Moving Beyond Seating-centered Learning Environments: Opportunities and Challenges Identified in a POE of a Campus Library

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ABSTRACT

Colleges increasingly are recognized as student workplaces, inspiring campus leaders to create healthier campus environments. Yet challenging this vision is burgeoning research regarding the health risks of sedentary behavior, an under-studied college health concern that implies deleterious health outcomes and, by extension, academic impediments as well.

Can movement be incorporated into academic activities such as studying or reading? This question—particularly relevant to libraries due to their increasing use as study spaces—requires the expansion of standard methods of evaluating student health needs and behaviors. We propose Post-Occupancy Evaluation (POE) methods as a novel way to investigate sedentary behaviors in a campus library *and* identify designs and practices to help promote movement.

In 2012 and 2013, as part of an undergraduate architecture class, we conducted two POEs of Berkeley's newest library to learn how the space is used and, inspired by new research about the perils of sedentary behavior, we also considered how the library could be used. Through our findings we confirmed the changing role of campus libraries as study spaces, observed social and built environment contexts of sedentary behaviors in library settings, and identified possible interventions to introduce postural variation and physical activity into observed patterns of library use.

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INTRODUCTION

School and college settings increasingly are recognized as the workplace of students (Gardner & Kelly, 2005), inspiring campus leaders across the nation to define and create healthy campuses. This endeavor involves a complex intersection of the body, environment, and health. We see health holistically and define a healthy campus as a place that supports the whole student—a unified bio-psycho-social entity—and actively promotes positive health outcomes.[1] Posing an exceptional challenge to campus health, however, is a burgeoning body of research regarding the health risks of sedentary behavior and physical inactivity that together produce myriad health risks *regardless of physical activity levels* (Dunlop et al., 2014; Hamilton, Healy, Dunstan, Zderic, & Owen, 2008; Saunders, 2011; Tremblay, Colley, Saunders, Healy, & Owen, 2010). As de facto centers of student life and quintessential places of sitting, academic libraries are uniquely suited to participate in the creation of healthy campus environments.

In this paper we employ Post-Occupancy Evaluation (POE) methods as a means of evaluating student uses and perceptions of UC Berkeley's newest library and propose another use of POE as well: a novel way to investigate sedentary behaviors and, in so doing, illuminate possible designs and practices that can help to simultaneously reduce sedentary behaviors *and* promote physical activity. Thus, we present here an initial, exploratory study employing POE methods to understand the social and built environment contexts of students' study-related behaviors and, in response, identify practical solutions that simultaneously support observed use and introduce opportunities for healthy postures and activities in library (and other campus) settings.

INTRODUCTION TO POST-OCCUPANCY EVALUATION METHODS

Post-Occupancy Evaluation, a field of study that arose in the 1960s from an "extraordinary confluence of interests among social scientists, designers, and planners" (Zimring, 2001, p. 306) has been defined as:

The *systematic* assessment of the process of delivering buildings or other designed settings or the *performance* of those settings as they are actually used, or both, as compared to a set of *implicit or explicit standards*, with the intention of *improving* process or settings [emphasis in original]. (Zimring, 2001, p. 317)

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  [1] The 1948 World Health Organization constitution offers this definition of health: "a state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity" (in Nutbeam, 1998).

Said another way, Post-Occupancy Evaluation is the study of buildings *in use*—after they have been completed and occupied—and an important aspect of the field of environment-behavior research that helps to illuminate the experience of the non-paying client (building user) and offer insight to inform policy, design, and program changes at the site and other similar buildings (Zeisel, 1975; Zimring, 2001). As a general type of study, POEs can focus on assessing the stated goals of the building as compared to its actual performance and use, evaluate services and advise on new (see for example Cranz, 2013), and investigate user perceptions of building design and programming. In so doing, POEs can support organizational learning (Zimring, 2001) and provide accountability with public projects (Cranz, 2013; Lushington & Kusak, 1991). Further, POEs are useful to address a number of concerns—such as design, maintenance, user experience, and policy—from a variety of perspectives, including users (Cranz & Cha, 2006), staff (Schneekloth & Keable, 1991), or both (Cranz, Taylor, & Broudehoux, 1997).

Cranz (2013) argues that libraries in particular are rich sites for POE studies due to the many constituencies they contain and many publics they serve. Summarizing the collective value of POE research conducted in libraries, Cranz writes:

> In general we can conclude that library POEs have been useful for helping planners and designers create good user experiences and functional libraries. Collectively, they have highlighted wayfinding, user preference for choice in seating, staff workflow, and the importance of flexibility for continuous growth and changes in library materials and technology. (p. 78)

Thus, POE research can be helpful to library design, space planning, and administration in two ways. First, the collective findings of previous studies can help provide general clues into common issues, needs, and experiences, and thus provide important, evidence-based insight to design, program, and policy issues that can inform other projects. Second, Post-Occupancy Evaluation studies are an essential component of organizational learning and "fine-tuning" of the building (Zimring, 2001) to assess and make changes to a building once it has been completed and occupied.

In this way, in POE research, the objectives of new buildings "can be treated as hypotheses to be tested once the building is complete and by studying how the users occupy the space" (Cranz et al., 1997, p. 39). Yet our study, presented below, differs in an important way: we utilized not only the stated goals and objectives of the building as hypotheses, but also burgeoning research in student health and sedentary physiology as inspiration—and justification—for our study.

HEALTH IMPLICATIONS OF SEDENTARY STUDENT BEHAVIOR

Saunders (2011), citing recent studies linking prolonged sitting to changes in skeletal muscle, blood cholesterol, and lipid and glucose levels, argues that sedentary behavior—even a few hours at a time—poses a health risk greater than that of smoking, obesity, and old age. More alarmingly, the mortality risk linked to sedentary behavior is not ameliorated or offset by exercise; in other words, meeting recommended exercise levels—or even increasing "leisure time" physical activity levels—is unlikely to prevent obesity and other deleterious health outcomes in an otherwise sedentary lifestyle (Chastin & Skelton, 2012; Owen, Bauman, & Brown, 2009). College students, who spend an estimated 30 + hours per week engaged in sedentary behaviors (Buckworth & Nigg, 2010),[2] are not immune to these risks. Obesity among college students is on the rise—in fact, one study of University of New Hampshire students found that 47% of college males met the criteria for obesity in 2011—and the sedentary student lifestyle increases college students' risk for developing cardiovascular disease and diabetes mellitus

Image 1. Why do academic activities assume the use of a chair? (Image credit: Caitlin DeClercq).

(Morrell, Lofgren, Burke, & Reilly, 2012). These findings call into question typical conceptions of health promotion and implore us to reconsider our designs for campus health; in particular, we cannot take the sedentary norm of academic environments for granted.

Thus, the implication is clear: we must shift the focus of our health promotion efforts to the reduction of sedentary hours and aim our interventions at the environments in which we spend the majority of our waking hours sitting down: at work and school.

RETHINKING SEDENTARY LEARNING ENVIRONMENTS

The common, unquestioned assumption that academic activities are sedentary (see Buckworth & Nigg, 2010) can be read in the built environment: even a casual observer will notice that classrooms, libraries, cafes, and common areas are filled with chairs and benches (Image 1). Such sitting-centered environments undoubtedly contribute to long hours of sedentary behaviors and may play a larger role in the transition between active childhoods and sedentary adulthoods (Dunlop et al., 2014; Gordon-Larsen, The, & Adair, 2010). Further, the sitting posture itself is fraught with health concerns: ergonomic and somatic disciplines have long presented evidence of the ways in which chair-sitting contributes to back, neck, and eye problems (Cranz, 2000; Mandal, 1997).

Students are particularly susceptible to these ailments due to prolonged exposure to standardized school furniture (Mandal, 1997; Gardner & Kelly, 2005). In fact, 12.5% of college students reported back pain in the Spring 2012 National College Health Assessment Survey (American College Health Association, 2012),[3] a concerning statistic given that back pain is linked to truancy, distraction, and reduced motivation and physical activity (Gardner & Kelly, 2005). Further, physical activity is widely seen as a "leisure time" pursuit for college students (see American College Health Association, 2012 and Buckworth & Nigg, 2010), which is assumed to occur in non-academic spaces and thus remain spatially and temporally removed from academic activities.

Despite recent interest in the role of built environment interventions to improve the health of both children and adults (see Dannenberg,

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[2] Or more, as suggested by a pair of informal sitting-logs we distributed sitting logs in two architecture courses at UC Berkeley (Fall 2012 and Fall 2013).

[3] Though the cause of the back pain incidence is not specified, evidence from Mandal (1997), Cranz (2000), and Gardner and Kelly (2005) suggests that prolonged exposure to standardized furniture and sedentary behaviors could be a significant contributor to incidence of back pain among students.

Frumkin, & Jackson, 2011), as well as continued recognition of educational environments as effective sites for health interventions (Erwin, Fedewa, Beighle, & Ahn, 2012; Weschler, Devereaux, Davis, & Collins, 2000), college students are an under-studied and under-served population in regard to their sedentary behavior while studying (Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008). We must ask, then, what damage we are doing to the minds, bodies, and health of young people by designing learning environments for sitting. And in response, in this paper we argue the need to simultaneously reduce overall sedentary time, minimize the use of chairs, *and* promote physical activity in all academic environments. To that end, the principles of body-conscious design, informed by somatic conceptions of the mind and body and concerned with designing the "near environment" (Cranz, 2000)[4] for movement and postural variation, can guide the evaluation and design of campus environments.

TOWARD A HEALTHY CAMPUS

Our bodies are designed for movement (Opsvik, 2008); thus, environments that invite movement and postural range are naturally therapeutic for the body and, in turn, the mind (Cohen, 1993). Movement of all kinds is linked to cognitive function (Donnelly & Lambourne, 2011; Hillman, Kamijo, & Scudder, 2011), creativity, learning (Erwin et al., 2012), and memory (Cranz, 2000) as well as numerous health benefits across a range of mental and physical health outcomes (Penedo & Dahn, 2005). Additionally, exercise can help to reduce stress (Dannenberg et al., 2011), so designing educational spaces to include movement, one of the basic principles of body conscious design, could help to create a holistic, healthier campus ecology for students.

Thus, in light of the physical, mental, and academic consequences of a sedentary student culture, campus leaders, designers, and students alike must confront the status quo of sedentary student spaces and find novel and body-conscious solutions to foster physical activity and postural variation that, in turn, promote student health. We offer this Post-Occupancy Evaluation study as a unique method for exploring this hidden student health need. In this way, we see our study as offering a novel use of POEs for assessing student health behaviors and needs and identifying practical recommendations to interrupt the sedentary norm of campus environments.

In this paper we ask: Is it possible to move *and* study? In other words, how can movement be incorporated into routine academic activities like studying and reading? Perhaps nowhere is this dilemma in greater relief than in the academic library, a quintessential place of sitting on campus. To investigate this question in the specific context of college campuses requires the expansion of standard methods of evaluating student health needs and behaviors. To that end, POE methods can inform organizational learning and future practice (Zimring, 2001) regarding campus health needs and bring this hidden health issue into greater focus by: explicitly investigating student behaviors in a specific campus setting, illuminating contextual factors (Stokols, 1992) that contribute to sedentary behaviors in campus libraries, and identifying practical design and policy changes to create healthier libraries and other campus spaces.

In the fall of 2012, as part of an undergraduate architecture class, we conducted a POE of the Berkeley campus's newest library—the C.V. Starr East Asian Library (Image 2)—to study how the space is currently being used. Additionally, in light of new research about the perils of sedentary behavior, we kept an eye to how the library *could be* used. Based on our findings from the POE study, we recommend environmental interventions to interrupt the chair-bound, sedentary student lifestyle and identify broader implications for future campus planning and design.

SITE DESCRIPTION

The award-winning C.V. Starr East Asian Library, completed in 2008 by Tod Williams and Billie Tsien Architects (TWBTA), was designed to consolidate the University's collection of Chinese, Japanese, and Korean literature and is the United States' first freestanding library constructed exclusively for East Asian collections (Maclay, 2008; Sweeney, 2014). Today the library possesses one of the largest collections of East Asian language literature in the United States, with almost 950,000 volumes in Chinese, Japanese, and Korean languages on-site. The four-story, 60,000 square-foot building was designed over the course of two decades. Its exterior echoes the neo-classical style of nearby Doe Library, while large copper screens shading windows on two of its facades evoke Asian motifs (Image 2). The modern interior features a central staircase complemented by a beautiful mix of concrete, glass, and wood materials as well as skylights that provide natural light to the upper levels of the library. Anticipating widespread personal computer use, the library was equipped with wireless internet, and electrical outlets are located conveniently at or near all study spaces. Each of the building's four floors has a distinct feel, from the dimly-lit, quiet lower floors to the brighter, busier upper floors (note that the main entrance is located on the third floor of the building).

This paper investigates the open spaces of the library that Applegate (2009) has referred to as "'soft spaces'—areas that are not the stacks and not computer labs: carrels, tables, [and] … chairs…" (p. 341).[5] At the East Asian Library, such spaces are distributed throughout each of the four floors, though the specific furniture options and ambient qualities of spaces (for example, lighting and noise) vary slightly with each: the first floor, the quietest and most dimly-lit of the building, offers individual study carrels grouped into blocks of 6 and 12 desks; the second floor also offers 18 individual study carrels, but arranged single-file along the north wall, as well as two large tables that can seat 6 and 8 people, respectively; in the stairwell between the 2nd and 3rd floors is a small bench that can seat 1 or 2 people; the third floor, the busiest of the floors due to the main entrance on the east side of the building, offers a mix of both large tables and individual study carrels in the brightly-lit study space by the large windows on the north side of the building (see Image 3); and the fourth floor, lit by a large skylight and large windows, offers two 6-person tables and a row of 8 large, leather chairs facing the windows on the north side of the building (see Image 4). Stacks of books and periodicals are similarly distributed throughout all four floors of the library, including shorter waist-height shelving on the top floors of the library.

METHODS

Each fall, as part of a large undergraduate class, "Architecture 110AC: Social and Cultural Processes in Architecture and Urbanism", we conduct a Post-Occupancy Evaluation (POE) of a campus building.[6] This project has both a pedagogical goal of introducing a class of 150 undergraduate architecture students to social science research methods for architectural research and a practical goal of studying a building in use and obtaining insight into the user perspectives.[7]

RESEARCH DESIGN

In the fall of 2008, students in Architecture 110AC studied the newly-opened East Asian Library to learn how well-suited the building was to the needs of a variety of users—including

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[4] Body-conscious design is informed by both somatic and ergonomic principles, and thus considers not only the biomechanic aspects of movement common to ergonomics, but also the larger cultural, intellectual, and emotional meanings annealed with the body. In particular, body-conscious design advocates postural variation, respects a variety of body types, and encourages bodily movement (see http://www.bodyconsciousdesign.com).

[5] Though Applegate's (2009) definition of "soft spaces" also includes group study rooms, such spaces were beyond the scope of this study and thus are not included in our analyses.
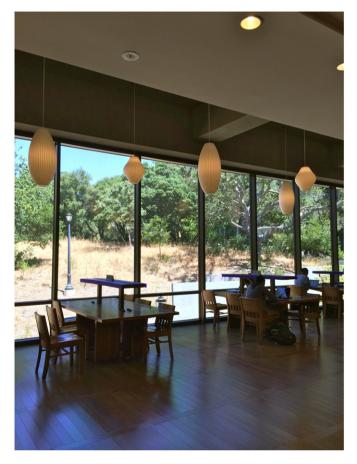
[6] See Cranz et al. (2013) for another POE conducted as part of this course.

[7] For more on the goals of POEs, see Zimring (2001) and Zeisel (1975).

Image 2. The south-east façade of the East Asian Library evokes Asian motifs with large bronze screens while complementing the classical style of nearby Doe Library. (Image credit: Caitlin DeClercq).

administrative and maintenance staff, student and faculty users, and members of the general public—and to identify practical suggestions for current and future adaptations. The initial POE addressed the following questions, which were developed in consultation with the campus architect and the head of collections at the East Asian Library:

1. What do people use the building for?
2. Where are people in the building? Where do they sit?
3. What are unmet needs? What future adaptations might be necessary?
4. Who are the users?
5. How effective is wayfinding/book-finding?
6. How do people circulate through the building?
7. What are the user and staff perceptions of aesthetics, vertigo, and acoustics?
8. What is the quality of maintenance in this building?

In the fall of 2012 and 2013, we decided to revisit Berkeley's East Asian Library and extend our evaluation into a three-part, panel study of the site. As our interests became more refined, we narrowed our research questions and the focus of our second Post-Occupancy Evaluation of the East Asian Library: though we carried over several questions from our initial investigation, half of our questions in these subsequent studies investigated patterns of use relating to postural range, physical activity, and sedentary behavior in the academic library environment. Our questions, developed in consultation with the head of collections, were as follows:

2012
1. Who uses the library?
2. What do people use the library for? Why do they choose this location?
3. Where do people go in the library? How much time do they spend there?
4. How many hours are spent sitting at the library? Elsewhere on campus?
5. What range of postures do people assume at the library? Elsewhere on campus?
6. How do people of all sorts (users, staff, passersby) respond to the look of the building?

Image 3. A light-filled study space on the third floor. (Image credit: Caitlin DeClercq).

2013

1. How does lighting (natural and artificial) impact users' activities?
2. What are user attitudes about the *exterior* architectural design of the building?
3. What are user attitudes about the *interior* architectural design of the building?
4. To what extent does the furniture in office areas support staff needs?
5. How easy it is to find books, toilets, elevators, and building entry/exit areas?
6. To what extent does the furniture in study spaces support patron needs?

These questions were distributed among the 6 student discussion sections in the course; these sections were further divided into 5 smaller workgroups, each focusing on a particular research method: observation, interview, questionnaire, photo elicitation, and archival/precedent studies.

In this way, we created a 6 × 5 matrix of questions and methods (see Table 1), wherein 5–7 students worked as a team on a given question and method. Ultimately, each question was addressed through a combination of 5 data collection techniques.[8]

DATA COLLECTION

Each team was assigned a reading or set of readings pertaining to their research method and was responsible to design their own data collection program and schedule.[9] Though the research approach varied from group to group, a few standards ensured a basic level of quality: for example, observers were required to spend 2 hours conducting observations and doing so at a range of days and times; interviewers (including those conducting photo elicitation interviews) were asked to conduct five 10–15-minute interviews each; questionnaire groups were asked to distribute at least 40 questionnaires; archive/precedent groups were required to note the keywords and sources that guided their research; and each group collected demographic data, where possible. Additionally, in 2008 and 2012 we decided that requiring beginning students to conduct archival research on two of the more specific questions was too difficult; in those circumstances, we split the observational method into two groups: direct observation and indirect observation. Otherwise, observation groups decided on their own which technique(s) (direct/behavioral or indirect/physical traces) would be best suited to their research question(s).

We realized several benefits with this model. First, on the whole we were able to collect a robust set of data: each question was addressed through 5 different research methods. Second, students were exposed to a variety of research methods (through in-class sharing exercises including a final summary of the class findings at our last meeting), yet were able to obtain in-depth experience with one method. Finally, the time and thought required to achieve these gains was shared among 30 student groups, with each student needing to invest only a few hours in data collection and analysis; thus, we see this approach as an efficient and valuable model for architectural firms or campus groups who want to evaluate the built environment without having to dedicate a full-time staff member or hire external consultants to focus on POE research.

Nevertheless, this study also has a number of limitations. First, this study is limited to the East Asian Library at Berkeley and thus does not make any explicit comparison to other libraries on campus. Second, the respondents were self-selected students who chose to use this library, either for its collection or as a study space; thus, it is possible that students who choose to study elsewhere may do so with greater postural variation and/or for different amounts of time than what is reflected in this study. Third, the questions asked in each study (2008, 2012, and 2013) varied and thus preclude a reliable assessment of

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Table 1
Matrix of research questions and methods.

Methods	Questions					
	#1	#2	#3	#4	#5	#6
Archive	1A	2A	3A	4A	5A	6A
Observation	1O	2O	3O	4O	5O	6O
Questionnaire	1Q	2Q	3Q	4Q	5Q	6Q
Interview	1I	2I	3I	4I	5I	6I
Photo elicitation	1P	2P	3P	4P	5P	6P

Note. Each cell (1A, 2A, etc.) corresponds to a unique student-led study consisting of a single research question and research method (see also Table 2).

longitudinal or trend data. Finally, because the groups looking at sedentary behavior were interested primarily in sitting and other postures within this library setting, it is possible that other behaviors that may increase movement or physical activity (such as taking regular breaks, stretching, or walking to/from the library or other destinations) may not have been observed or asked about.

In this paper we present evidence from data obtained over a 5-year period, with a specific focus on data obtained in 2012 and 2013 that helps us understand patterns of use that relate to sedentary behavior and physical inactivity (see list of student studies, referenced below using capital letters, in Table 2).

FINDINGS

In our first POE of the East Asian Library, conducted in 2008, we found that the majority of patrons used the library as a study space and experienced difficulty with wayfinding and book-finding. These findings are consistent with other studies of library spaces: wayfinding is a common problem in academic and public buildings (Weisman, 1981) and academic libraries are increasingly used as study spaces (Applegate, 2009; Stewart, 2010). We also found several patterns of use that contradicted the stated operational or architectural goals for the space. First, though the library was designed to be a hub for students and researchers as well as a place for cultural exchange (Maclay, 2008), less than 1/4 of students used books from the collection, and many engaged in independent study, using their own resources. Second, in an interview with the head librarian of the East Asian Library, we learned that the number of seats in the library was derived in relationship to the number of students majoring in East Asian studies, implying an anticipated correlation between major topic and library use; however, we found that student users represented a broad range of majors including but not limited to East Asian studies. Finally, though the space was designed to showcase circulation (Maclay, 2008) and invite users to meander for "slow discovery" of the library and its resources, we noticed that, once inside, users tended to move around very little. Data obtained in 2012–2013, discussed in greater detail below, confirmed and elaborated these findings.

USES OF THE LIBRARY

WHO GOES TO THE LIBRARY?

Similar to the aforementioned findings in 2008, in 2012 and in 2013 we found that student patrons were primarily undergraduates who represented a variety of majors (D, I); in fact, one research group specified that not one questionnaire respondent in their study self-identified as an East Asian Studies major (I).[10] In an interview with a library staff member, another group discovered that more students use the East Asian Library in its new location than ever before: previously, according to the staff member, about 12 people would visit the collection on a daily basis; today, the library can see 400 + visitors a day (N). Finally, though our data suggests that the vast majority of patrons are undergraduate

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[8] For more on this method, see Cranz et al. (2013) and Cranz et al. (in press).
[9] See Zeisel (2006), Pavlides and Cranz (2012), and Cranz et al. (in press).

[10] These capital letters correspond to unique student group studies; details are in Table 2.

Table 2
Student studies (referenced above in parentheses) by year, question, and method.

	Year	Question	Method
A	2012	How many hours are spent sitting at the library? Elsewhere on campus?	Unobtrusive observation
B	2012	How many hours are spent sitting at the library? Elsewhere on campus?	Interviews; n = 9
C	2012	How many hours are spent sitting at the library? Elsewhere on campus?	Direct observation
D	2012	How many hours are spent sitting at the library? Elsewhere on campus?	Questionnaire; n = 50
E	2012	How many hours are spent sitting at the library? Elsewhere on campus?	Photo elicitation; n = 56
F	2012	What postures are assumed at the library? Elsewhere on campus?	Direct observation; n = 187
G	2012	What is the library used for? Who uses it? Why?	Unobtrusive observation
H	2012	What is the library used for? Who uses it? Why?	Direct observation; n = 403
I	2012	What is the library used for? Who uses it? Why?	Questionnaire (*no n given*)
J	2012	Where do people go in the library? How long do they stay there?	Questionnaire; n = 25
K	2012	Where do people go in the library? How long do they stay there?	Interviews; n = 20
L	2012	Where do people go in the library? How long do they stay there?	Unobtrusive observation
M	2012	Where do people go in the library? How long do they stay there?	Direct observation
N	2012	Where do people go in the library? How long do they stay there?	Photo elicitation; n = 15
O	2013	To what extent does the furniture in study areas support patron needs?	Interview; n = 19
P	2013	To what extent does the furniture in study areas support patron needs?	Photo elicitation; n = 23
Q	2013	To what extent does the furniture in study areas support patron needs?	Questionnaire; n = 41
R	2013	To what extent does the furniture in study areas support patron needs?	Archive/precedent studies
S	2013	To what extent does the furniture in study areas support patron needs?	Direct & unobtrusive obs.
T	2013	How does lighting (natural and artificial) impact users' activities?	Direct observation
U	2013	What are user attitudes about the *interior* design of the building?	Photo elicit. (*no n given*)
V	2013	How easy it is to find books, elevators, entry/exits?	Interviews; n = 60
W	2013	To what extent does the furniture in office areas support staff needs?	Archive/precedent studies

students, faculty, graduate students, and members of the public ('families', according to one group, A)[11] also visit the library.[12] In many ways, the library itself sees a broader use than the collection and area of study might suggest (and than the library planners and architects had predicted); such a change and vast increase in use can be read as evidence of the increasing popularity and use of campus libraries as study spaces (as demonstrated below) and also may suggest the power of beautiful, new, and/or high-profile campus buildings to attract patrons and impact use patterns.

FOR WHAT PURPOSE?

We were surprised to discover that more patrons brought in their own resources (e.g., books, computers) than engaged with the collection of books at the library (G, I); in fact, in one study, only one interview respondent reported having checked out a book from the library (B). These observations are consistent with previous findings (Applegate, 2009; Stewart, 2010) that campus libraries are increasingly taking on a new role as study spaces. Continuing this theme, one group suggested that the East Asian Library is used as a "third space" (R; see also Oldenberg, 1999), or even as a place of "escape" (R; see also Young, 2003).[13]

What activities take place in this new campus study space? In short, a surprising range: 86% of respondents reported individual study/reading; 32% reported waiting in-between classes; others mentioned a range of computer-based activities such as "reading emails," "killing time," "browsing on laptop," or "organizing my life" (I, O). Another group found that students used the library as a place of transition during breaks between classes in addition to doing homework or studying (B). One group conducting observations recorded each of these activities in great detail, demonstrating the variety of uses of this building: on a weekday morning, of 233 patrons observed, 122 were on laptops; 25 were on a phone; 26 were reading; 25 were studying; 7 were using a library computer; 7 were sleeping (H). On a weekend morning, a similar pattern emerged: of 170 patrons observed, 128 were on a laptop; 2 were on a phone; 5 were reading; 26 were studying; 6 were using the library computer for book searches; 2 were sleeping; and 1 was relaxing (H). Perhaps most indicative of the library's changing role, in 2011, the East Asian Library was named one of the "Best Places to Study" on campus by the campus newspaper (Yurovsky, 2011), further evidence of the library's expanding role in campus life (Stewart, 2010; Young, 2003).

WHY THIS LIBRARY?

Ostensibly, any of the aforementioned activities could occur elsewhere; thus, the choice of the East Asian Library as students' chosen study space is telling. We found that drawing students to this library is a mix of pragmatic and aesthetic concerns that help to illuminate what student patrons value in study—and by extension, library—spaces. First, students value the library's ambience and proximity (I). Reasons students chose to patronize this library included: ambience (57%), lighting (47%), its 'close proximity' (40%), and noise levels (35%) (I). Regarding the latter, students explained that they seek a quiet area that won't be distracting while trying to work (I).

Still, though 75% named the East Asian Library as one of their top 3 favorite spots on campus, other students reported preferring other campus libraries due to longer open hours and proximity to other classes (J).

TIME SPENT (IN VARIOUS LOCATIONS) IN THE LIBRARY

HOW MUCH TIME IS SPENT IN THE LIBRARY?

Given the range of activities that occur in the East Asian Library, it is perhaps not surprising that the length of stay ranged from 15 minutes to more than 2 hours. While one group found that about 56% of patrons stay for more than 1 hour and 36% spend an hour or less (J), another group extended this observation, noting that those who spent 15 minutes typically moved around the library; those who stayed for hours were typically studying and sedentary (C). Regarding gender, one group calculated not only an average length of stay of 2.5 hours, but also a gender difference in time spent at the library: men reported longer stays (3 hours) than women (2 hours, 20 min) (O).[14]

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[11] In one questionnaire study, all 41 respondents were undergraduate students (Q); 18 out of the 19 interview participants of another study were undergraduate students (O).

[12] According to the head librarian at the East Asian Library, the EAL serves as a 'neighborhood library' for local speakers of Chinese, Japanese, and Korean languages.

[13] See Given and Leckie (2003) and Kelman (2001) for more on libraries as public spaces.

[14] The same group found that men self-reported coming to the East Asian Library more frequently than women did; yet specific numbers were not given, nor was the total number of men/women reported in this study. Though the significance of these findings cannot be calculated, they do support findings in previous studies. Applegate (2009) and Given and Leckie (2003) identify other gender differences in library use: for example, men use libraries more often than women do; women bring more personal items with them to libraries; and women prefer more public seating and men prefer private carrels (notably, the latter finding reverses Mozingo's (1989) previous observations about how women select quieter, more secluded places to sit in downtown open spaces compared to the busier, more visible areas preferred by men).

Image 4. Seating options at the East Asian Library.
(Photo credit: Caitlin DeClercq).

Taking other places student frequent into consideration, one group discovered that the majority of respondents preferred to spread out their studying, spending approximately 5 hours or less at a time in other places on campus or at home each day. Still, the same questionnaire group found that 10 of 50 respondents reported spending 5 + hours in a single location (D).

It is clear from these results that students spend many hours studying in campus and home spaces; thus, we propose that such study spaces—of which libraries are our primary focus in this study—can be particularly important and effective site for interventions.

WHERE DO PEOPLE GO DURING THAT TIME?

In general, patrons chose seats on the periphery of the building: one group found that most patrons expressed a preference for seats on the periphery and aligned themselves with the edges of the building, particularly near windows and doors (L); other groups offered potential explanations for this trend: privacy (R) or proxemic (S) concerns (see Hall, 1959; also see similar findings regarding the reluctance of "unaffiliated" patrons to sit next to each other in Applegate, 2009, p. 343), with the latter also used to explain an observation that patrons tended not to select seats directly next to someone else unless there was no other choice (S). Another group reported that people tended to sit as close to the main entrance as possible and tended to stay on the lower levels of the library (K); this preference was validated through photo elicitation interviews: pictures of spaces located furthest from the entrance and on the 4th floor were the least recognizable to respondents (N). By contrast, spaces with natural light (N) and with visual connections to the outside (U) were the most positively reviewed.

Once seated, patrons remained in the same location for the duration of their stay, an observation that could be due, in part, to the personal belongings students bring with them: a hesitation to leave personal items unattended could serve as a barrier to circulation, including quick trips to the restroom. Notably, one group recommended that designers be cautious of noise generated by furniture movements (in particular, the propensity for heavy wooden furniture to make noise against the EAL's concrete floors, and of such noise to travel vertically in the building); noise is thus a possible barrier to movement because libraries are typically quiet (A, F).[15]

Finally, one research team found that 65% of respondents did not report having a favorite spot (J), while other respondents described favorite spaces as either the library's individual study desks or seating areas located near windows. Another team found that all interviewees reported having a favorite space in the library, yet were not always able to access their favorite seat, particularly during busy times like midterms and finals (O).[16] What emerged from these data is that circulation through and positioning of patrons in the library is the result of a combination of factors, including spatial qualities, desired or available activities, and personal preferences and concerns, but not one in particular.

FURNITURE USED (AND REQUESTED)

WHAT FURNITURE OPTIONS DO PATRONS PREFER?

One group employing photo elicitation methods to study how well furniture in study areas supported patrons' needs and activities identified a typology of seating options at the library including: study rooms,

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[15] For additional information about the social implications of noise in library settings, see Kelman's (2001) study of the New York Public Library.
[16] See also Applegate (2009) for findings about the increased use of academic libraries at end of the semester (p. 344).

group study tables, single chairs, group study carrels, computer-ready seating in carrel configuration, benches, and other options (floor, stool, etc.), many of which are displayed in Image 4 (P).[17]

In general, the type of chair favored depended on perceived comfort and use. One respondent said it well: "It depends on what you are doing. I guess if you are trying to read something, it is better to…[have] a place with soft padding; if you are trying to solve problems, you need a table and lights" (P). Other reported preferences included: soft, "comfy" chairs for reading; cubicles for studying; and soft-padded seats for using a laptop (couches were also preferred furniture for using computers) (E).[18] Comfort was similarly important to users: in one study, 63% of interview respondents noted the importance of comfort in library furniture; further, patrons staying 3 hours noted 'comfort' as a reason for their lengthy stay (O). Another group, conducting archival work, added that control over ones workspace—which could be facilitated with a choice of furniture and/or moveable or adjustable furniture options in the specific context of this study—is an important aspect of comfort (W; see also Lee & Brand, 2005). Finally, echoing the proxemics-territorial-privacy concerns mentioned above, the same group observed that those visiting the library alone tended to choose more "isolated" spaces in which to sit, and that tables designed for 6 people were typically used by a maximum of 3 or 4 patrons. Offering a proxemic explanation for similar findings in a study of library study spaces, Applegate (2009) distinguished between seating area measures of capacity (for example, the number of seats available) and "'full' comfortable use" (which she defined as typically around 50% of maximum capacity, p. 343). Yet another research team offered a complementary explanation for tendency of group tables to remain below their maximum seating potential: the amount of storage space required for the personal belongings students bring with them to the library (S).[19]

WHAT FURNITURE OPTIONS WERE REQUESTED?

Soft-padded seats were the most frequently requested furniture type, a somewhat perplexing finding given that 8 of these chairs are available on the 4th floor of the library. The location of soft-padded seats on the 4th floor of the library (the least used and recognized according to aforementioned data) may make the seats difficult to find (P).[20]

POSTURES

WHAT POSTURES ARE ASSUMED WHILE IN THE LIBRARY?

Although the architects provided a unique and handsome standing desk on the 4th floor, sitting is still the overwhelming norm in the library (R): 99% of patrons were observed sitting in a chair; of those, 76% leaned forward (F). In a survey, 56% of respondents self-reported "slouching" or being "hunched over" while seated at the library (Q)[21]; the ubiquity of this posture is concerning given the risk of back pain that accompanies prolonged exposure to poor posture (Gardner & Kelly, 2005). One student respondent stated: "My posture is terrible…

I was leaning forward…that's how most people reading books are because the text is so small" (P). Opsvik (2008) has cautioned about the seated posture as the norm for academic work and Mandal (1997) has observed the deleterious impacts on the back and eyes of having to conduct "precision work"—close reading—without the benefit or aid of a slanted desk.

One group observing postural variation in the East Asian Library environment and in other locations on campus found that the range of postures assumed at the library are limited as compared with those observed in other locations (where postures were generally more diverse and eclectic). Further, the group wondered if the postures assumed in the library might be limited by users' tasks, the availability of furniture, and nature of the library setting (F): for example, for patrons wishing to stand or perch while conducting their work, few options exist at the library to support such postures, the only exception being a pair of computers at standing-height, outside of the elevator on the 4th floor (and thus removed from other study spaces), for patrons to electronically browse library collections.[22] Thus, given the dearth of options to support standing, it is not surprising that we observed little variation in the range of postures people assume in the library (F). Further, a greater range of postures was observed elsewhere on campus, including a number of people lying down or using improvised "urban furniture", particularly in Sproul Plaza and Memorial Glade (F). Ostensibly, students could study anywhere on campus, but their choice of the East Asian Library limits the range of postures and movement they can assume (F).

Still, despite these barriers, some postural variation was observed. One group observed a range of "unconventional" postures and uses of furniture in the East Asian Library including the use of shorter bookshelves as "standing desks" or chairs as footrests; slouching and leaning back in chairs; and sitting or sleeping on the floor (S). This same group expressed surprise at patrons' creative use of furniture—"the users used the beautiful wooden furniture as if they were in their own living room"—and the range of postures they observed, in contrast to the perceived "formality" of the library space (S). Though sitting is by far the most common posture observed in the library, we see the surprising range of postures observed in those choosing not to sit—or making creative use of chairs—as evidence of students trying to tell us how they prefer to study and thus, how we might better design and use academic buildings and furniture in a way that supports a range of movements and postures.

Further, Gifford and Sommer (1968) found that students who chose to study in a lying posture (e.g. on a bed) showed no difference in Grade Point Average than students who studied in more conventional, upright chairs. These authors came to a similar conclusion as our own: given the range of postural and spatial needs articulated by students—which upright chairs and desks alone cannot accommodate—recommendations or assumptions that studying is best done in straight-back chairs are unsubstantiated by empirical research and therefore "the use of softer and more comfortable furniture in libraries and study [spaces] deserves attention" (p. 876).

CONCLUSION

Our study is grounded in empirical research and theoretically oriented as well: by studying the patterns and nature of use at the East Asian Library, we will extrapolate our findings to larger implications for student health and academic outcomes and recommend a set of design interventions to be implemented at the East Asian Library and inform, more broadly, future library projects.

Additionally, the practice of conducting Post Occupancy Evaluations is part of a larger tradition of evaluating buildings in use from the user perspective (Sommer, 1983). Thus, the POE methodology we derived for this class project not only contributes to the larger culture of

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[17] Applegate (2009) refers to these non-stack study spaces as "soft spaces".
[18] This study did not make clear the type of computer work—for example, studying or checking personal emails—students prefer to do while seated on couches, or if such a distinction is made by or useful to library users.
[19] In a study of the campus libraries at the University of Rochester, Foster and Gibbons (2007) found, through asking students to map their daily routes and take photos of the contents of their backpacks, that students are away from home for many hours at a time and bring many personal belongings with them to campus. Such findings help to inform our hypothesis and related suggestion (below) regarding the need for more storage space in campus settings such as libraries.
[20] Note: Our recommendations below, informed by empirical and research data, offer additional suggestions about furniture options to add to library and other academic settings.
[21] Note: Though *bending forward* and *slouching* were not made distinct in these studies, from an ergonomic perspective, the two postures are and should be considered as two different concerns, as each exerts a different impact on the spine: slouching opens the angle between the torso and thighs and therefore can have some benefit, yet bending forward rounds and collapses the spine and has no redeeming benefit (see Cranz, 2000).

[22] Though not explicitly studied, other data mentioned above raises a question about the extent to which these computers are used at the East Asian Library.

architectural practice (Cranz et al., 2013), but also exemplifies a dual use of POE studies: we analyzed the library's current use in reference to both its intended use and in reference to recent research regarding the health implications of sedentary behavior.

This POE study confirmed the changing role of campus libraries as study spaces (see also Applegate, 2009; Stewart, 2010) by demonstrating that the vast majority of patrons we studied utilized the East Asian Library at UC Berkeley for personal computer use and reading of materials from outside of the library collection. Relating to the increasing use of libraries as study spaces, however, is a less-studied phenomenon into which our study offers an initial glimpse: the length of time and range of postures students assume in library spaces and factors (built and social) that contribute to each.

We began this study by asking: how can we change sedentary student behaviors and minimize the use of chairs? And further, how might such an intervention contribute to a healthy campus ecology? What is at stake is student health (*health being broadly defined, encompassing both the physiological and the psycho-social*) and learning outcomes, making this a central problem for campuses to confront. A recent article in the *British Medical Journal* suggests just how far we have yet to go: "limiting sitting to less than 3 hours per day…may increase life expectancy at birth in the US by between 1.4 and two years" (Schofield, in Stock, 2012). Student life far exceeds this 3-hour recommendation; thus, how might we begin addressing this issue? Though we propose a series of design interventions below, we also recognize that the effort to create a healthy campus requires as well a change in how we define and measure student health. For example, the National College Health Assessment (e.g., American College Health Association, 2012), the most common and comprehensive survey of college student health behaviors and perceptions, does not track sedentary behaviors; rather, only more common measures of physical activity and Body Mass Index (BMI). Clearly, a number of primary mechanisms of student health are missing from such evaluations.

Thus, though our data provides some initial insights into the prevalence of sedentary behaviors and environmental limitations to physical activity, more studies are needed to understand and track this issue among students. Additionally, how might we begin to assess the availability of resources to promote postural variation and physical activity in campus settings, beyond what is available in gymnasia? What, for example, might the walkability or bikeability of a campus tell us about the possibility for students to engage in physical activity as incidental exercise (Jackson, in Dannenberg et al., 2011)? Or how might walking mazes,[23] treadmill desks, or general accessibility to standing workstations and ergonomic furniture help architects and planners design a healthy workplace for students and staff alike?

Though such questions have up until now exceeded the bounds of campus libraries, we argue that, because campus libraries have become increasingly central to student life in recent decades (Applegate, 2009; Stewart, 2010), they are uniquely poised to participate in interventions to promote student health. In other words, we believe that libraries can and should lead the *movement* toward healthier campuses.

DESIGN RECOMMENDATIONS

By adapting a POE to address contextual factors (Stokols, 1992) related to student sitting in the library environment, we identified a number of specific interventions to interrupt the chair-bound student lifestyle. Our hope is that these inform not only possible modifications

to the East Asian Library, but also the design and renovation of campus spaces more broadly.

- *Provide furniture that aligns with and supports actual uses and postures*, such as cushions for floor-sitting, and footrests and reclining (or rocking) chairs to support the observed postural range. Rocking chairs and perch-height stools actively use the feet and legs and thus help to prevent the stasis of sedentary behavior. Lounge chairs admittedly promote sedentary behavior, but they provide a useful counterpoint to classical right-angle seated posture (with its stresses on the lumbar, thoracic, and cervical spine) and thus are healthier alternatives to options currently available (Cranz, 2000).
- *Introduce adjustable-height and slanted-desk workstations* to encourage healthier postures, greater postural variation, and better support for common activities such as book-reading and computer use (see Cranz, 2000; Focal Upright, 2012; Mandal, 1997).
- *Ensure a mix of furniture options that together welcome a variety of healthy postures*. For example, perching on bar stools is a healthy posture from a bio-mechanic and metabolic point of view. When perching, the legs and feet take more of the body's load, so they are more active physiologically; additionally, keeping large muscle groups active seems to be the key to signal to the pancreas that it still needs to keep producing lipase, the enzyme necessary to help the liver metabolize fats.[24] Thus, stools at reading bars could be an attractive option in library settings.[25] Additionally, the lounge position features the same open angle between thigh and trunk found in the perch position, yet with the additional benefit of resting the neck and back; thus, lounge chairs could be a useful part of the mix of postural options available to library users. Ultimately, since no posture is stress-free, the ideal is to move stress throughout the body through movement and changing postures (Cranz, 2000; Opsvik, 2008).
- *Provide rooms where students can stretch and take short breaks*. Having a room with equipment such as yoga balls and mats—and even videos showing quick, 2-minute movement routines—might encourage and better enable students to take regular breaks. Such spaces would have an additional benefit of helping to counteract the impression that libraries are quiet, stuffy, and "formal" spaces.
- *Offer moveable furniture* that can be moved elsewhere in the library, such as quieter areas or other preferred locations.[26] The act of moving the furniture would have modest benefits in itself.
- *Create opportunities to introduce physical activity into library settings*. In gyms, treadmills and elliptical machines are often fitted with magazine holders, thus encouraging reading while exercising. Because this combination of physical activity and reading is available (and engaged in) elsewhere on campus, why not try something similar in other campus spaces? In fact, treadmill desks were recently added to a library at the University of California, San Francisco (University of California, San Francisco Library, 2013). Further, due to the deleterious impacts of sedentary behavior, office workers are increasingly using standing desks and—in some cases—treadmill desks for office work. Campus libraries, an integral part of the workplace of both students and staff, could be ideal places to adopt these precedents.
- *Make available lockable, secure storage spaces* to enable students to take periodic stretch breaks and quick trips to the bathroom or other parts of the library.[27]
- *Prioritize study spaces*. Given libraries' increasing role as study spaces (Applegate, 2009; Stewart, 2010), students suggested prioritizing

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[23] See, for example, the meditation labyrinth at the University of Rochester Interfaith Chapel (2014) and the library-based treadmill desks at the University of California, San Francisco Library (2013).

[24] Without lipase undigested fats go to the liver, and then the overworked liver makes the body vulnerable to heart attack, stroke, and cancer (Saunders, 2011).

[25] See Cranz and Cha (2006) for a successful use of such a design in a young adult space in a public library.

[26] See also the City of New York's (2010) *Active Design Guidelines* for additional suggestions about how to design buildings to encourage physical activity.

[27] A study at the University of Rochester (Foster & Gibbons, 2007), headed by the library anthropologist, found (a) via mapping, students spend a long time away from campus home each day and (b) via pictures of backpack contents, students carry a lot of personal belongings with them to campus.

more study space in the library; some suggested replacing less-used bookshelves with computers and desks.

- *Locate study spaces near windows and along the periphery of the building*; also ensure study spaces have natural light.
- *Consider how the placement of furniture educates users.* Placing standing or slanted-desk workstations in favored areas could familiarize students with new furniture and new behaviors.

PRACTICE RECOMMENDATIONS

The following practices can help contribute to organizational learning and change (Zimring, 2001) at higher levels of building, organization, and campus administration to support the aforementioned design recommendations:

- *Welcome creative uses of space.* Comparative observations of other places on campus reveal greater postural variation in less "formal" spaces (e.g. the use of staircases and ledges as seats; or grass for sitting, standing, or lying). Student researchers observed that both materials (soft vs. hard materials) and the social norms of spaces (for example, libraries as typically quiet, formal environments) can foster or discourage novel (or desired) uses of space.
- *Conduct Post-Occupancy Evaluations* of both new and existing campus libraries—and other campus spaces—to assess building performance, identify needs, and prioritize areas for change.
- *Assess the needs of all user groups.* Though beyond the scope of this paper, our study also identified distinct needs of library staff; yet one group's archival studies regarding library designs and POEs revealed a general lack of attention to staff, including maintenance staff, spaces in the literature.
- *Find creative ways to engage students in conducting POEs.* This POE is one such example: students worked in small teams to obtain useful data and hands-on experience (see also Cranz et al., 2013 and Cranz et al., 2014).
- *Understand campus as the workplace of students* and staff alike and invest in equitable access to workplace equipment for all members of the campus community.
- *Develop a theory of action*—a plan for "how an organization or individual decision-makers can implement the results of the POE" (Zimring, 2001, p. 317)—in order to ensure the successful realization of recommended changes identified through the POE process.

FUTURE IMPLICATIONS

Cranz (2000) offers a three-pronged theory of change toward body-conscious design that can inform the pursuit of healthier campuses; to realize such a goal requires:

- *Change in environments and physical objects.*[28] In particular, we propose the addition of furniture (chairs, floor cushions, storage spaces) that welcomes a variety of postures and encourages movement;
- *The education of users and designers.* We argued above how the design of the environment itself can help educate users about new ways of working and resting, both through the provision of resources and their placement in favored areas of the library;
- *Broader cultural change* including the meaning and value assigned to objects, environments and their users. In this study, we suggest that the perception of the library as a formal, quiet space may be a hindrance to active circulation and creative uses of furniture (and, in turn, movement and postural variation); thus, we argue that movement could be encouraged as part of a larger cultural and perceptual

change of the library to a place that welcomes and encourages postural variation and physical activity.

This paper—including in particular the program of organizational, practical, and environmental change recommended above—articulates a path toward change in all three areas: first by identifying environmental design elements and objects in the "near environment" that support postural variation and physical activity; second by educating administrators, designers, and patrons alike about the possibilities for interrupting the sedentary norm of campus environments and the importance of implementing such change in the spaces (such as libraries) in which students study; and finally by suggesting opportunities for broader cultural change that can help support the creation of healthier, body-conscious academic spaces.[29]

We see these design and practice changes not only as opportunities to reimagine healthy campus spaces, but also to inspire a larger movement among educators, health professionals, and designers to participate in changing the sedentary norm of academic environments.

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[28] Not only the provision of resources (e.g., furniture), but also how aesthetics can help to make such spaces appealing and thus encourage use; see Cranz and Cha (2006) and the City of New York's (2010) *Active Design Guidelines* for examples of spaces that are both conducive to physical activity as well as aesthetically interesting (and how appealing or interestingly designed spaces can help encourage use).

[29] Cranz and Cha (2006), in a POE of a "teen zone" in an Oakland, CA library, demonstrate how playful, colorful, and active environments—in other words, spaces that welcome a range of postures and physical activity—in teen library spaces in particular have been helpful in bridging a historic institutional gap between young adults and public libraries.

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