the unsustainable rising financial costs of our healthcare system. According to the Centers for Disease Control and Prevention, in 2014 National Health Expenditures (NHE) totaled 17.5% of the United States’ Gross Domestic Product, or roughly \$3 trillion.[1] Furthermore, as of 2014, the U.S. health care industry spent \$6.5 billion annually on energy costs.[2]

In the *Triple Bottom Line* theory of sustainability, financial sustainability is seen as inexorably intertwined with social and environmental sustainability. This accounting and supply chain management theory was first coined in 1994 by John Elkington, the founder of a British environmental consulting agency in his paper entitled “Cannibals with a Fork.” In his seminal work, Elkington argued that companies should be preparing three different (and quite separate) bottom lines.

“One is the traditional measure of corporate profit—the “bottom line” of the profit and loss account. The second is the bottom line of a company’s “people account”—a measure in some shape or form of how socially responsible an organization has been throughout its operations. The third is the bottom line of the company’s “planet” account—a measure of how environmentally responsible it has been. The triple bottom line (TBL) thus consists of “three Ps”: profit, people and planet. It aims to measure the financial, social and environmental performance of the corporation over a period of time. Only a company that produces a TBL is taking account of the full cost involved in doing business.”[3]

It is with this conceptual framework of sustainability that we approached the question of environmental sustainability in healthcare, and specifically within dentistry. Broadly, projects to “green” our medical institutions (meaning make their goods and services more environmentally sustainable), have the potential to improve all aspects of the triple bottom line.

“Sustainability can improve population health by contributing to healthier communities, reducing pollution and reducing the use of community resources such as water and energy. Sustainability can contribute to a better patient experience by improving a hospital’s environment and public perception and by promoting loyalty among patients concerned about the environment. Finally, sustainability can reduce the per capita cost of health care by reducing health care expenses; for example, spending less money on utilities enhances hospitals’ ability to free up resources for patient care.”[4]

Environmental Sustainability in Health Care

With the constant pressure to provide high quality patient care in an efficient manner taking precedence, sustainability is understandably a low priority in the minds of most health and dental care providers. As explained by one U.S. surgeon, “...being green is not going to be at the forefront of my daily existence, so the only way to keep it a priority is to keep putting it in front of me and my peers.”[5] However, data from isolated hospitals and medical institutions that have integrated environmental sustainability into their missions suggests that sustainability can be made a priority without compromising patient care. In fact, most documented case studies of hospitals and medical clinics who have undertaken green initiatives have demonstrated cost-neutral or cost-savings outcomes.[6]

In the U.S., the approach to environmental sustainability has been piecemeal. The regulatory regime, where environmental regulation of healthcare is divided among organizations like the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Department of Health & Human Services (HHS), among others, reflects the decentralized nature of this approach. Compulsory regulation regarding environmental standards in the medical field has been minimal. In 1998, the EPA issued a Memorandum of Understanding (MoU) in conjunction with the American Hospital Association (AHA) that established broad goals for improving the environmental impact of healthcare practices including reducing waste production, minimizing mercury waste and encouraging the growth of leadership in this field. While it outlined a partnership between two powerful regulatory bodies, this MoU did not establish specific standards or set up policies for enforcement where hospitals are noncompliant.

To address the lack of governmental guidance, nonprofit organizations such as Practice Greenhealth[7] and Health Care Without Harm[8] offer voluntary membership to institutions interested in codifying their commitment to sustainability and provides best practices guidelines, as well as other educational tools. These organizations often sponsor conferences, host trainings, and generally provide much needed platforms for engagement among like-minded institutions.

The Field of Dentistry: Changing Demographics and Opportunities for Sustainability

When we narrowed our focus within health care to sustainability within dentistry specifically, we found that the current body of literature and case studies of successful initiatives was even sparser. In the few studies that address environmental sustainability in dentistry, the term “eco-friendly dentistry” is often used. The term was originally “coined and trademarked by the founder of Ora Dental Studio,[9] the nation’s first green group dental practice.”[10] Other individual green clinics have also been documented, including Front Street Dental in Ontario, Canada owned by Dr. Ali Farahani, a leader in the eco-friendly

dentistry movement.[11] Dr. Farahani, in particular, has been vocal about his eco-friendly approach to dentistry and published the recommendations he developed for greening the dental clinic. Subsequent studies have drawn heavily from his recommendations.[12]

Most of Dr. Farahani's suggestions address selection of building materials and dental instruments with less environmental impact and techniques for reducing the production of waste in the daily operation of a dental clinic.[13] Rather than publishing their own recommendations, Ora Dental Studio adapted the Green Guide for Health Care to the dental setting, which were developed by the Health Care Without Harm collaboration and also address green infrastructure and products.[14]

While these limited resources do not offer data on the cost-saving potential of introducing sustainable practices and products, our findings from surveys of average clinical practices and supply usage at the UM Dental School suggest that larger, multisite clinics or educational institutions could potentially save tens of thousands of dollars per year simply by limiting unnecessary use and disposal of products and purchasing reusable products. While the savings at a smaller scale, sole proprietorship will be less dramatic, they may still be significant. A 2009 American Dental Association (ADA) survey on private practice dental expenses found that dentists spend an average of 6-7% of their annual budget on dental supplies alone, which often constitutes the largest expenditure outside of personnel expenses.[15] If the average incorporated clinic has total expenses of roughly \$600,000 per year, then supplies could constitute anywhere from \$36,000-\$42,000 per year. Using reusable supplies could reduce these costs, while taking other sustainability initiatives such as limiting water and electricity usage could reduce utility charges.

Relatively few resources on environmental sustainability in dentistry currently exist, but shifting demographics and attitudes in the field could create increased interest in this area. For example, surveys of the dental industry demonstrate that the number of multisite dental clinics (rather than single-site, sole proprietorships) has increased almost twenty-fold since 1992.[16] This shift in dental operation classification could allow for increased cost-savings and easy streamlining of sustainable practices due to economies of scale.

Furthermore, there is a common perception in the field of dentistry that the dental workforce is quickly approaching a dentist retirement "cliff" – i.e. that due to the impending retirement of many dentists of the baby boomer generation, the dental workforce will soon face a drop in the number of dentists.[17] Economists have found that this forecast is unlikely to come true, rather the per capita supply of dentists is likely to increase.[18] This projected increase is in part attributable to rising enrollments in dental schools, which will in turn cause an influx of new, young dentists and a "de-aging" of the dental workforce.[19]

This “de-aging” is significant in terms of shifting attitudes toward sustainability among dentists and dental students because young adults are often more receptive to environmental concerns. For example, recent surveys have found that younger generations are more likely to overwhelmingly support increased investment in clean and renewable energy sources and are more likely to say that climate change is caused mostly by human activity.[20] Thus, it is likely that many dental students today view the use of sustainable practices and products in dental care more favorably than the generations before them.

Greening the Dental Clinic: Conceptual Framework

Although the literature on sustainability in dentistry is sparse, the broad themes can be leveraged to assist environmentally conscious dentists and dental seeking to minimize the environmental impact of his/her practice. With that ambitious objective in mind, we divided the potential areas for improvement into four categories:

1. Organizational Development - developing the work atmosphere and stated values of the dental clinic to foster environmental sustainability among both employees and patients
2. Waste Prevention – incorporation of reusable materials and minimization of waste generation
3. Environmentally Preferred Purchasing (EPP) – selection of products used in the daily workflow of the clinic based on complete life cycle analyses with minimal environmental impact
4. Built Environment – design of infrastructure and energy usage

This framework delineates the categories utilized in the “Greening the Dental Clinic” toolkit. Ideally, these proposed guidelines provide cost-savings without compromising clinical efficiency and quality patient care. These recommendations and the supporting data will be fully delineated in this white paper. However, our recommendations are also more easily accessible as an online version of the toolkit for dental providers interested in implementing eco-friendly changes in their own practice.

[1] Centers for Disease Control and Prevention. (Oct. 2016). *FastStats: Health Expenditures*. Retrieved from <http://www.cdc.gov/nchs/fastats/health-expenditures.htm>. See also Centers for Medicare & Medicaid Services. (Aug. 2016). *NHE Fact Sheet*. Retrieved from <https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/nationalhealthexpenddata/nhe-fact-sheet.html>

[2] Health Research & Educational Trust. (May 2014). *Environmental sustainability in hospitals: The value of efficiency*, 7. Retrieved from www.hpoe.org.

[3] Hindle T. (2009). Triple Bottom Line - It Consists of Three P's: profit, people and planet. *The Economist online*.

[4] Health Research & Educational Trust (2014), see *supra* n.2, at 7.

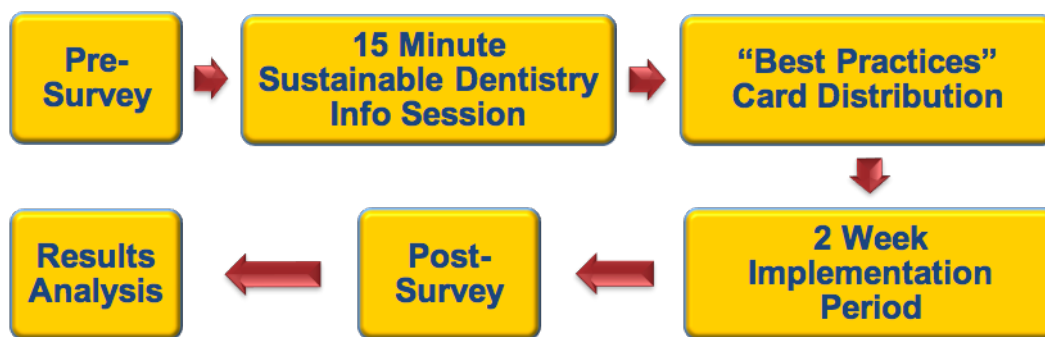
[5] Peregrin, T. (2015, May 1). *Strategies for Sustainability: Going Green in the OR*. Bulletin of the American College of Surgeons. Retrieved from <http://bulletin.facs.org/2015/05/strategies-for-sustainability-going-green-in-the-or/> (Quoting Dr. Tom Paluch).

[6] For example, both the Kaiser Permanente health system and the University of California, San Francisco provide models of broad, sweeping green initiatives that have generated significant cost-savings without diminishing the level of care provided. Smaller institutions including Spectrum Health in Michigan, Memorial Hermann Health System in Texas and Sullivan County Community Hospital in Indiana have successfully implemented narrower green initiatives with small cost-savings. (Boone, T.

- (Apr. 2012) Creating a Culture of Sustainability: Leadership, Coordination and Performance Measurement Decisions in Healthcare. *See also* Health Research & Educational Trust (2014)).
- [7] Practice Greenhealth. (2016). <https://practicegreenhealth.org/>
- [8] Health Care Without Harm. (2016). <https://noharm.org/>
- [9] Ora Dental Studio. (2016). *Environmental Stewardship*. Retrieved from <http://www.oradentalstudio.com/eco-friendly/stewardship.php>.
- [10] Avinash B, et al. (2013). Going Green with Eco-friendly Dentistry. *Journal of Contemporary Dental Practice* 14(4), 767.
- [11] Adams, E. (2007). Eco-friendly Dentistry: Not a Matter of Choice. *Journal of the Canadian Dental Association* 73(7), 581-84.
- [12] *See, e.g.,* McClea, P.T. et al. (2011). The environmental sustainability of dental practice. *New Zealand Dental Journal* 107(1), 24-26; Avinash et al. (2013), *supra* n.10.
- [13] Adams (2007), *supra* n.11
- [14] Green Guide for Health Care. (2016). <http://www.gghc.org/>
- [15] American Dental Association. (Aug. 2010). *2009 Survey of Dental Practice: Annual Expenses of Operating a Private Practice*. Retrieved from <https://www.ada.org/en>
- [16] Guay, A. D.M.D., et al.. (Feb. 2014). Research Brief: A Proposed Classification of Dental Group Practices. *Health Policy Institute of the American Dental Association*.
- [17] Vujicic, M. (2016). The De-Aging of the Dentist Workforce. *The Journal of the American Dental Association* 147(10), 843-45.
- [18] Munson, B. & Vujicic, M. (Oct. 2014). Supply of Dentists in the United States is Likely to Grow, *Health Policy Institute of the American Dental Association*, <http://www.ada.org/en/science-research/health-policy-institute/publications/research-briefs>.
- [19] Vujicic (2016), *supra* n.17.
- [20] Pew Research Center. (Nov. 2011). *The Generation Gap and the 2012 Election*. Retrieved from <http://www.people-press.org/2011/11/03/section-8-domestic-and-foreign-policy-views/>. *See also* Pew Research Center. (June 2014). *Beyond Red v. Blue: The Political Typology*. Retrieved from <http://www.people-press.org/2014/06/26/section-7-global-warming-environment-and-energy/>.

III. UNIVERSITY OF MICHIGAN SCHOOL OF DENTISTRY (UMSOD) – CASE STUDY

In order to both understand the perspectives and practices of aspiring dentists regarding sustainability and better inform our sustainability guidelines in the “Greening the Dental Clinic” toolkit, the authors utilized the UMSOD’s dental clinic as a case study. As future dental professionals, dental students are a prime audience to gauge attitudes and inform behavior within a clinic setting. Conducted in September 2016, the case study focused on a group of 142 third year UM dental students and included two surveys and educational interventions to inform student behavior. The below graphic illustrates the case study method employed by the authors.



UM Dental Clinic Redesign

The case study comes at an important time for the UMSOD. In September 2016, the UM Board of Regents approved a proposed redesign of the school. The \$122 million project will renovate approximately one-third of the existing building in areas with the highest priority and need. A new 31,000 square-foot addition will provide the school and its students with additional patient care areas.[1]

Administrators at the UMSOD have been supportive of implementing sustainable design in the new facility, making it an apt time to study current operations and thought related to sustainability at the school. We paid particular attention to the student clinic, where dental students perform a variety of procedures as part of their professional training and educational experience. This clinic resembles a typical community dental clinic in many ways.

Background on the UMSOD Student Dental Appointment Format

The UMSOD provides patient care in 20 clinics, four of which are undergraduate Vertically Integrated Clinics (VICs) and seven graduate clinics: endodontics, advanced general dentistry, oral surgery, orthodontics, pediatrics, periodontics, and prosthodontics. The UMSOD is open to the public; this includes both general public and faculty, staff and students. Treatment cost is typically less than in a

private dental practice, so the school often provides treatment to patients seeking low-cost care. There are currently 642 students, 120 full-time faculty and 320 full-time staff. The majority of students at the UMSOD are pursuing their Doctor of Dental Surgery (DDS) degree, which is a four-year program.

The case study focuses on the VICs clinics where third year dental students conduct appointments in uniform personal cubicles. Student providers have a responsibility to maintain cleanliness within the dental cubicle to protect themselves and the patients. The standard procedures are highlighted on the UMSOD website and supported by OSHA's Bloodborne Pathogens standard [2], and detailed steps are outlined for hand hygiene, use of personal protective equipment (PPE), safety while using sharps, safe injection practices, maintaining sterility of instruments, devices, and work areas. Focusing on PPE is integral to decreasing waste because face masks, gloves, and disposable goggles called "googles" are three major contributors to the waste generated during student appointments.

During an appointment, students are required to wear a facemask and gloves throughout the entirety to protect against exposure from infectious agents. The current guideline indicates that students need to replace their mask and gloves each time they leave and re-enter the cubicle, as well as between different patients.[3] In addition, dental student providers must wear protective eyewear to prevent exposure to blood, saliva and other microorganisms during the dental procedures.[3] The UMSOD provides students with protective eyewear called "googles," a clear, disposable shield that connects to a reusable plastic rim. However, the plastic shield is disposable and replaced after each appointment. While preventing infections and protecting patient and provider safety is paramount, improvements can be made to the student PPE while continuing to adhere to OSHA guidelines.

Pre-Survey

As the first component of the case study, we administered a survey to 142 third year dental students as a component of their Professionalism and Dental Practice course, taught by Dr. Mark Fitzgerald, to measure their attitudes towards sustainability, support of proposed clinic changes, and current material usage. In surveying material usage, we asked students to enter the amount of common materials they utilized during four of the most common procedures in the student clinic: exams and treatment plans, dental cleanings, restorations, and denture related procedures. The surveyed items included gloves, masks, protective blue barrier tape, and paper sheets, which contribute a large portion of the overall waste generated by the clinic.

Educational Intervention

To gauge whether students would be receptive to sustainability education and if it would have an impact on their material usage in clinic procedures, the authors conducted a 15-minute educational

session for the group of third year UM dental students Following the educational session, the authors provided dental students with a laminated “Best Practices” card (see below). The card contains tips for students to reduce their environmental impact during procedures and was designed to fit in a clinic coat so that students could carry it around as a reminder. The card contents can be found below:

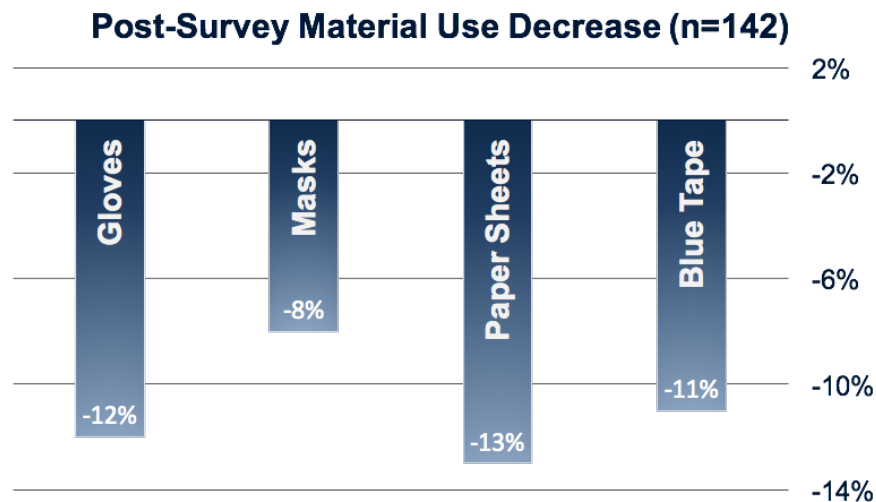
<p style="text-align: center;"><u>SUSTAINABILITY CHECKLIST</u></p> <p><i>Follow these tips to reduce your environmental impact in the VICs!</i></p> <p><u>Setting up the cubicle</u></p> <ul style="list-style-type: none"> • Plan ahead for the procedure. Know which materials you will need for all possible outcomes. Let's reduce waste by not creating it! • Bring reusable safety glasses for the patient to wear, thoroughly wipe down after each appointment. • Do not use paper on the bracket tray, only use the plastic sleeve. • Do not use 7 sheets of counter top paper, only take as many as you need to keep the counter protected from instruments and materials <p><u>During the appointment</u></p> <ul style="list-style-type: none"> • If your mask is not visibly soiled, save the mask on a clean surface in the cubicle before you leave and reuse. Replace after each patient. • Use the Faculty Request System (FRS) to its maximum potential--limiting the number times you leave the cubicle reduces glove and mask waste. • Reduce waste of materials: <ul style="list-style-type: none"> ○ Only take what you need. Don't take extra materials! ○ If something is sealed in plastic (impression trays, alginate packets), wipe it down and return to dispensing. <p><u>During Patient Interaction</u></p> <ul style="list-style-type: none"> • Encourage patients to turn the facet off while brushing teeth to save 8 gallons of water everyday and over 200 gallons every month!
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Post-Survey and Analysis

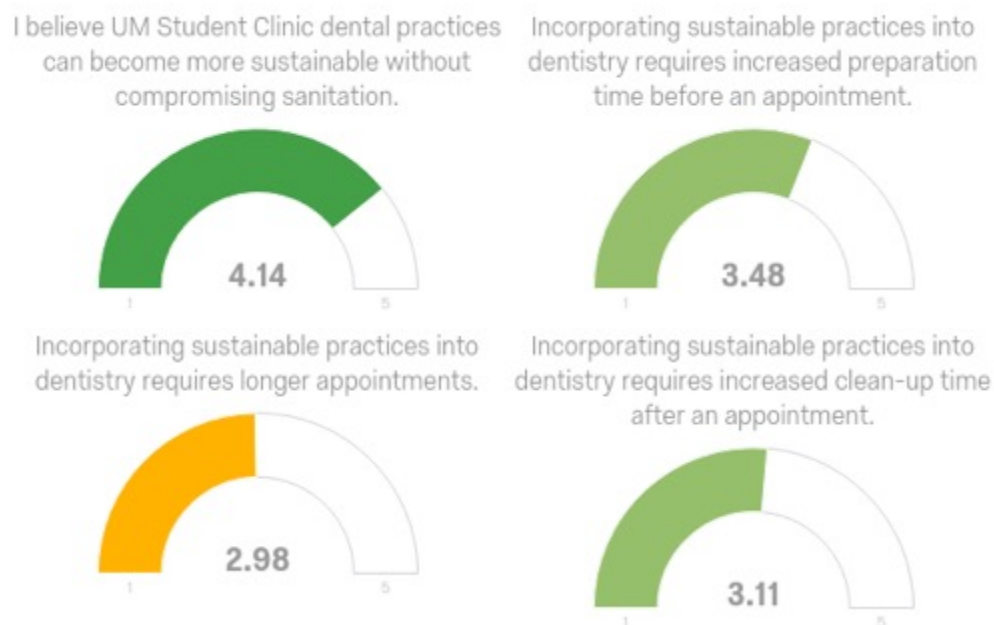
Two weeks following the educational intervention, students completed a second, identical survey in order to measure their material usage during the intervening two weeks. The results showed that students were receptive to the educational material and that it resulted in decreased material usage across several key categories. Seventy-four percent of students stated that environmental sustainability was important to them personally.

The below chart demonstrates noticeable changes in material usage levels by surveyed students across four key categories: gloves, masks, paper sheets, and protective blue tape. Additional charts found on the following page show that UMSOD students believed that environmental sustainability could be incorporated to higher levels in the UMSOD clinic. However, a number of students indicated some

concern regarding increased time constraints by incorporating sustainable practices into their preparation and cleanup processes.



Q: Rate how strongly you agree or disagree with the following statements. (n=143)



Outcomes and Impact

The results of this case study provided two major contributions to our Dow Masters Fellows project. First, the results informed our recommendations delineated in the “Greening the Dental Clinic” toolkit. Second, the survey and our financial analysis identified several key areas in which the UMSOD VICs can improve sustainability without compromising patient care or increasing costs. The school-

specific recommendations are described in this section because other dental schools could likely benefit from implementing similar initiatives.

The first recommendation is to eliminate the use of disposable safety glasses. Currently the school uses disposable “googles” to provide eye protection to patients as well as providers, amounting to approximately \$32,000 annually. The approximate cost to provide reusable safety glasses to patients and providers in VICs would range from \$750-\$1,000 and the payback time would be within one academic school year. Using our Dow Master Fellows project budget, we plan to provide all third year UMSOD students who participated in our team’s sustainability survey with reusable protective lenses, and the UMSOD is going to order reusable lenses for patients in the dental clinics.

Second, waste at UMSOD can be minimized by decreasing or eliminating extra packaging of materials. The school tends to purchase prepackaged, uni-dose products because most students are novice users, and to ensure that the materials are rotated properly to avoid expiration of products. Unfortunately, this extra packaging creates waste in the form of plastic bags, as well as unused materials. The estimated financial savings from removing the extra packaging of prophylaxis materials is approximately \$1,280 annually. Implementation of this change largely depends on the willingness of the school to teach students how to utilize bulk supplies without contaminating the stores, as well as staying up to date with inventory control.

Although we tailored these recommendations to the UMSOD, similar changes could be implemented in any dental school clinic, or even in a community setting.

[1] “University projects approved for capital outlay funding.” The University Record. Retrieved November 14, 2016, from <https://record.umich.edu/articles/university-projects-approved-capital-outlay-funding>

[2] Standards Precautions (2016). Retrieved November 8, 2016, from <https://umich-dent.wikispaces.com/Standard+Precautions>

[3] PPE (2016). Retrieved November 8, 2016, from <https://umich-dent.wikispaces.com/PPE>

IV. “GREENING THE DENTAL CLINIC” TOOLKIT

As mentioned above, the culmination of our literature review and UMSOD case study was the production of recommendations to assist dental professionals in implementing sustainable practices in their clinics. These recommendations fall into four categories: organizational development, waste prevention, environmentally preferred purchasing (EPP) and the built environment. The final product that incorporates these recommendations is the *Greening the Dental Clinic Toolkit* and its companion document *Unpacking the Toolkit*. Although a similar resource has been developed for improving the environmental impact in operating rooms (ORs), no such resource exists for dentistry.

Lessons from “Greening the OR”

The Greening the Operating Room (OR) Toolkit provided by Practice GreenHealth serves as a tool and endorsement program to identify hospitals adopting and continuously pursuing sustainable practices within their ORs. This tool provides clear guidance and ideas on what steps can be implemented to improve the environmental performance and allows knowledge sharing and continuous improvement among healthcare providers. It also provides case study data from multiple facilities that have implemented the toolkit’s ideas, helping support the economic, environmental and social benefits of a strong sustainability program. The Greening the OR Toolkit is still in the early stages of adoption within the healthcare industry, but with business and consumer interest gravitating towards sustainability, widespread implementation is likely a matter of time.

The Greening the OR Toolkit provided a foundation for our proposed Greening the Dental Clinic Toolkit (GDCT), as many of the considerations within operating rooms translate to all medical facilities. Dental clinic designs are less regulated and require different specialty equipment, but sanitation, waste management, user comfort, workplace culture and environmentally friendly purchasing considerations are consistent across both types of facilities. As a result, the Greening the OR Toolkit served as inspiration and a baseline for the GDCT. Individually, the GDCT is adaptable within large open-air dental clinics, private practices and dental schools. Ultimately, the availability of both these toolkits, and perhaps more

PRACTICE GreenHealth

Greening the Operating Room® Checklist

Hospitals rank among the largest users of energy, highest producers of waste and are a major consumer of chemicals, paper, water and other resources, resulting in an industry with a huge environmental footprint. In an effort to reduce the impact on the environment, healthcare organizations are asking for information on best practices, guidance in establishing green practices and methods to measure success. They are also asking for guidance on where to focus their efforts. As a primary source of hospital revenue, one of the largest users of supplies and generators of hospital waste, the operating room (OR) is a strategic priority for any hospital hoping to reduce its impact on the environment. This tool is designed to assist health care providers in assessing the status of environmental best practices in the OR.

For organizations just beginning to identify sustainability programs in the operating room, this tool will illustrate where opportunities exist. For those further along, it can highlight products, processes and elements that may have been overlooked. Whether your organization is just beginning its sustainability journey or is looking for ways to assess and measure progress, this tool was designed for you.

GREENING THE OR

Facility Name: _____

Contact Name: _____ Title: _____

Phone: _____ Email: _____ Date: _____

Instructions: Place an uppercase "X" in the appropriate box next to each activity. Please only use one "X" per line.

	Endorse and participate in Practice GreenHealth's Greening the OR initiative	Build a Green Team specific to Surgical Services/OR	Educate OR staff on benefits of greening and opportunities for cost and waste reduction and safety benefits	Utilize reusable hard cases for surgical instrumentation	Additional Notes
Organizational Development					
Endorse and participate in Practice GreenHealth's Greening the OR initiative	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Build a Green Team specific to Surgical Services/OR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Educate OR staff on benefits of greening and opportunities for cost and waste reduction and safety benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize reusable hard cases for surgical instrumentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

toolkits in the future, as online resources will support a wide range of medical facilities with the ideas, tools, and certification steps necessary to improve sustainability across the medical field.

DOMAIN 1: Organizational Development

While the structure and culture of an organization can have a massive impact on the success of any sustainability initiatives, they can also be challenging to alter since neither can be concretely quantified nor measured. Implementing organizational change to support sustainability initiatives should be seen as complementary to any process or infrastructure changes, because ultimately these more concrete initiatives must be maintained by a supportive culture and an organization dedicated to this cause. To that end, “Organizational Development (OD) is a field of research, theory, and practice dedicated to expanding the knowledge and effectiveness of people to accomplish more successful organizational change and performance.”[1]

Assessment of Current Practices

Prior to initiating change in any capacity, a thorough assessment of the organization’s current practices must be completed. In the dental clinic, this process encompasses assessing everything from the efficiency of the current appliances, to the habits of dental care professionals to the beliefs of the office staff regarding sustainability. It is imperative to “reach a consensus in understanding the process as it is actually practiced” prior to proposing changes.[2] Equally important, the assessment should be documented and communicated to all stakeholders to serve as a clearly defined starting point.[3] While this first step can feel frustrating and overwhelming, its importance cannot be overstated.

*Resist the temptation to dive in and start fixing things...Only work on what is understood.
Let me repeat that again; only work on what is understood. Why does it bear repeating?
If a change is implemented to a poorly understood process and things start going better,
you won’t know why they started to improve. And you certainly won’t understand why
things don’t go well later on.[4]*

Both the “Greening the Dental Clinic Toolkit” and “Unpacking the Toolkit” provide a concise means of assessing any clinic’s commitment to sustainability. Further, utilizing this toolkit provides an easy means of documenting the clinic’s starting point. It can also be distributed to employees, shareholders, volunteers, patients and any other interested parties as a manageable, comprehensible snapshot of the clinic’s current practices and structure. This toolkit assesses a clinic’s starting point on all four domains

of sustainability: Built Environment, Waste Reduction and Prevention, Environmentally Preferred Purchasing, and lastly Organizational Development.

Opportunities for Improvement

The Toolkit identifies areas for improvement across all four domains of sustainability. This paper addresses possible improvements in each domain individually. This section will focus specifically on how Organizational Development can be employed to bolster a clinic's sustainability initiatives. Specific areas for possible improvement within organizational development can be divided into managerial commitment, organizational structure, individual practitioners and external impact.

MANAGERIAL COMMITMENT

Few studies have specifically examined the cultural changes that can be implemented in a clinic setting to improve an organization's sustainability. Further, no studies specifically examine this question within a dental clinic. Thus, many of our recommendations are derived from the broader business and management literature. However, a 2013 study surveyed 64 Australian healthcare professionals in semi-structured interviews regarding the visibility of sustainability issues within healthcare and the barriers to implementing sustainable changes in the clinic setting.[5]

A major barrier described by interviewees from all disciplines is the current reactive nature of the healthcare sector, where the acute needs of patients and resource constraints dominate practice... Change within this environment is difficult. Shifting from reactive to proactive work environments requires strong leadership.[6]

The first step toward demonstrating such leadership involves incorporating sustainability into the organization's mission. Amending the code of conduct, mission statement or corporate plan to reflect a *Triple Bottom Line* perspective on sustainability demonstrates strong commitment to this cause. Further, encouraging involvement from employees at all levels can provide an avenue for personal engagement and individual agency within the clinic. Long term, employees will feel more invested in an initiative they had a hand in writing.[7]

Alternatively or in addition to incorporating sustainability into the governing documents of the clinic, business leaders within the clinic can choose to endorse the Practice Greenhealth Initiative.[8] Such an endorsement bridges the line between communicating management's commitment to sustainability among employees and publicly displaying the clinic's commitment to environmental preservation. Regardless of whether a clinic commits to sustainability through internal documentation or

external membership in an organization like Practice Greenhealth, this commitment can be incorporated into any advertising and informational materials. With ever-rising consumer interest in sustainability, such initiatives may provide increased incentive to many potential clients.

INDIVIDUAL PRACTITIONERS

Although an initial, formal declaration of commitment to sustainability is a crucial starting point, any clinic that seeks to implement and maintain sustainable practices must incorporate sustainable practices into the daily clinic flow. Similar to seeking staff input in the drafting of the sustainability mission statement, empowering employees--and dental practitioners specifically-- to set targets and define goals will generate greater investment in sustainability outcomes. Additionally, with the input of practitioners who will be subject to any new practices, sustainability initiatives are more likely to be successfully incorporated into the daily workflow. “Empowering staff to resolve key barriers they have identified allows the gradual transition to proactivity where a future-focus dominates.”[9] Frequently, the impetus for clinics to formally address sustainability derives from the grassroots efforts of individual employees or practitioners. It is therefore only natural to incorporate these important stakeholders in the process of goal-setting and defining practices.

When initiating discussion within the clinic community regarding potential improvements, the initial assessment conducted utilizing the Toolkit can provide an impetus for discussion.

Ultimately, this discussion should foster the development of agreed-upon, concrete, achievable targets. Documentation of these goals and the plan for meeting them is crucial to maintaining commitment to these changes. The more documented specifics regarding the necessary staff training, financial investment and process changes needed to achieve the agreed-upon goals, the greater the chance of success and the easier future evaluation of the targets will be.

ORGANIZATIONAL STRUCTURE

Once the clinic has agreed upon initial specific targets and individual staff have been appropriately trained, the clinic’s organizational structure should be evaluated to ensure that there are mechanisms in place to maintain the clinic’s commitment to sustainability. Successful examples from the *Greening the OR* movement have shared three organizational commonalities: sustainability-related quality assessments, a feedback mechanism and incentives for success.

Any dental clinic will be familiar with having a process for collecting data and measuring its clinical efficiency and patient outcomes. This information is crucial to ensure that patients are receiving the best possible clinical care. Once specific sustainability targets have been defined, quality indicators that capture the clinic’s progress toward achieving those goals should be developed. The most successful

indicators are easily incorporated into the existing clinical assessment process. Importantly, both the quality indicator and frequency of assessment should be clearly defined. Constant self-assessment ensures continued progress toward the ultimate goal.

In addition to frequent assessments, the most effective way to ensure that any issues with the sustainability initiatives are appropriately and regularly assessed is to create a formal mechanism for feedback. This mechanism can take many shapes, and may be as minimal as a regular forum to discuss the clinic's sustainability. This forum can serve as a two-way street; data collected on the quality indicators can be shared with practitioners and employees can provide feedback on the barriers to sustainability in day-to-day practice. Many of the successful examples of hospital-based sustainability initiatives incorporated a "Green Team" into the organizational structure. In larger centers, this team was frequently led by an individual whose primary responsibility was managing the system's sustainability initiatives. The benefit of incorporating an employee whose sole focus is sustainability is that environmental initiatives can remain a priority since this individual does not have to balance competing interests of quality patient care and efficiency. But most importantly, "Green Teams" incorporated employees at all levels who could act as advocates for the initiatives.

Lastly, the most successful green initiatives provided incentives to employees who improved the sustainability of their practice. These incentives ranged from financial bonuses to simple public praise. Each incentive system was tailored to the culture of the specific institution.

EXTERNAL IMPACT

Much of this section has focused on the internal changes a single clinic can implement to improve its environmental impact. While important, such initiatives will not generate systemic change in dentistry. Ultimately, these changes "do not challenge organizational structures, power relationships or professional paradigms that may be inhibiting the [healthcare sector's] responsiveness to sustainability issues overall. Fundamental transformational change may be more effective." [10]

The energy and enthusiasm of staff within a clinic that has successfully implemented sustainable changes can be harnessed to catalyze greater fundamental change. Outside the walls of the clinic, staff can become sustainability leaders within their communities. Frequently, partnerships with local organizations with similar interests can broaden the scope of impact. Further, clinics can mobilize their staff to lobby local government and professional organizations to demand stronger commitment to sustainability in business regulations and the education of future dental professionals, respectively. However, these external goals require stronger organization and are best tackled by a clinic with a demonstrated record of commitment to sustainability. Thus, external targets are often the last horizon addressed by a clinic seeking to improve its environmental impact.

Avoiding a Plateau

Commitment to sustainability is not a one-time initiative. If a clinic successfully meets its initial targets, this accomplishment should certainly be celebrated. However, more challenging, forward-looking goals should then also be set rather than allowing the clinic's commitment to sustainability to plateau. Within the management literature, the *Deming Cycle* is frequently cited as the most simple and effective tool for continuous improvement. The development of this cycle is credited to Dr. W. Edwards Deming who first described the concept during a lecture in Japan in 1950.[11]

The Deming Cycle involves four steps: plan, do, check, act. After completion of the final “act” step, an organization should circle back to a new planning stage. In the **plan** step, an organization identifies a specific problem and analyzes the current relevant practices. With this information, possible solutions are brainstormed and a specific change is selected. In the **do** step, the proposed change is implemented narrowly. Often, the change is implemented via a pilot program or only within a smaller section of the organization. During the **check** step, the results of the implemented change are assessed. Was the desired goal achieved? If not, why? Were the overall results satisfactory? It is in this step that the importance of quality indicators comes into play. Finally, in the **act** step, any changes deemed successful are standardized within the greater organization and implemented on a larger scale. Once broadly implemented, the **plan** step restarts as individuals within the organization continually reassess the new process within the greater organizational context.

It is not difficult to imagine how this cycle might play out within the dental clinic. For example, after a clinic makes a public commitment to sustainability by incorporating the *Triple Bottom Line* concept into its mission statement, a forum of staff convenes to identify specific targets for improvement. One common “quick fix” involves the amount of excess *hazardous waste* generated by any given clinic. This type of waste includes any blood-soaked materials and toxins. It is disposed of in specific, red trash bags and requires incineration. Disposal of this waste has the largest impact on the environment, and is also most costly to the clinic. During the **plan** step, the clinic identifies minimizing the generation of hazardous waste as its specific goal. They agree to re-train dental practitioners on the definition of “hazardous waste” and choose to change the specified waste bins to be the smallest bins placed in the most distant location in the room from the practitioner's chair. Prior to implementing these changes, they conduct a multi-week assessment of the total weight of hazardous waste generated. In the **do** step, a quarter of the staff is re-trained and the hazardous waste bins in their clinic rooms are replaced with smaller, less convenient bins. In the **check** step, the hazardous waste generated by the test group is compared to the same number of practitioners in the control group. If the improvement is significant, the clinic moves onto the **act** step where all employees are re-trained and all hazardous waste bins are

replaced. After several weeks, the clinic once again evaluates areas for improved sustainability and identifies excess water use as the next area for improvement. Then the cycle repeats.

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- [1] University of Pennsylvania Perelman School of Medicine. (2016). *Organizational Development Theory*. Health Behavior and Health Education. Retrieved from <http://www.med.upenn.edu/hbhe4/part4-ch15-organizational-development-theory.shtml>
- [2] Bushell, S. (1992). Implementing plan, do, check and act. *The Journal for Quality and Participation*, 15(5), 58, 2.
- [3] *Id.*
- [4] *Id.*
- [5] Dunphy, JL. (Mar. 2013). *Enhancing the Australian healthcare sector's responsiveness to environmental sustainability issues: suggestions from Australian healthcare professionals*. Australian Health Review.
- [6] *Id.*
- [7] See the following online resources to assist in drafting a sustainability mission statement: Green Plus. (2016). *Mission, Vision, and Value Statement*. Retrieved from <http://gogreenplus.org/nuts-and-bolts-guide/performance-nuts-and-bolts-guide/organizational-planning-documentation/mission-vision-and-values-statements/>; <http://gogreenplus.org/sustainability-vision-statements/>; Michigan Department of Environmental Quality. (2016). *Sample Environmental Mission Statements*. Retrieved from http://www.michigan.gov/deq/0,4561,7-135-70153_70155_3585_57765_57804-95945--,00.html.
- [8] Practice Greenhealth. (2016). <https://practicegreenhealth.org/>
- [9] Dunphy (2013), *supra* n.3.
- [10] *Id.*
- [11] Moen, R. D., & Norman, C. L. (2010). Circling back. *Quality Progress*, 43(11), 2233.

DOMAIN 2a: Waste Reduction and Prevention

The second sustainability domain addressed in the toolkit is waste reduction and prevention. Broadly, this domain includes aid to green the dental clinic via identifying the largest sources of waste, reducing waste output, and redirecting waste output.

The first step is to conduct a waste audit to identify the largest sources of waste. With the green team, set a time to collect waste bags produced from either an average day of operations, or over the course of a standard number of patients. Complete a consumption analysis of individual products (gloves, masks, protective barriers, disposable products), measuring items by either weight, volume, or item number. Due to the small size and lightweight of many dental products, we recommend conducting your analysis based on either volume or by counting individual items. Identify the largest sources of waste based on this analysis. In the following paragraphs, we will discuss ways in which you can eliminate, reduce, or redirect these sources of waste, but please note that this will be different for every dental clinic. To reduce overuse of hazards and sharps containers, assess the appropriate disposal of waste contaminated with body fluid. Make these smallest and furthest away in the room to prevent the unnecessary use of these special waste containers. Additionally, evaluate the current method of metal disposal. Ideally, the dental clinic should have segregated recycling bins for metals from any amalgam scraps, extracted teeth containing amalgam fillings, lead radiograph foils, etc. as these are very toxic and can leach into waste. If metals are found in the regular waste stream during the waste audit, a special recycling bin must be implemented, details below.

The second step is to reduce waste by minimizing use of disposable items and to consider use of reusable items. Implement a process for proper disinfection of patient areas to reduce use of disposable barriers (i.e. paper covers, blue tape, head covers). Utilize reusable materials (i.e. stainless steel suction tips and air/water syringe tips, washable cloth bibs, reusable protective eyewear for staff and patients, etc). If the clinic uses paper barriers on surfaces for infection control, reduce use of paper barriers on “housekeeping surfaces,” only protecting clinical contact surfaces. Housekeeping surfaces such as floors, walls, and sinks have limited risk of disease transmission. Distinguishing the differences between housekeeping and clinical contact surfaces is important to prevent cross-contamination between surfaces, and to ensure surface disinfectants and barriers are being used on the proper surfaces. To replace disposable bibs, consider using washable OR cotton towels as patient bibs, or moving from 2-ply to 1-ply disposable bibs. A significant method to reduce waste is utilizing digital dentistry. This can be accomplished by converting all x-ray imaging to digital radiographs, utilizing digital charting, and CAD/CAM systems. The American Dental Association recommends digital radiographs because x-ray fixer is a hazardous waste substance due to its high silver content (3,000 to 8,000 mg/l of silver) [1]. Transitioning from paper charts to electronic health records, can save a significant amount of paper. It must be stressed that single use products are never to be reused items, and these products will be marked with the universal symbol, pictured below, for single use disposable items.



[2]

The third step is to reduce waste by utilizing products to the full potential. Follow manufacturer directions for material usage to ensure the accurate mixing of chemicals and limit material waste. Ensure sterilizers and cleaning units are full to reduce the number of cycles per day, saving cleaning solutions, water, and energy. Use products made from recycled materials, chose products packaged with recycled materials, and packaging that contains more items per product (e.g. purchasing gloves in boxes of 200 rather than 100). Additionally, proper inventory control can reduce the waste of expired dental materials. Rotate the oldest products to the front line and utilize a clear system of tracking inventory.

The fourth step is to redirect waste by implementing a process to maximize office recycling. Contact the local recycling facility to clarify and maximize what can be recycled. Gather information about the items that were found to create the largest amount of waste in the waste audit (gloves, masks, sterilization pouches, etc.) and communicate with the local recycling facility about what/how these items can be recycled. If the local recycling facility is unable to process some of these items, identify partners/vendors willing to recycle unique waste items (e.g. recycling sharps containers, disposable gloves). As part of the UMSOD case study, we purchased “Zero Waste Boxes” from the company

TerraCycle [3] to recycle nitrile gloves in the student simulation lab. These nitrile gloves will be sent back to the company in a pallet to be cryogenically frozen and processed into a powder which can be used to make new plastic products such as park benches and container bins. Other unique programs, include the Hu-Friedy Envirodent [4] program, where for every even increment of 12 instruments you recycle, you can select 1 Hu-Friedy instrument, absolutely free. As an alternative to the incineration of medical waste, many companies have developed ways to compact and sterilize medical waste. Sterilis Medical [5] offers a system to effectively and efficiently transforms full sharps containers, scalpel blades, surgical drapes and capes, glass ampules, suture kits, and all other forms of regulated medical waste into sterile solid waste in less than 60 minutes in a machine the size of a photocopier. Red Bag Solutions [6] also offers cost effective treatment technology that simultaneously grinds and sterilizes medical waste “onsite.” The waste is rendered unrecognizable, volume is reduced up to 90% and weight by up to 30%, which in turn reduces the amount of waste going into the landfill. Another option regarding disposing of sharps; instead of buying disposable sharps containers that go into the infectious waste stream and drive up waste costs while also requiring ongoing replacement, consider moving to reusable sharps container systems. Full containers are collected by a service provider who mechanically empties, cleans, and disinfects the containers and returns them for reuse. Containers are often used hundreds of times, driving down both waste and replacement supply costs. [7]

The above information is by no means the definitive guide in the waste management of the green dental clinic, but it offers a solid starting point for moving towards more sustainable methods.

[1] Dental Wastes. (2015). Retrieved November 21, 2016, from <http://www.hercenter.org/wastereduction/dentalwastes.cfm>

[2] Use of Symbols on Labels and in Labeling of In Vitro Diagnostic Devices Intended for Professional Use. (2004, November 30). Retrieved November 21, 2016, from <http://www.fda.gov/RegulatoryInformation/Guidances/ucm085404.htm>

[3] Disposable Gloves Zero Waste Box. (n.d.). Retrieved November 21, 2016, from https://www.terracycle.com/en-US/zero_waste_boxes/disposable-gloves

[4] HF Envirodent. (n.d.). Retrieved November 21, 2016, from <http://www.hu-friedy.com/envirodent/>

[5] Oral Surgeons. (n.d.). Retrieved November 21, 2016, from <http://www.sterilismedical.com/practicetypes/oralsurgeons.htm>

[6] About Biohazardous and Regulated Medical Waste Management. (n.d.). Retrieved November 21, 2016, from <https://www.redbag.com/about-red-bag-solutions>

[7] The Business Case for Greening the OR. Practice Greenhealth 2011. Greening the OR. Page 6.

DOMAIN 2b: Mandatory Waste Reduction and Regulation

The primary way that the Environmental Protection Agency (EPA) regulates the dental industry is through its administration of the Clean Water Act (CWA).[1] Under the CWA, Congress makes the “discharge of pollutants” into any “navigable waters” of the United States illegal unless the actor first obtains a permit.[2] These permits are subject to certain effluent limitation guidelines and standards and are granted through the National Pollutant Discharge Elimination System (NPDES) program if the actor is the type of actor that discharges waste directly into navigable waters (e.g. large industrial facilities).

Actors who do not discharge directly into navigable waters, but rather discharge waste indirectly through publically owned treatment works (POTWs) must instead comply with pretreatment standards, which are also promulgated by the EPA under the CWA. These General Pretreatment Regulations “establish responsibilities among federal, state, and local government; industry; and the public to implement pretreatment standards to control pollutants.”[3][4]

The primary pollutant of current concern within the dental industry is mercury, which is a “persistent and bioaccumulative pollutant”[5] that can cause severe effects on human health. In 2005, a study funded by the ADA found that dental offices contributed more than 50% (6.5 tons of 12.3 tons) of mercury entering POTWs.[6] Mercury discharges in dental offices can occur when “dentists dispose of old amalgam fillings from patients’ cavities, and dispose of excess amalgam after placing a new filling.”[7]

The EPA has proposed regulating the disposal of mercury from the dental industry through a pretreatment standard under the CWA. These standards would require dentists to control the discharge of mercury into POTWs by introducing the use of amalgam separating technology and adopting certain Best Management Practices, including (1) eliminating the flushing of scrap amalgam down drains and (2) cleaning chair-side traps with non-bleach, non-chlorine cleaners.[8] To support this rule, the EPA looked at data from the Health Services Industry Detailed Study and collected information from many stakeholders, including environmental organizations and the ADA.

Most states do not have mandatory amalgam disposal requirements for dental offices. The ADA had already developed a national, voluntary program for the reduction of amalgam called the “Best Management Practices for Amalgam Waste,”[9] which are recognized as the industry standards. In 2007, the ADA added the installation of amalgam separators to these practices. In addition, as of 2014, twelve states, including Michigan, already had passed state laws mandating the installation of amalgam separators; however, these states had different requirements for technology and operation specifications, as well as different methods for demonstrating compliance.

A national rule, while still costly for the industry, would streamline requirements across states. Without a national rule, providers in Michigan face higher compliance costs than providers in, for example, Ohio where separation is not mandated. The extra cost of doing business may draw providers from Michigan to Ohio, possibly creating skewed incentives that do not necessarily align with supply and demand. Even when voluntary programs may demonstrate that a majority of providers participate, a national rule is still the more equitable approach. Most importantly, EPA estimates that enactment and compliance with this proposed rule would reduce mercury discharges into POTWs by 4.3 tons and other metal discharges by 4.5 tons per year.[10] The notice and comment period on the rule has closed and the ADA announced in April that it expects the EPA to release the final rule in December of 2016.[11]

[1] 33 U.S.C. §1251 et seq. (1972)

[2] *Id.*

[3] 40 CFR 403

[4] Environmental Protection Agency. (Oct. 2014). *Technical and Economic Development Document for the Proposed Effluent Limitation Guidelines and Standards for the Dental Category (40 CFR 441)*. EPA-821-R-14-006.

[5] *Id.*

[6] *Id.* at 2-1.

[7] *Id.*

[8] *Id.*

[9] *Id.* at 6-3.

[10] *Id.* at 11-5.

[11] Garvin, J. (May 2, 2016). Amalgam separator rule delayed until December. *ADA News*. Retrieved from <http://www.ada.org/en/publications/ada-news/2016-archive/may/amalgam-separator-rule-delayed-until-december>

DOMAIN 3: Environmentally Preferred Purchasing

The third domain of the “Greening the Dental Clinic” online toolkit highlights a number of components in environmentally preferred purchasing (EPP), emphasizing environmentally friendly products and improving the provider’s comfort and the patient’s satisfaction. The understanding of Environmentally Preferred Purchasing (EPP) relies on the EPA’s program and standards which started in 1993, reinforced by an Executive Order in 2015 to improve federal sustainability in the next decade [1]. “Environmentally preferred” refers to products that have a reduced impact on human health, and we suggest that all dental clinics consider the environment in their normal purchasing process [1]. At the UMSOD and in any dental care setting, maintaining a high infection control standard is crucial, and following strict sterilization practices in the cubicle is a key component in this process. In addition to the patient/provider chairs, certain clinical contact surfaces in the dental operatory need to be properly disinfected to prevent the transmission of disease, such as the light handles, switches, dental radiograph equipment, and countertops [2]. Current procedure indicates that dental students are required to wipe down the cubicle surfaces and chairs after each appointment with a Clorox disinfectant [3]. An alternative, considers cleaning and disinfecting the cubicle with a non-toxic, intermediate-level hospital grade disinfectant. For example, utilizing wipes and/or a trigger pump instead of a spray disinfectant would reduce aerosols and inhalation exposure to the chemicals found in the cleaning spray and would keep the disinfectant contained. One hydrogen peroxide based eco-friendly surface disinfectant recommended by the EPA is manufactured by SciCan called *OPTIM 33TB* which does not have a strong chemical odor, falls into the EPA’s lowest toxicity category, does not irritate the eyes or skin, and is biodegradable [4]. In addition, *OPTIM 33TB* has a fast contact time and 1 minute bactericidal and virucidal kill time which helps to maximize efficiency in the clinic setting when the turnover time between providing care to each patient is small and rapid cleaning is in order [4].

While considering sterilization and disinfection in the dental operator, it is also important to address environmentally friendly hand hygiene products. Many medical grade hand antiseptics often have antimicrobial agents in them, and in September 2016 the FDA banned triclosan in over-the-counter antimicrobial soaps [5]. Although this regulation does not apply to medical grade products, some animal research has shown that triclosan may alter hormones, prompt the proliferation of cancer cells, and increase the growth of antibiotic resistant bacteria [6]. There is inconclusive evidence that says triclosan containing soap is more effective than regular soap, so one alternative is to use alcohol based hand rubs which not only kill bacteria but minimize human and environmental exposure (releasing into the water system) to triclosan.

In addition, the last few recommendations focusing on environmentally preferred purchasing support the dental provider's posture, involve community engagement, and incorporate partnership with major dental companies. In order for dental providers to offer the best care possible, dental clinics should consider the ergonomic design of the dental instruments used in everyday appointments. Utilizing lightweight, durable hand pieces that enhance ergonomic support will reduce stress and fatigue. Less stress on the body improves the dentist's wellness and longevity allowing him or her to continue practicing at the highest level. In addition, employing interactive patient education tools and engaging the patients in conversations about sustainability in dentistry will enhance the dental experience. Allowing patients to consider sustainability in dentistry may encourage them to carry out sustainable practices in their own lives or will motivate patients to recommend the eco-friendly dental practice to others, therefore helping to increase the patient base. Dentists are health care providers, but they can also act teachers, instilling the notion of sustainability in everyday life in their patients. For example, talking with patients about how they can engage in sustainable practices such as turning water off while brushing teeth and highlighting how the dental practice uses reusable protective eyewear instead of disposable gear are excellent talking points. Lastly, dental clinics should consider partnering with oral care supplies companies to provide patient samples that have minimal impact on the environment and encourage their recycling take-back program. For example, TerraCycle, an innovative recycling company, partners with Colgate to take back used toothbrushes and packaging, toothpaste tubes, empty dental floss containers, and toothpaste cartons. Any dental provider can sign up for the recycling take back program, and for every two pounds of recycled materials that TerraCycle receives, the donating group earns redeemable points to support environmental charities. The donated plastic is melted and molded into new recycled products [7].

Overall, dental care providers should consider environmentally preferred purchasing to source resources for their dental setting to minimize the impact their products have on the environment.

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- [1] Sustainable Marketplace: Greener Products and Services. (2016). Retrieved November 20, 2016 from <https://www.epa.gov/greenerproducts/about-environmentally-preferable-purchasing-program>
- [2] Guidelines for Infection Control in Dental Health-Care Settings. (2003). Retrieved November 20, 2016 from <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5217a1.htm>
- [3] Disinfection Protocol. (2016). Retrieved November 8, 2016, from <https://umich-dent.wikispaces.com/Disinfection+Protocol>
- [4] OPTIM 33TB one-step disinfectant & cleaner, a breath of fresh air. (2016). Retrieved November 20, 2016, from <http://www.scicanusa.com/optim-33tb>
- [5] FDA issues final rule on safety and effectiveness of antibacterial soaps. (2016). Retrieved November 20, 2016, from <http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm517478.htm>
- [6] The Truth About Triclosan, (2016). Retrieved November 20, 2016, from <http://www.webmd.com/a-to-z-guides/features/what-is-triclosan#2>
- [7] Colgate Oral Care Recycling Program. (2016). Retrieved November 20, 2016, from <http://www.terracycle.com/en-US/brigades/colgate>

DOMAIN 4: Built Environment

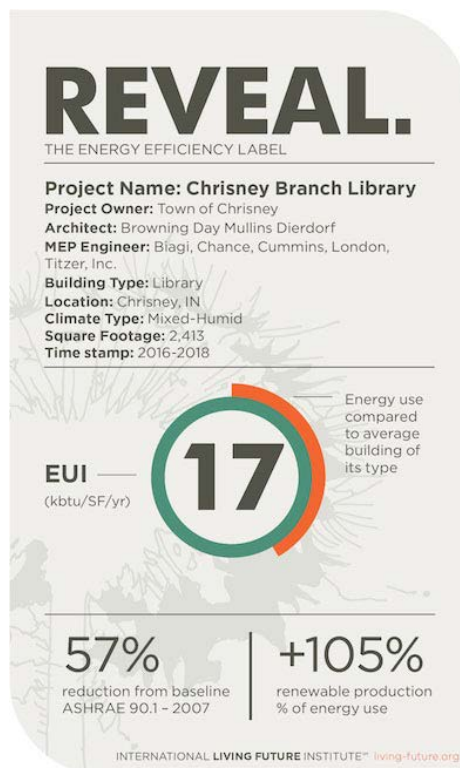
The fourth domain of the toolkit addresses the design, construction and operation of a facility, which provides unlimited opportunities to improve a building's environmental performance and occupant comfort. The following sections will provide ideas for designers, architects and facility managers to improve the environmental performance of their buildings while also fostering an environment conducive for occupant performance and wellbeing. Of note, the built environment domain of the "Greening the Dental Clinic" toolkit is meant to extend beyond the widely accepted recommendations for LEED certification. LEED guidelines specifically address overarching building design and energy issues for buildings of any type. The authors strongly suggest that any dental clinic committed to sustainability strive to meet these requirements and obtain LEED certification. However, this section will focus on infrastructure and design improvements which may not be discussed in widely adopted building certification programs, but which provide significant energy and financial savings along with improvements in occupant performance. These recommendations are specifically tailored to the dental clinic setting.

Energy

One of the most important aspects of a building is its energy use, and is often the primary economic and environmental factor considered in a building's design. Energy savings can be achieved in a myriad of ways, from proper HVAC sizing and design to on-site renewable energy generation.

BUILDING ENERGY MANAGEMENT SYSTEM

A key consideration when trying to minimize energy within a facility is to install a building energy management system (BEMS) to facilitate routine energy audits, allowing continuous energy performance improvements over the lifetime of the building. A BEMS provides potential to realize up to 50% energy savings within a building, and can help digitally control a building's temperature,



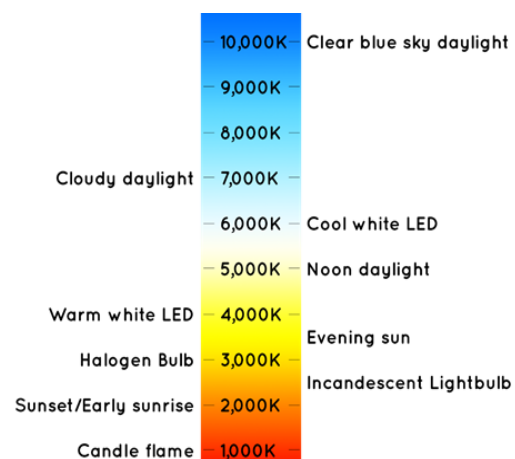
illumination, security, and other mechanical or electrical operations.[1] Beyond energy savings, a BEMS can assist facility managers and engineers in optimizing a building’s performance while meeting occupant comfort, two objectives which are challenging to marry unless sufficient data is available from a BEMS. Achieving LEED certification does not necessarily translate into reduced energy consumption, and LEED does not currently require re-certification or assessment of energy performance to attain or retain certification. A properly employed BEMS system can help address this need.

TRANSPARENCY AND REPORTING

In an effort to increase transparency and accountability, facility managers should conduct regular energy audits and report performance. A tool which can provide this transparency is the REVEAL Label developed by the International Living Future Institute (ILFI). The REVEAL Label displays a building’s energy use intensity (measured in kBtu/ft²-year), is calculated and validated by ILFI, and requires renewal every two years. The benefit of using this label is it provides comparisons between the evaluated building and other similar-type buildings on multiple metrics including ASHRAE 90.1 (which provides minimum requirements for energy-efficient design of most buildings). In all, disclosing this type of information helps facility managers understand their energy performance relative to established standards and other buildings, serving as motivation for continuous assessment and improvement of building energy programs.

Lighting

Lighting is unique within the dental clinic setting as specific light characteristics are necessary for practitioners to properly conduct procedures requiring color-matching. Many characteristics should be accounted for when selecting dental task lighting, but most important are color temperature and color rendering index (CRI). Color temperature varies between about 1,000°K to 10,000°K, with 5,500°K representing direct sunlight.[2] CRI is calculated



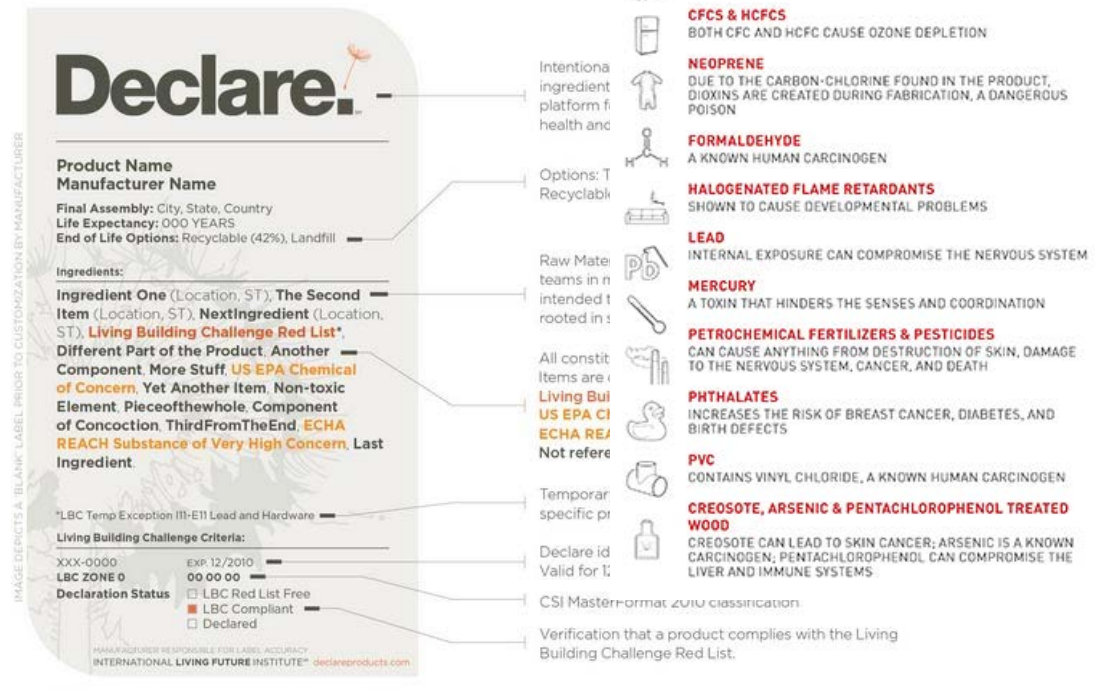
algebraically from a chromaticity diagram, and is the measure of the completeness of the light spectrum within a light source.[3] CRI values fall on a scale from 0 to 100 with 100 indicating the entire visible light spectrum is present.[4] For reference, most incandescent bulbs have a CRI of 75 and full natural daylight has a CRI of 100. It is recommended that, for proper color-matching, dental task lighting have a CRI greater than 93 and color temperature as close to 5,500°K as possible.[5] LED lights offer energy saving and versatile options when selecting lighting within a clinic.[6] The most energy saving lighting source is natural daylight, and providing large windows or skylights within a dental facility will help reduce demand for overhead lighting, provide quality light within the characteristics for precise dental work, and have positive psychological impacts on building occupants.[7][8]

Having both energy impacts as well as occupant performance benefits, daylighting should be incorporated into a design as much as possible. A newly emerging lighting system concept which drastically reduces energy usage is daylight harvesting. Daylight harvesting is the managed process of exploiting and coordinating natural and artificial light sources to meet occupant lighting requirements. Often managed within a building's BEMS, sensors and blinds within building spaces control artificial light output based on available daylight through windows and skylights, reducing artificial sources during peak daylight periods.[9] If designed and implemented properly, daylight harvesting can provide consistent lighting conditions for occupants while minimizing lighting energy loads up to 40%.[10] Another lighting energy saving method is employment of motion sensors in work spaces to automatically turn-off lights when occupants are not present. Refer to LEED design criteria for further information.

Materials

Considerations in the sourcing and material composition of design elements such as flooring and casework can provide environmental benefits in the material extraction, manufacturing and end-of-life stages of the facility's life cycle, as well as potentially reduce some adverse human health impacts during use of the materials.

Material
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environmentally harmful in their manufacturing or due to their extended timeline and negative effects during decomposition once returned to the environment. The International Living Future Institute (ILFI) has published the “Red List,” which identified products are to be avoided when designing and building a facility due to their human health impacts as carcinogens or endocrine disruptors. The LEED program provides some incentive to select products with environmentally, economically, and socially preferable life-cycle impacts within its Materials and Resources credit category, but does not specifically support designers and architects in sourcing materials meeting this criteria. The ILFI’s Declare certification, addresses this deficit in the LEED guidelines by setting strict product standards and transparency for designers. Designers can search for materials and products meeting the Declare criteria, or use it as a launching point to discover other products that meet specific design needs.

RECOMMENDED RESOURCES

- *Declare Products through ILFI* (<https://living-future.org/declare-products>) - Products range from building materials like masonry and moisture protection to design elements and finishes like carpet and furnishings. Product descriptions and materials are included, and each certification identifies whether a product meets LEED v4 product disclosure and optimization compliance, is Red List Free, or meets ILFI’s Living Building standards.
- *Eco Dentistry Association* (<http://www.ecodentistry.org/green-dental-industry/>) - Specific products aimed at supporting dental practices. Products range from dental instruments to

operatory lighting and modular casework. Products come from a variety of suppliers, some touting the environmental benefit of their specific products or advertising the sustainable aspects of their business operations.

Human-centered design

Moving past the bounds of typical building design metrics, a key consideration for designers should be occupant comfort and performance provided by the indoor environmental quality (IEQ). As seen in the UMSOD case study, student clinics serve as both a functioning open-air clinic for patients while also serving as a learning environment for students. As such, spaces should be designed and controlled to optimize learning, performance, and comfort of all occupants. These same considerations transfer to private practices and other dental clinics, which should seek to provide comfortable and inviting spaces for both patients and practitioners. It is important to note that simply designing to achieve LEED certification does not guarantee increased occupant satisfaction, so additional elements must be included when designing a space.[11] To better assess whether IEQ meets occupant needs, a post-occupancy evaluation (POE) may help designers understand how well a space meets an occupant's satisfaction and performance.[12]

Biophilic Design

Beyond the environmental impact of a building, a central tenet of a sustainable design is that buildings are a habitat for people, who should be conceived of as biological organisms.[13][14] With this in mind, designers should seek to incorporate design elements with aims to improve the health, wellbeing, and work performance of a building's occupants. Biophilic design provides a conceptual framework for achieving these goals, providing benefits for building occupants which translates into economic savings.[15] This section will first discuss what a good building habitat should support for occupants, some of the benefits of incorporating these elements, and provide additional specificity for design elements and patterns for designers to consider.

According to environmental psychologist Judith Heerwagen, building spaces should provide few key elements including: a connection to nature, a sense of community and belonging, behavioral choice and control, opportunity for regular exercise, sensory variability, and privacy (when desired).[16] As the building features feeding these elements are numerous, they are provided in a concise format in Appendix B, Table 1. For additional elements and attributes refer to Stephen Kellert's elements and attributes of biophilic design.[17]

Incorporation of these elements can occur in many forms, and biophilic design is a design concept currently undergoing significant growth. For a quantitative method and strategy for incorporating

biophilic elements in a design, designers can use the biophilic design matrix (BDM).[18] Based on Kellert's elements of biophilic design, the BDM provides a simple checklist-style approach to assessing biophilic design within a space, and can help designers determine which elements are most fitting for their specific design. The BDM provides a full list of biophilic design patterns and processes for application.

The benefit of biophilic design are numerous, from improving occupant performance to positively impacting behavior and mood. These benefits translate into economic savings for employers, specifically by improving worker productivity, reducing illness and absenteeism, staff retention, and improving healing and learning rates.[19][20] For example, in one study a researcher found that up to 10% of employee sick days taken within an administrative office building at the University of Oregon could be attributed to architecture without connection to nature.[21] Within the dental school, dental student absenteeism may decrease by a similar percentage, helping improve learning and student value. Presenteeism, the phenomenon of being present physically while mentally absent, also decreases as a result of biophilic design, meaning workers or students may be more engaged and productive.[22] Considering dental schools specifically, studies show that simply providing good daylighting in the academic setting can improve tests scores, reduces off-task behavior, and positively impact the achievement of students.[23] Some studies show test score increases between 7-18% and student learning rates increasing 20-26%.[24][25] when adequate daylight is provided. Another key benefit of biophilic design is its ability to reduce stress and anxiety, which can provide tremendous value for apprehensive patients within dental clinics. Providing visual and non-visual connections to nature, presence of water, unimpeded views and natural designs all serve to mitigate stress responses.[26] All considered, biophilic design can provide tremendous economic, health, and social value within dental facilities and schools. For a comprehensive list of stress reduction, cognitive performance and emotional preference impacts across all biophilic design patterns, see Appendix A.

Biophilic design includes many elements which provide building occupants with stimulation of nearly all their senses. Design patterns are located in Appendix B, Table 2, with each pattern having additional elements and creative mechanisms for incorporation into space planning. For example, within the "Complexity and order" pattern, there are near unlimited opportunities through material choices, scaling, artwork, and architectural elements to incorporate fractals and symmetry geometries within a space.[27][28] These patterns should be incorporated carefully and deliberately within each building space to provide occupants with frequent and sufficient human-nature interactions while still meeting function and flow in the design.

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- [6] A-Dec.
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V. LOOKING TO THE FUTURE

It is clear that the field of dentistry is changing and that its future promises a departure from past practices. The field has already shifted from its historical focus on treatment of oral disease to focusing on prevention and maintenance.[1] This shift has been in large part due to public health initiatives such as

public water fluoridation, but also due to educating and motivating patients during dental visits.[2] Furthermore, it is likely that going forward the dental profession will be younger and more female as the older generations of dentists retire and dental school enrollments continue to increase.[3]

Dental insurance has also affected utilization of dental visits and impacted the general population's dental health. Recent analyses of the effect of the Affordable Care Act on dental health suggest that the Act's passage has resulted in greater dental care utilization among children, in part because the Medicaid and Children Health Insurance Programs (CHIP) made dental health care an essential benefit for children, and thus more affordable.[4] Further analysis on the impact of the ACA reveals that the Act actually may have caused adult utilization of dental care to decrease from 2001-2010, at least among the population aged 26-64.[5] However, more recent studies show that dental care utilization among working age adults is increasing, perhaps due to the establishment of health insurance marketplaces where adults can purchase dental benefits and also improving economic trends.[6] Thus, financial barriers prove to be some of the most important barriers to dental care utilization, rather than supply of dentists.

Due to the influence of these financial barriers and improved understanding of how oral health can be associated with other health problems such as cardiovascular disease, many practitioners and policy advocates have suggested, further integration of dental care into overall health care.[7] The number of multi-site dental firms has already rapidly expanded, and this change in dental provider structure may be conducive to increased cooperation with medical providers. Further integration of dental care and medical care might promote increased coverage of dental costs by including them with health benefits offered through private insurance or Medicaid. Increased integration could also promote increased environmental sustainability because medical and dental providers can then cooperate to identify "green" products, improved design techniques, and more sustainable waste disposal methods.

The GDCT serves as a tool for dental practitioners, schools, and other facility operators to guide decision making within all aspects of their operations. This tool covers equipment, materials, sourcing, procedural and cultural changes which can help any facility improve their environmental performance. Eventually this tool should be accompanied by a certification or endorsement from Practice Greenhealth or another supervisory organization, helping to identify and celebrate dental facilities meeting the goals of the GDCT.

As the GDCT receives wider adoption, there is increased opportunity for an expansion of the tools and resources available to dental practitioners to continue operating more sustainably. These future opportunities include:

1. *Case Studies*: As schools and dental practices adopt greener practices, case studies can help enforce and inform the movement towards more sustainable practices. Specifically, sharing data highlighting the economic, social and environmental benefits of adopting greener practices will help the transition between early adopters and the dental field.
2. *Endorser and Sponsor Certificate Program*: Dental facilities participating in the Greening the Dental Clinic initiative should be recognized, and a certification from a respected organization like Practice Greenhealth will increase the desirability of pursuing greener practices. In the future, the GDCT will
3. *Online Calculator*: An online calculator will allow practitioners interested in making facility improvements an opportunity to determine up-front costs, the long term economic benefits, payback period, and any environmental benefits. This will assist in determining the cost-benefit of any decision, and will help decision-makers determine which improvements best align with their specific goals.
4. *Equipment and Material Sourcing*: With the plethora of dental equipment providers available, confusion and frustration can arise when trying to decipher which equipment options are most environmentally friendly and economically feasible. A sourcing tool for flooring, dental chairs, gloves, casework, etc., will reduce the time dental providers spend looking for sustainable equipment and materials for their facilities. This tool will provide options based on cost, user ratings, and features, while meeting baseline sustainability criteria.

Looking into the future, we believe there is a great benefit to dental students and other dental professionals in learning to “green” the dental clinic. As such a clinically based profession, many of the methods dental students are taught in school carry through the rest of their career. Intervening with an educational component on sustainable dentistry can have a large immediate impact, but an even greater impact on the future as dental students go on to open their own practices with the sustainable habits instilled in them. In the ideal future, dental schools will provide a short course covering the various topics addressed in our “Greening the Dental Clinic” toolkit taught to dental students in their second or third year of dental school.

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[2] *Id.*

[3] Vujicic, M. (2016). The De-Aging of the Dentist Workforce. *The Journal of the American Dental Association* 147(10), 843-45.

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[5] *Id.*

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- [7] Guay (2016), *supra* note 1.

VI. CONCLUSION

Improving sustainability within dentistry has not traditionally been a widely explored topic, and this project offers exciting research that will supplement the UMSOD clinic redesign, a project due to begin in 2017. Attending the CleanMed Conference in May 2016 enhanced this project and taught how sustainability has and continues to be implemented in the medical field. Incorporating the “Greening the OR” model from Practice GreenHealth, helped to create a “Greening the Dental Clinic” checklist with various measures dental practitioners and educational institutions can act upon to improve sustainability and reduce environmental impact in their facilities. This checklist suggests different methods to improve sustainability such as organizational development, waste reduction and prevention in the dental clinic, environmentally preferred purchasing, and the built environment. All of these measures focus on different aspects of sustainability, but the driving factor that will make this checklist successful is the cooperation of dental practitioners and students around the country to make innovative changes into the core practice of their field.

In order to evaluate the cultural acceptance of sustainability in dentistry, the dental clinic setting was the primary area of focus and third year dental student class at UMSOD participated in a case study. This particular group of students was selected because they have some clinical experience. The case study, conducted in September 2016, evaluated students’ initial perspectives on sustainability before and after an in-class intervention on waste reduction strategies. Students understood the importance of reducing waste in the clinics and realized how they could reduce PPE and protective paper sheet waste in each cubicle. Evaluating students’ perspectives was a useful component of this project that provided hopeful results; foster students’ understanding of sustainability is important because they are the future leaders of the field.

Finally, it is essential to demonstrate how sustainability in dentistry is cost-effective and will benefit the dental clinic setting in the long-run. For example, through life cycle assessment and financial analysis, UMSOD could reduce spending by \$31,879 by replacing disposable “googles” with reusable protective eyewear, a change that is both environmentally friendly and saves money.

Overall, sustainability in dentistry can be examined through a multi-faceted approach. Looking at the environmental impact and financial burden of products in the dental operator, examining the built environment, performing a cultural assessment with current dental students and future practitioners, and providing some tools for organizational development were key components of this project, and will serve as valuable resources in the further development of sustainability in dentistry.

APPENDIX A: BIOPHILIC DESIGN PATTERNS & BIOLOGICAL RESPONSES

14 PATTERNS	*	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	Visual Connection with Nature	* Lowered blood pressure and heart rate (Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)	Improved mental engagement/ attentiveness (Biederman & Vessel, 2006)	Positively impacted attitude and overall happiness (Barton & Pretty, 2010)
	Non-Visual Connection with Nature	* Reduced systolic blood pressure and stress hormones (Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)	Positively impacted on cognitive performance (Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)	Perceived improvements in mental health and tranquility (Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdotter & Grahn, 2003)
	Non-Rhythmic Sensory Stimuli	* Positively impacted on heart rate, systolic blood pressure and sympathetic nervous system activity (Li, 2009; Park et al., 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)	Observed and quantified behavioral measures of attention and exploration (Windhager et al., 2011)	
	Thermal & Airflow Variability	* Positively impacted comfort, well-being and productivity (Heerwagen, 2006; Tham & Willem, 2005; Wigö, 2005)	Positively impacted concentration (Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)	Improved perception of temporal and spatial pleasure (alliesthesia) (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschemong, 1979)
	Presence of Water	* Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure (Alvarsson, Wiens, & Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman & Vessel, 2006)	Improved concentration and memory restoration (Alvarsson et al., 2010; Biederman & Vessel, 2006) Enhanced perception and psychological responsiveness (Alvarsson et al., 2010; Hunter et al., 2010)	Observed preferences and positive emotional responses (Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphries et al., 2010; Kamanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)
	Dynamic & Diffuse Light	* Positively impacted circadian system functioning (Figueiro, Bruns, Plitnick et al., 2011; Beckett & Roden, 2009) * Increased visual comfort (Elyezadi, 2012; Kim & Kim, 2007)		
	Connection with Natural Systems			Enhanced positive health responses; Shifted perception of environment (Kellert et al., 2008)
NATURAL ANALOGUES	Biomorphic Forms & Patterns	*		Observed view preference (Vessel, 2012; Joye, 2007)
	Material Connection with Nature		Decreased diastolic blood pressure (Tsunetsugu, Miyazaki & Sato, 2007) Improved creative performance (Lichtenfeld et al., 2012)	Improved comfort (Tsunetsugu, Miyazaki & Sato, 2007)
	Complexity & Order	* Positively impacted perceptual and physiological stress responses (Salingaros, 2012; Joye, 2007; Taylor, 2006; S. Kaplan, 1988)		Observed view preference (Salingaros, 2012; Hägerhäll, Laike, Taylor et al., 2008; Hägerhäll, Purcella, & Taylor, 2004; Taylor, 2006)
NATURE OF THE SPACE	Prospect	* Reduced stress (Grahn & Stigsdotter, 2010)	Reduced boredom, irritation, fatigue (Clearwater & Coss, 1991)	Improved comfort and perceived safety (Herzog & Bryce, 2007; Wang & Taylor, 2006; Petherick, 2000)
	Refuge	* * *	Improved concentration, attention and perception of safety (Grahn & Stigsdotter, 2010; Wang & Taylor, 2006; Wang & Taylor, 2006; Petherick, 2000; Ulrich et al., 1993)	
	Mystery	* *		Induced strong pleasure response (Biederman, 2011; Salimpoor, Benovoy, Larcher et al., 2011; Ikemi, 2005; Blood & Zatorre, 2001)
	Risk/Peril	*		Resulted in strong dopamine or pleasure responses (Kohno et al., 2013; Wang & Tsien, 2011; Zald et al., 2008)

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This table illustrates the functions of each of the 14 Biophilic Design Patterns in supporting stress reduction, cognitive performance, emotion and mood enhancement and the human body. Patterns marked with three asterisks (***) are supported by more rigorous empirical data, indicating that the quantity and quality of available peer-reviewed evidence is robust and the potential for impact is great. No asterisk indicates that there is minimal research to support the biological relationship between health and design, but the anecdotal information is compelling and adequate for hypothesizing its potential impact and importance as a unique pattern.

Table from Terrapin Bright Green LLC, 14 Patterns of Biophilic Design [1]

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APPENDIX B: BIOPHILIC DESIGN ATTRIBUTES AND PATTERN DESCRIPTIONS

TABLE 1. Features and Attributes of Buildings Linked to Well Being Needs and Experiences	
<u>Experience/Need</u>	<u>Environmental Features and Attributes</u>
Connection to nature and natural processes	Daylight; views of outdoor natural spaces; views of the sky and weather; water features; gardens; interior plantings; outdoor plazas or interior atria with daylight and vegetation; natural materials and décor.
Opportunity for regular exercise	Open interior stairways; attractive outdoor walking paths; in-house exercise facilities; skip-floor elevators to encourage stair climbing.
Sensory change and variability	Daylight; window views to the outdoors; materials selected with sensory experience in mind (touch, visual change, color, pleasant sounds and odors); spatial variability; change in lighting levels and use of highlights; moderate levels of visual complexity
Behavioral choice and control	Personal control of ambient conditions (light, ventilation, temperature, noise); ability to modify and adapt environments to suit personal needs and preferences; multiple behavior settings to support different activities; technology to support mobility; ability to move easily between solitude and social engagement and spaces to support both
Social support & sense of community	Multiplicity of meeting spaces; use of artifacts and symbols of culture and group identity; gathering “magnets” such as food; centrally located meeting and greeting spaces; signals of caring for the environment (maintenance, gardens, personalization, craftsmanship)
Privacy when desired	Enclosure; screening materials; ability to maintain desired distances from others; public spaces for anonymity.

Adapted from Heerwagen, Judith (2006). Investing in People: The Social Benefits of Sustainable Design [1]

TABLE 2. Descriptions of Biophilic Design Patterns	
<u>Biophilic Design Pattern</u>	<u>Description</u>
Visual Connection with Nature	A view to elements of nature, living system and natural processes
Non-Visual Connection with Nature	Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems of natural processes
Non-Rhythmic Sensory Stimuli	Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely
Thermal & Airflow Variability	Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments
Presence of Water	A condition that enhances the experience of a place through seeing, hearing or touching water
Dynamic & Diffuse Light	Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature
Connection with Natural Systems	Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem
Biomorphic Forms & Patterns	Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature
Material Connection with Nature	Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place
Complexity & Order	Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature
Prospect	An unimpeded view over a distance, for surveillance and planning
Refuge	A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead
Mystery	The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment
Risk/Peril	An identifiable threat coupled with a reliable safeguard

Adapted from 14 Patterns of Biophilic Design, Terrapin Bright Green LLC [2]

[1] Heerwagen, Judith (2006). Investing in People: The Social Benefits of Sustainable Design. In: Proceedings of the Rethinking Sustainable Construction '06, Sarasota, FL Conference, September 2006.

[2] Browning, W.D., Ryan, C.O., Clancy, J.O. (2014). 14 Patterns of Biophilic Design. New York: Terrapin Bright Green llc.

APPENDIX C: GREENING THE DENTAL CLINIC TOOLKIT

Greening the Dental Clinic

Dow Sustainability Fellowship 2016-2017

Shivani Kamodia, Mary-Catherine Goddard, Rob Meyer, Sean Pavlik, Megan Schmenk, Liz Yates

Guidance Documents

1. Background from Greening the OR® and Practice Greenhealth
2. How to Use this Toolkit
3. Business Case for Greening the Dental Clinic
4. Greening the Dental Clinic Checklist

Background from Greening the OR®

“Greening the OR® is an initiative led by Practice Greenhealth to coalesce and build the body of knowledge around environmental best practices in the OR that can also improve patient safety, worker health and the bottom line. A number of hospitals have made significant advancements in identifying green best practices in the OR, but until now, no one has stepped in to make those best practices accessible in one place, nor facilitate the kinds of dialogue needed to drive green innovation in the OR forward. Tackling OR culture, while difficult, is possible when you have strong data to base decisions upon, peer hospitals who can model best practices, and leadership from within the OR. Patient safety must and will remain paramount in any discussion of alternate practices or products.”¹

This toolkit is an adaptation of Greening the OR® to “Greening the Dental Clinic.” This toolkit is meant to help guide any interested persons who want to “green” their dental clinic, be it a small private practice or a large clinic setting such as a dental school. Below is a list of points on how to use the toolkit and the “Greening the Dental Clinic” checklist. This initial version was written as a starting point for the movement towards sustainable dentistry.

How to Use this Toolkit

Complete the provided checklist to get a sense of how far along your facility is in greening its clinics. Use this checklist to do a self-audit. You will discover how many sustainable practices you already have in place, the areas in which changes must be implemented, and many new ideas you have not yet explored.

We plan to provide Implementation Modules and Case Studies in the future to help guide your clinic through these changes.

Business Case for Greening the Dental Clinic

Sustainability within the United States (U.S.) healthcare industry, and specifically within dentistry, is a largely untapped field. Despite the increasing recognition and implementation of sustainable practices across the corporate sector and the visibility of environmental issues in the news over the past decade, sustainability has yet to become a priority in the field of healthcare. In the U.S., isolated institutions have adopted internal initiatives to decrease the environmental impact of their facilities. In an effort to connect these institutions and aid in their sustainability goals, several professional interest groups have developed. In contrast, the European Union (EU) and Australia have adopted ambitious implementation strategies and regulations to encourage increased sustainability. For example, the EU has gone as far as to publish Green Public Procurement (GPP) guidelines for all

¹ Greening the OR: The Business Case for Greening the OR. Practice Greenhealth 2011.

governmental organizations, including healthcare institutions. Furthermore, the overwhelming majority of the health-related research and regulations that have been implemented in the U.S. pertain to hospital systems and operating rooms, while the literature or awareness surrounding sustainability in dentistry is almost nonexistent.

Additionally, improving sustainability affords tremendous opportunity for cost savings. The constant, unsustainable rise of healthcare costs in America, has fueled increased attention to cost-saving initiatives. The “Greening the Dental Clinic” movement provides an opportunity to curb the cost curve and simultaneously ensure more environmentally sustainable practices. The Greening the OR® movement serves as a model for our dental initiative, especially because the two fields are not without similarities. Most importantly, like operating rooms, dental clinics are relatively uniform in their setup and materials usage within a single institution. This standardization better enables a uniform implementation of cost-saving, green changes.

Furthermore, recent surveys from the American Dental Association indicate that the proportion of large, multi-site dental clinics is growing. One survey found that the number of dental firms with more than ten offices expanded from 157 in 1992, to 3,009 in 2007, and this growth is continuing. The shift from the traditional sole proprietorship model to a multisite model provides an important opportunity to streamline and maximize sustainability across clinics.

This “Greening the Dental Clinic” toolkit is one part of a larger effort to address the dearth of literature on sustainability in dentistry by providing a quick and comprehensive checklist for providers who want to improve the sustainability of their clinics, while also being mindful of economic considerations.

Greening the Dental Clinic Checklist

Facility Name: _____

Contact Name: _____ Title: _____

Phone: _____ Email: _____ Date: _____

Greening the Dental Clinic Checklist	Fully Established (> 1 Year)	Implementation in Progress	Not Implemented	Unaware of the Program / Process	Not Applicable (N/A)	Additional Notes
Organizational Development						
Assess the Current Processes and Identify Problems in Sustainability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Endorse and Participate in the Greening the Dental Clinic Initiative	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Identify potential partners and Build a Green Team specific to the Dental Clinic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Educate Dental Clinic Staff on Benefits of Greening and Opportunities for cost and waste reduction and safety benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Train Staff on Use and Collection of Reusables	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Create a Mechanism for Feedback to assess implementation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Track Improvements and Recognize Successes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Promote involvement in sustainability activism	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Implement staff training program around proper sanitation of reusable products (headrest covers, patient bibs, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Waste Reduction and Prevention in the Dental Clinic					
Conduct Waste Audit to identify largest sources of waste and target reduction and/or redirection of this waste stream	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Implement Process for recycling as much as possible. Contact local recycling facility to clarify and maximize what can be recycled					
Implement Process for proper disinfection of patient areas to reduce use of disposable barriers (i.e. paper covers, blue tape, head covers)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize reusable materials (i.e. stainless steel suction tips and air/water syringe tips, washable bibs, reusable protective eyewear for staff and patients, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Identify partners/vendors willing to recycle unique waste items (e.g. reusable sharps containers and disposable gloves)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use digital dentistry (digital radiographs, digital charting, CAD/CAM systems) to reduce waste and minimize chemical usage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize products to the full potential, and purchase products that support sustainable choices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Environmentally Preferred Purchasing					
Utilize non-toxic hand hygiene products such as alcohol based hand rubs that do not have triclosan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Partner with oral care supplies company to provide patients samples that have minimal impact on the environment and to encourage participation in recycling take-back program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use autoclaves, instrument disinfectants and surface disinfectants that are non-toxic and maximize efficiency and infection control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use interactive patient education tools to enhance dental experience to expand patient base over time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize lightweight, durable handpieces that enhance ergonomic support by reducing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

stress and fatigue					
Built Environment					
Utilize occupancy sensors for lighting to reduce energy use in unoccupied rooms.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Program HVAC systems to reduce air changes when rooms are unoccupied in order to reduce energy use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Employ LED lighting to reduce energy use and increase thermal comfort	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use an anesthetic gas capture system to capture waste anesthetic gases (WAGs) and prevent venting to outside air	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize modular casework that does not contain harmful substances ¹	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize durable countertops such as solid surfacing that do not contain harmful substances ¹	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize flooring products that do not contain harmful substances ¹	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Utilize epoxy-free and bisphenol A (BPA)-free coatings for walls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Implement ASHRAE 170 guidance as a mechanism to reduce energy use in the Dental Clinic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use paperless documentation systems to prevent errors, speed information exchange, conserve resources and reduce space.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Incorporate natural design elements like plants, artwork, or structural elements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Employ ceiling fans to circulate air, reducing energy use and improving occupant comfort	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Provide user control over ambient conditions with operable windows, temperature control systems, fans, or other technologies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Employ building monitoring systems to track energy and water use. Track performance and implement changes as needed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Employ low-flow faucet adaptors to reduce water use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Install on-demand hot water heaters or solar hot water heating systems to reduce energy usage for water heating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

¹ Harmful substances include urea formaldehyde or chlorine derivatives. The “gold standard” for products will meet ILFI DeclareSM criteria.

APPENDIX D: UNPACKING THE TOOLKIT

Unpacking the Toolkit

Some of the suggestions in the “Greening the Dental Clinic” toolkit are broad and difficult to translate into concrete, specific actions. Where appropriate, we have provided specific suggestions on how to tackle various aspects of the sustainability toolkit. None of the resources provided are specifically endorsed or verified by the “Greening the Dental Clinic” team, but are intended as initial resources and as a basis for comparison. We recognize that each dental clinic is unique in its scope of practice, patient cohort and goals so each of these suggestions is intended as a jumping-off point that can be tailored to each user. Please feel free to contact us (dowdental2016@umich.edu) with any suggestions or implementation strategies that have worked for your institution that are not represented here.

Organizational Development	
Assess the Current Process and Identify Problems	<ul style="list-style-type: none">- Survey employees’ sustainability beliefs and in-clinic practices- Assess mission statement/administrative documents for sustainable principles- Survey patients’ sustainability beliefs, values- Specifically assess hazardous waste disposal because the red hazard bins are often overused. Review relevant regulations here: https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-regulations#haz, https://www.epa.gov/hw
Endorse and Participate in the Greening the Dental Clinic Initiative	<ul style="list-style-type: none">- Incorporate sustainability into mission statement- Become a member at https://practicegreenhealth.org/- Incorporate information on sustainable practices in advertising materials
Identify potential partners and Build a Green Team specific to the Dental Clinic	<ul style="list-style-type: none">- Investigate local hospitals’, health centers’ sustainability initiatives- Request information from local government on incentives for green practices- Designate specific staff at multiple levels to participate in an interdisciplinary “Green Team” tasked with design and maintenance of initiatives. Consider how/when these staff should communicate with employees and administration
Educate Dental Clinic Staff on Benefits of Greening and Opportunities for cost and waste reduction and safety benefits	<ul style="list-style-type: none">- Potential resources for discussion: ***- Circulate savings information via email with implementation of waste reduction processes- Provide training on what qualifies as hazardous waste
Train Staff on Use and Collection of Reusables	<ul style="list-style-type: none">- Contact local recycling agency to ensure appropriate compliance- If not using digital x-rays, train staff to recycle fixer/developer solutions and lead foil (http://www.hercenter.org/wastereduction/dentalwastes.cfm)
Create a Mechanism for Feedback to assess implementation	<ul style="list-style-type: none">- Can be an assigned responsibility of the Green Team or a specific point-person- Consider an anonymous process to encourage honest feedback
Track Improvements and Recognize Successes	<ul style="list-style-type: none">- Incorporate assessment of sustainability practices into regular process evaluations- Provide incentives for successful completion of sustainability goals

	<ul style="list-style-type: none"> - Publicize employees or teams who make notable efforts to decrease the environmental impact of their practices
Promote involvement in sustainability activism	<ul style="list-style-type: none"> - Inform local ADA of your clinic's sustainability efforts and request that they incorporate sustainability into their mission statement - Reach out to local government regarding sustainable business regulations and incentives - Discuss at-home sustainable practices with your patients (minimizing tap water use while brushing, choosing a sustainable dentist)
Waste Reduction and Prevention in the Dental Clinic	
Conduct Waste Audit to identify largest sources of waste and target reduction and/or redirection of this waste stream	<ul style="list-style-type: none"> - Set a time to collect waste bags produced from either an average day of operations, or over the course of a standard number of patients. - Complete a consumption analysis of individual products (gloves, masks, protective barriers, disposable products), measuring items by either weight, volume, or item number. Due to the small size and light weight of many dental products, we recommend conducting your analysis based on either volume or by counting individual items. - Identify the largest sources of waste based on this analysis. - To reduce overuse of hazards and sharps containers, assess the appropriate disposal of waste contaminated with body fluid. Make these smallest and furthest away in the room to prevent the unnecessary use of these special waste containers. - Evaluate the current method of metal disposal. Ideally, the dental clinic should have segregated recycling bins for metals from any amalgam scraps, extracted teeth containing amalgam fillings, lead radiograph foils, etc. as these are very toxic and can leach into waste. If metals are found in the regular waste stream during the waste audit, a special recycling bin must be implemented.
Implement Process for recycling as much as possible. Contact local recycling facility to clarify and maximize what can be recycled	<ul style="list-style-type: none"> - Contact the local recycling facility to clarify and maximize what can be recycled. - Gather information about the items that were found to create the largest amount of waste in the waste audit (gloves, masks, sterilization pouches, etc.) and communicate with the local recycling facility about what/how these items can be recycled.
Implement Process for proper disinfection of patient areas to reduce use of disposable barriers (i.e. paper covers, blue tape, head covers)	<ul style="list-style-type: none"> - If the clinic uses paper barriers on surfaces for infection control, reduce use of paper barriers on "housekeeping surfaces," only protecting clinical contact surfaces.
Utilize reusable materials (i.e. stainless steel suction tips and air/water syringe tips, washable bibs, reusable protective eyewear for staff and patients, etc.)	<ul style="list-style-type: none"> - To replace disposable bibs, consider using washable OR cotton towels as patient bibs, or moving from 2-ply to 1-ply disposable bibs. - Consider moving to autoclavable stainless steel suction tip and air/water syringe <ul style="list-style-type: none"> - http://www.hagerworldwide.com/index.php/component/virtuemart/view/productdetails/virtuemart_product_id/1507/virtuemart_category_id/lang/en - Also consider alternatives to plastic products, such as these ECOTip HVE Tips made from renewable, sustainable paper, and designed to withstand moisture absorption and fraying <ul style="list-style-type: none"> - http://www.practicon.com/item/vented-dental-drawings-ecotip-hve-tips-7108316/7108316

	<ul style="list-style-type: none"> - Use reusable protective eyewear which can be washed with soap and water or wiped down between patients. <ul style="list-style-type: none"> - Consider stocking each chair with multiple cleaned glasses so there is no disruption in the turnover of patients, and clean all of the used glasses together at the end of the day
Identify partners/vendors willing to recycle unique waste items (e.g. reusable sharps containers, disposable gloves, broken or damaged dental instruments)	<ul style="list-style-type: none"> - Depending on what your local recycling facility can process, reach out to other vendors who will recycle unique waste items. Below are a few ideas: <ul style="list-style-type: none"> - http://wastetogreen.com/recycling/index.html - “Zero Waste Boxes” from the company TerraCycle offer many ways to recycle unique items such as disposable gloves, personal protective equipment (safety glasses and masks), and even oral hygiene products. For example, recycled nitrile and/or latex gloves will be sent back to the company in a pallet to be cryogenically frozen and processed into a powder which can be used to make new plastic products such as park benches and container bins. <ul style="list-style-type: none"> - https://www.terracycle.com/en-US/zero_waste_boxes/disposable-gloves - http://zerowasteboxes.terracycle.ca/products/safety-equipment-and-protective-gear-zero-waste-boxes - http://zerowasteboxes.terracycle.ca/products/oral-care-waste-and-packaging-sponsored-zero-waste-boxes - Participate in the Hu-Friedy Envirodent program, where for every even increment of 12 instruments you recycle, you can select 1 Hu-Friedy instrument, absolutely free. <ul style="list-style-type: none"> - http://www.hu-friedy.com/envirodent/ - As an alternative to the incineration of medical waste, many companies have developed ways to compact and sterilize medical waste. <ul style="list-style-type: none"> - Sterilis Medical offers a system to effectively and efficiently transforms full sharps containers, scalpel blades, surgical drapes and capes, glass ampules, suture kits, and all other forms of regulated medical waste into sterile solid waste in less than 60 minutes in a machine the size of a photocopier. http://www.sterilismedical.com/practicetypes/oralsurgeons.htm - Red Bag Solutions also offers cost effective treatment technology that simultaneously grinds and sterilizes medical waste “onsite.” The waste is rendered unrecognizable, volume is reduced up to 90% and weight by up to 30%, which in turn reduces the amount of waste going into the landfill. https://www.redbag.com/about-red-bag-solutions - Consider moving to reusable sharps container systems, instead of buying disposable sharps containers that go into the infectious waste stream and drive up waste costs while also requiring ongoing replacement. Full containers are collected by a service provider who mechanically empties, cleans, and disinfects the containers and returns them for reuse. Containers are often used hundreds of times, driving down both waste and replacement supply costs. <ul style="list-style-type: none"> - https://medsafewaste.com/services/reusable-sharps-program/
Use digital dentistry	<ul style="list-style-type: none"> - Convert all x-ray imaging to digital radiographs

(digital radiographs, digital charting, CAD/CAM systems to reduce waste and minimize chemical usage	<ul style="list-style-type: none"> - Transitioning from paper charts to electronic health records, can save a significant amount of paper. - Utilize CAD/CAM systems to streamline the process of taking impressions, making models, and fabricating restorations.
Utilize products to the full potential, and purchase products that support sustainable choices	<ul style="list-style-type: none"> - Follow manufacturer directions for material usage to ensure the accurate mixing of chemicals and limit material waste. - Ensure sterilizers and cleaning units are full to reduce the number of cycles per day. - Use products made from recycled materials, such as paper towels or the ECOTip HVE suction tip mentioned above - Chose products packaged with recycled materials and packaging that contains more items per product (ie. purchasing gloves in boxes of 200 rather than 100). - Maintain proper inventory control to reduce the waste of expired dental materials. Rotate the oldest products to the front line and utilize a clear system of tracking inventory.
Environmentally Preferred Purchasing	
Utilize non-toxic hand hygiene products such as alcohol based hand rubs that do not have triclosan	<ul style="list-style-type: none"> - Non-toxic intermediate-level hospital grade disinfectant - Hydrogen peroxide based product that breaks down to oxygen and water - OPT/IM 33TB is one example http://www.scicanusa.com/optim-33tb
Partner with oral care supplies company to provide patients samples that have minimal impact on the environment and to encourage recycling take-back program	<ul style="list-style-type: none"> - TerraCycle partners with Colgate to partners with Colgate to take back used toothbrushes and packaging, toothpaste tubes, empty dental floss containers, and toothpaste cartons. - Plastic is melted to create new recyclable materials - http://www.terracycle.com/en-US/brigades/colgate
Use autoclaves, instrument disinfectants and surface disinfectants that are non-toxic maximize efficiency and infection control	<ul style="list-style-type: none"> - Follow proper cleaning procedure in dental operatory to disinfect the patient and provider chairs, and all clinical contact surfaces including light handles, switches, dental radiograph equipment, and countertops - Surface disinfectants with efficient kill times will maximize efficiency in the clinic setting when the turnover time between providing care to each patient is small and fast cleaning is needed
Use interactive patient education tools to enhance dental experience to expand patient base over time	<ul style="list-style-type: none"> - Engage patients in conversations about sustainability in dentistry to encourage sustainable practices in daily life such as reduced water usage during while brushing teeth - Notion of sustainability will motivate patients to recommend the dental practice to others, therefore increasing the patient base over time
Utilize lightweight, durable handpieces that enhance ergonomic support by reducing stress and fatigue	<ul style="list-style-type: none"> - Less stress on the dental provider's body will improve wellness and longevity allowing him or her to continue providing care at the highest level
Built Environment	

Utilize lighting occupancy sensors and daylight harvesting to reduce energy use.	<ul style="list-style-type: none"> - Install daylight responsive controls in daylit areas which dim lighting sources based on available sunlight. - Occupancy sensors are available through multiple vendors, providing ample options for specific facilities. - Both the above lighting options provide LEED credits during certification
Program HVAC systems to reduce air changes when rooms are unoccupied in order to reduce energy use	<ul style="list-style-type: none"> - This is controllable through the building's BEMS system. Facility managers should monitor occupancy trends and alter HVAC performance accordingly. - Follow ASHRAE standards for indoor air quality when determining air exchange rates.
Employ LED lighting and other energy-saving lighting technologies to reduce energy use	<ul style="list-style-type: none"> - Proper lighting quality (CRI, Temperature) are critical in the dental setting. For color-matching, lighting color temperature should be close to 5500°K and have a CRI of at least 93. - Dental operatory lights are available through Dental EZ Integrated Solutions and A-Dec. <ul style="list-style-type: none"> - http://www.dentalez.com/products/dentalez/dental-operatory-lights - http://ie.a-dec.com/en/Products/Dental-Lights
Use an anesthetic gas capture system to capture waste anesthetic gases (WAGs) and prevent venting to outside air	<ul style="list-style-type: none"> - Follow OSHA guidelines for anesthetic gas exposure: https://www.osha.gov/dts/osta/anestheticgases/ - Anesthetic Gas Reclamation, LLC developed a Dynamic Gas Scavenging System (DGSS) which collects and reuses 99% of anesthetic gases without chemically altering them in the process. <ul style="list-style-type: none"> - http://www.gasrecycler.com/products/
Utilize modular casework that does not contain harmful substances	<ul style="list-style-type: none"> - Seek out products without harmful chemical substances identified on the Red List - http://living-future.org/redlist - Product sourcing can be done through the following websites which offer products vetted for "sustainability": <ul style="list-style-type: none"> - https://living-future.org/declare-products - http://www.ecodentistry.org/greendoc/product-guide/
Utilize durable countertops such as solid surfacing that do not contain harmful substances ¹	<ul style="list-style-type: none"> - Seek out products without harmful chemical substances identified on the Red List - http://living-future.org/redlist - Product sourcing can be done through the following websites which offer products vetted for "sustainability": <ul style="list-style-type: none"> - https://living-future.org/declare-products - http://www.ecodentistry.org/greendoc/product-guide/
Utilize flooring products that do not contain harmful substances ¹	<ul style="list-style-type: none"> - Seek out products without harmful chemical substances identified on the Red List - http://living-future.org/redlist - Product sourcing can be done through the following websites which offer products vetted for "sustainability": <ul style="list-style-type: none"> - https://living-future.org/declare-products - http://www.ecodentistry.org/greendoc/product-guide/
Utilize epoxy-free and bisphenol A (BPA)-free coatings for walls	<ul style="list-style-type: none"> - Inspect all Material Safety Data Sheets (MSDS) for wall coating to ensure they are epoxy-free and BPA-free. <ul style="list-style-type: none"> - http://healthybuilding.net/uploads/files/bisphenol-a-in-building-materials-high-performance-paint-coatings.pdf
Implement ASHRAE 170 guidance as a mechanism to reduce energy use in the Dental Clinic	<ul style="list-style-type: none"> - ASHRAE standards serve as a baseline for many aspects of building performance, they also publish guidance documents for high performing buildings and energy design guides. Use them to generate ideas for improving your facility's performance.
Use paperless documentation systems to	<ul style="list-style-type: none"> - Electronic health records (EHR) help improve quality of care, security, and efficiency in the dental office./

prevent errors, speed information exchange, conserve resources and reduce space.	<ul style="list-style-type: none"> - Use digital systems for X-Rays, generating treatment plans, and most other documentation. - Some companies providing paperless documentation software include: <ul style="list-style-type: none"> - http://www.ace-dental.com/ - http://dovetail.co/ - http://unbouncepages.com/curve-dental-software-capterra/
Incorporate natural design elements like plants, artwork, or structural elements	<ul style="list-style-type: none"> - Benefits for incorporating biophilic design into spaces are numerous, from increased cognitive function to decreased stress and blood pressure. - Use various biophilic patterns when designing a space: <ul style="list-style-type: none"> - https://www.terrapinbrightgreen.com/report/14-patterns/
Employ ceiling fans to circulate air, reducing energy use and improve occupant comfort	<ul style="list-style-type: none"> - Depending on your thermostat set-point, installing fans can provide up to 20% HVAC energy savings. - Key considerations for fans include: <ul style="list-style-type: none"> - Proper placement for optimal air circulation - Proper sizing - Proper set speed to improve occupant thermal comfort
Provide user control over ambient conditions with operable windows, temperature control systems, fans, or other technologies.	<ul style="list-style-type: none"> - Occupant control over temperature, noise, air movement, and lighting are important components of an effective work environment. - When possible, provide control to occupants to manage their individual thermal comfort, airflow, lighting and noise levels. - Consider implementing smart building technology to learn occupant trends and preferences.
Employ a Building Management System (BMS) to track energy and water use. Track performance and implement changes as needed.	<ul style="list-style-type: none"> - A BMS provides potential to realize up to 50% energy savings within a building, and can help digitally control a building's temperature, illumination, security, and other mechanical or electrical operations. - A BMS should be tailored to its building, and many commercial systems are available which provide varying degrees of control, tracking and management of building systems.