How Many Public Computers in the Library?

Maximum Concurrent Usage as a Metric to Determine the Size of the Computer Fleet in a Post-COVID-19 Landscape

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ABSTRACT

Computer workstations have been an integral part of libraries of all types since the 1980s, but the optimal number of workstations that should be deployed in a space has not been directly studied in the last 20 years. During that time, laptop computer and other mobile device ownership has continued to increase, and there is some reason to think that behaviors and preferences first seen during the recent coronavirus 2019 pandemic have further shifted how students use public desktop computers in libraries. McGill University Libraries reduced the size of its computer fleet in the aftermath of the pandemic by looking at the maximum concurrent usage of different clusters of computers across campus, a metric that indicates how busy a space can get with users. This article explains how this metric is calculated and how other libraries can use it to make an evidence-based decision about the optimal size of a computer fleet.

INTRODUCTION

Computer workstations have been a valuable resource in academic libraries since their introduction in the 1980s when they served almost exclusively as gateways to the public access catalog. Over the years, they have also provided students with access to CD-ROMs and electronic resources, specialized software, and the World Wide Web, so much so that by the early 2000s, library design plans were actively incorporating computers as an integral part of the new innovation commons.[1] Over the last 20 years, the role of computers in libraries has continued to be studied alongside students' changing space preferences and study patterns. One overlooked question in this discussion has been "How many computers does a modern library need to have in its building?" This is not an easy question to answer, and the consequences for getting it wrong have a direct negative influence on student success. If there are not enough computers to meet student demand, there could be long wait times for available stations. But if there are more computers than are needed in a given space, there are costs borne by the library. For example, the cost of buying and maintaining the machines, the staff time and expertise in troubleshooting them, and the space costs of an underutilized workstation must all be considered.

McGill University Libraries faced the question of how many computers should be in its fleet in the aftermath of the first three waves of the COVID-19 pandemic in Quebec (spring 2020 through spring 2021). At the beginning of the pandemic, two of the libraries, the Humanities and Social Sciences Library and the Nahum Gelber Law Library, were converted into Study Hubs, socially distanced spaces where students could work during the primarily remote instruction 2020–2021 school year. As part of this process, nearly all of the desktop computers were removed from these libraries over concerns about the practicality of disinfecting computer equipment. In mid-2021, as

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plans were being formed to restore this equipment for the fall 2021 semester, the library needed to decide the optimum number of computers to put back and reconnect. This paper will discuss the process that was used at McGill to determine how many computers to redeploy in a post-COVID-19 setting. In doing so, we highlight a usage metric that has so far been unexplored in the library literature: maximum concurrent usage. This metric is valuable both for making sense of historical usage data and for planning the optimum size of a computer fleet. After a review of the literature, we describe the algorithm we used to measure maximum concurrent usage. In the appendix, we provide R code so that other libraries can transform standard log data into a visualization of maximum concurrent usage over time, allowing them to make similar evidence-based recommendations on the size of their library computer fleet.

LITERATURE REVIEW

In the last two decades, there has been a rapid increase in the affordability, quality, and popularity of mobile technology, especially smartphones and laptop computers. In the college-aged population, this is evident in work done by EDUCAUSE Center for Analysis and Research (ECAR), which in 2018 found that 91% of students owned a laptop and 95% owned a smartphone.[2] Mobile technologies have been popular for a decade; in 2010, laptop ownership was 89%, while Internet-capable handheld device ownership was 63%.[3] Not surprisingly, many students bring their laptops with them to class. According to ECAR, 98% of students used their laptops in at least one course, and 94% rated them very or extremely important.[4] Personal laptop use within academic libraries has not been studied as systematically, but it would appear that it has increased in the last decade as well. Briden and Marshall found as early as 2010 that laptop use at the University of Rochester's River Campus Libraries grew dramatically between 2005 and 2008.[5] By the mid-2010s, the concept of Bring Your Own Device (BYOD) was salient enough to lead Walton to wonder whether libraries would soon reconsider the need to provide access to fixed PCs for students.[6] The picture is complicated, however, because research has shown that BYOD devices and fixed computers are used differently by students, with fixed computers much more likely to be used for academic work.[7] For instance, students may require specialized software installed on some computer workstations, or they may prefer the atmosphere or lack of distractions when working in a library computer lab. Some libraries have directly examined what effect rising BYOD behavior has on desktop computer usage. Thompson found that despite the popularity of laptops, students still preferred to use desktop computers in the library.[8] More recently, Chao et al. have noted that in addition to changes in technology, space considerations have been pushing more libraries to adopt a BYOD approach.[9] Diaz has found that desktop computers are still very much used and appreciated at the California Institute of Technology Libraries, whereas Zaugg has found that the trend of decreasing use of public access computers has finally come to the Brigham Young University Library.[10]

The COVID-19 pandemic, while a very recent phenomenon, must be considered as a potential factor in changing how students use technology in the library. There are at least three mechanisms. First, there may be concerns over surface contagion with public workstations or lendable technology. This has led Cox to speculate that public computers "may become a thing of the past in a post-COVID-19 world."[11] The scientific consensus on COVID-19 surface contagion shifted over the course of the pandemic, and most agree now that it contributes negligibly to disease spread.[12] However, it remains to be seen whether users will be comfortable touching public computers, especially given the variety of public health directives across jurisdictions concerning surface hygiene. Second, the nearly universal adoption of Zoom and other remote teaching tools during the pandemic may have caused students, who already had very high rates of

laptop ownership, to view their laptop as a truly indispensable device in their academic careers. In the aftermath of the first wave of the pandemic, with computer labs limited and many schools forced to adopt predominantly remote instruction, access to a personal laptop with webcam and microphone became essential for students to participate in class. Third, it is conceivable that the widespread use of remote teaching accelerated the trend of preferring open-source, freely accessible software over proprietary software limited to workstations in labs. It remains speculative to assert that these lingering effects of COVID-19 will have any role in the potential declining use of library workstations years after the pandemic, but it merits further investigation.

There is a small body of literature on the measurement and assessment of desktop computer usage in academic libraries, but it is notable that methods are quite heterogeneous. A 2006 white paper entitled "Factors Influencing the Number of Computers in Libraries: An Exploratory White Paper" was an early attempt to help academic libraries determine how many computers should be made available to users. The authors ultimately concluded that creating a single standard, even one that took into account the size of the student population, was "a difficult, if not impossible, task in an era when technology is changing at an ever-increasing pace."[13] Instead, they recommended considering nine factors, including institutional requirements for student ownership of computers, space and cost issues, the number of computer labs on campus, and software available only in the library. Weessies looked at login data, specifically the number of times a computer was logged in to, to analyze the relative usage of different computer clusters in the library. This allowed her to correlate usage with space-related features such as proximity to an entrance or service point.[14] Finally, observational studies and surveys of students have also been used to figure out the relative prevalence of laptops over desktop computers.[15]

METHOD

McGill University is a large urban research university located in Montreal, Quebec, Canada. It serves approximately 39,500 students, of which more than 10,000 are graduate students. McGill University Libraries consists of 11 divisions of libraries and other units, including the central Humanities and Social Sciences Library as well as libraries focusing on law, music, physical and life sciences and engineering, and Islamic studies.

Like many universities throughout the world, McGill shifted all of its courses to an online format in March 2020 in response to the pandemic. Access to campus buildings was severely restricted for the remainder of the semester. The 2020–2021 academic year adopted a hybrid model, in which most coursework remained online, but certain activities (e.g., laboratories, rehearsals) met in person under conditions of vigilant social distancing measures. The Libraries adopted a model of operation known as "Study Hubs," in which some library buildings opened to students but under significant restrictions. For example, access to most stacks was forbidden since the Libraries negotiated an agreement with HathiTrust to make available, on a temporary basis, all of their digitized books to which McGill had corresponding print access. Only materials not available in HathiTrust were permitted to be loaned to students, and this too was mediated by library staff who retrieved books from the shelves. Other restrictions in Study Hubs were more directly related to public health considerations. Group study work and virtually all talking were not permitted on the assumption that close-quarters talking could spread the SARS-CoV-2 virus. Furthermore, students in Study Hubs were required to sit two meters apart and disinfect their area before they left the building. During the planning phase before Study Hubs were launched, the decision was made to remove public computers in the areas of the libraries where students would be working. This was because it was believed keyboards and mice could not be adequately and easily

disinfected. Removing public computers from the libraries was a hard decision: the 2020–2021 school year would be reliant on web and computer technologies in a way not previously seen in colleges and universities, and we know that some students at McGill face barriers that prevent them from easily accessing a computer. (For instance, even if one owns a laptop computer, one might not have the ability to carry it around and keep it charged easily, and one's home environment might not be conducive to quiet study.) Ultimately, however, having disinfected surfaces was seen as the priority public health consideration, and so computers were removed and stored away. Students were encouraged to bring their personal laptops to Study Hubs to do their coursework.

The Study Hub model continued through the summer of 2021. McGill University planned on reverting to a predominantly in-person model in fall 2021, like many other universities. Some public health directives, including slightly moderated social distancing and mask requirements, would continue for another year, but a return to a more normal operational library building was planned for the beginning of the semester in August.

An important question was raised: How many public computers should be returned to their spots in the library? The Digital Initiatives unit was responsible for examining this and making the decision. Our thinking was influenced by two observations. First, even prior to the pandemic, we suspected that certain areas of the library contained more public computers than were needed, based primarily on repeated observations of empty computer desks. Second, as a result of the pandemic, would patterns of public computer usage change? For instance, students may have internalized the behavior of avoiding unnecessary touching of surfaces. They may also have shifted even more heavily to carrying and using personal laptops throughout the entire school day. These considerations led us to take a more careful, deliberative approach to returning computers. We wanted to use usage data to determine how many computers should be put back, with the aim of minimizing unneeded computers in the space.

Our methodology relies on having a tabular dataset of when users log in and out of a computer. In our case, McGill University IT Services uses a program called KeyServer to deploy software and meter licenses on public-facing workstations. KeyServer tracks both login and software usage data, and through our contacts at IT Services, we were able to obtain data going back to 2014. These data were CSV files with four columns: (1) l_division, indicating the library in which the workstation is located; (2) l_computer, the computer name; (3) l_date, the date and time of when the user activity ended; and (4) l_duration, the length in seconds of the user session. See Table 1 for an example snippet of the dataset. These files were limited to locations across all libraries. The analysis, including filtering to libraries or computers of interest and performing calculations, was carried out by library staff according to our research questions.

The key metric we were interested in calculating is the maximum concurrent usage of a set of computers over a period of time. Maximum concurrent usage (also known as peak usage) is the maximum number of computers that were simultaneously logged in to during a timeframe. It provides an answer to the question: At the busiest point in the day, how many people were using the computers? Informally, this is calculated by keeping a running total of the number of people logged in to the computers, adding one when a new user logs in, and subtracting one when a user logs out. More formally, the algorithm can be described as follows.

Table 1. Example of a computer usage dataset prior to analysis.

l_division	l_computer	l_date	l_duration
Schulich 2nd Floor Guest	034-170-209-01	2024-02-19 10:29:08 AM	1020
Barton Public	034-405-FLR2-19	2024-02-19 10:30:24 AM	1928
McLennan Reference	034-108-FLR1-39	2024-02-19 10:33:42 AM	1054
McLennan Reference	034-108-FLR1-08	2024-02-19 10:51:17 AM	817
Redpath eClass S15	034-178-S15-011	2024-02-19 10:59:50 AM	4303
Barton Public	034-405-FLR2-18	2024-02-19 10:59:57 AM	694
Redpath Commons	034-178-FLR1-15	2024-02-19 11:05:06 AM	2228
Barton eClass 206	034-405-206-11	2024-02-19 11:08:14 AM	689
Redpath eClass S15	034-178-S15-007	2024-02-19 11:08:31 AM	3787
McLennan Reference	034-108-FLR1-03	2024-02-19 11:14:40 AM	309

Step 1: Start with a data frame (e.g., a CSV file) with at least two columns for login and logout timestamps. See Table 2.

Table 2. Example of a two-column dataset with login and logout timestamps.

Login	Logout
2020-09-01 08:44:32	2020-09-01 10:04:03
2020-09-01 11:07:14	2020-09-01 11:56:16
2020-09-01 11:00:20	2020-09-01 11:14:57
2020-09-01 12:30:08	2020-09-01 19:20:20
2020-09-01 14:44:50	2020-09-01 17:01:26
2020-09-01 16:36:30	2020-09-01 08:04:10

Step 2: Transform the data frame into a new two-column data frame as follows: One column consists of each timestamp from the two columns of the original data frame. The second column is either a 1 if the corresponding timestamp came from the login column in the original data frame or a –1 if the corresponding timestamp came from the logout column. See Table 3.

Table 3. Example of a two-column dataset with timestamp and event indicator.

Timestamp	Event
2020-09-01 08:44:32	1
2020-09-01 11:07:14	1
2020-09-01 11:00:20	1
2020-09-01 12:30:08	1
2020-09-01 14:44:50	1
2020-09-01 16:36:30	1
2020-09-01 10:04:03	–1
2020-09-01 11:56:16	–1
2020-09-01 11:14:57	–1
2020-09-01 19:20:20	–1
2020-09-01 17:01:26	–1
2020-09-01 18:04:10	–1

Step 3: Sort the data frame chronologically on the timestamp column. See Table 4.

Table 4. Example of a two-column dataset with timestamp and event indicator, sorted chronologically.

Timestamp	Event
2020-09-01 08:44:32	1
2020-09-01 10:04:03	−1
2020-09-01 11:00:20	1
2020-09-01 11:07:14	1
2020-09-01 11:14:57	−1
2020-09-01 11:56:16	−1
2020-09-01 12:30:08	1
2020-09-01 14:44:50	1
2020-09-01 16:36:30	1
2020-09-01 17:01:26	−1
2020-09-01 18:04:10	−1
2020-09-01 19:20:20	−1

Step 4: Calculate the cumulative sum (running total) of this second column. See Table 5.

Table 5. Example of a three-column dataset, adding the cumulative sum of the event column.

Timestamp	Event	Cumulative Sum
2020-09-01 08:44:32	1	1
2020-09-01 10:04:03	−1	0
2020-09-01 11:00:20	1	1
2020-09-01 11:07:14	1	2
2020-09-01 11:14:57	−1	1
2020-09-01 11:56:16	−1	0
2020-09-01 12:30:08	1	1
2020-09-01 14:44:50	1	2
2020-09-01 16:36:30	1	3
2020-09-01 17:01:26	−1	2
2020-09-01 18:04:10	−1	1
2020-09-01 19:20:20	−1	0

Step 5: Finally, find the maximum of this cumulative sum. In our example, it would be three, meaning that at its peak busyness, this cluster of computers had three simultaneous users.

This algorithm will work for any data frame that has a login and logout timestamp for each user session. For example, libraries with computer availability systems may be able to consult a log of all data or modify an open-source solution to store this data in a database.[16] The data from KeyServer that we were provided only had a logout column (l_date), but since it also contained a duration column, the login timestamp could be computed by simply subtracting l_duration from l_date. Some software, such as the newest version of KeyServer, even calculates maximum concurrent usage out of the box, so no further work is needed.

Given the large amount of data we had available, spanning multiple years across several libraries, each containing multiple computer clusters, we decided to calculate the daily maximum concurrent usage for just the spaces we were interested in, then aggregate them by month on the maximum value. As an example, we calculated the maximum concurrent usage for each day in September 2020 for the main floor in the Humanities and Social Sciences Library, then took the maximum of those 30 values, representing the peak of computer occupancy in September 2020.

To run our analyses, we used R. The sample R code with comments is provided in the appendix.

FINDINGS

We examined data for every library at McGill University, but the focus here is on the Humanities and Social Sciences Library, the largest library and primary Study Hub during the pandemic. In the summer and late fall of 2020, we removed computers (or computer peripherals) from four floors: the first floor of the McLennan Library Building and the second, first, and lower level of the Redpath Library Building. The first floor of the McLennan Library Building contains the largest cluster of workstations. They occupy a sprawling amount of real estate on the main floor, just beyond the circulation desk. In total, before the pandemic, there were 86 computers in this area. The monthly maximum concurrent usage for this floor, from January 2014 until March 2020, is plotted in Figure 1.

Figure 1. Monthly maximum concurrent usage of McLennan first floor.
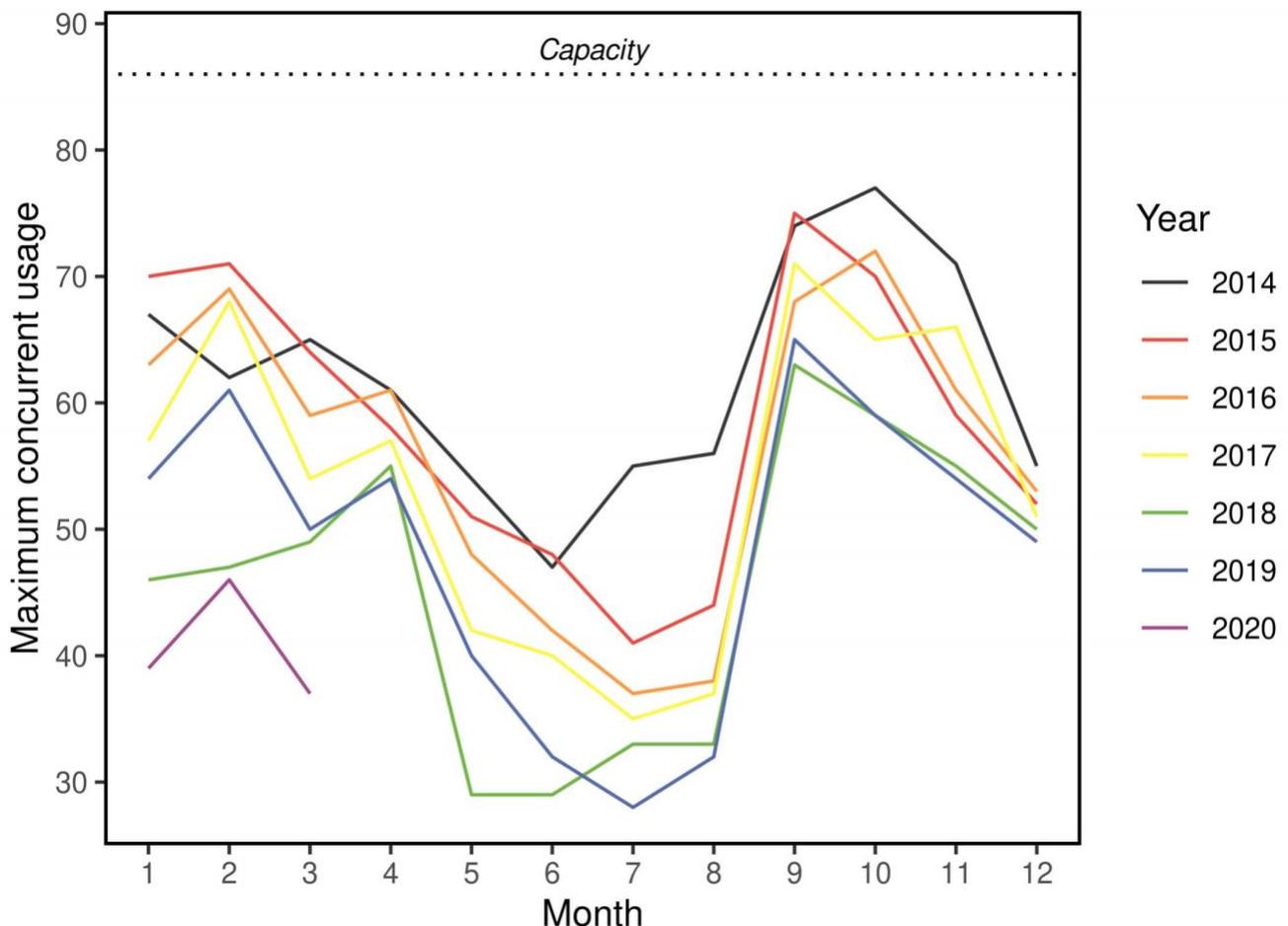
At no point in this period were all 86 computers being used simultaneously. Indeed, by around 2018, concurrent usage never exceeded 65. There is a clear seasonal pattern common to all universities on a semesterly calendar. One can also detect a very slight downward trend in that successive years tend to have lower peaks.

The lower level of the Redpath Library Building is known as the Cybertheque. It was opened in 2008 as a collaborative creative space with a focus on technology. More than 100 individual workstations were distributed throughout the floor in March 2020. The Cybertheque also features glass-enclosed group study rooms and booths with LCD screens for collaborative work. The monthly maximum concurrent usage for this floor, from January 2014 until March 2020, is plotted in Figure 2.

Figure 2. Monthly maximum concurrent usage of the Cybertheque.
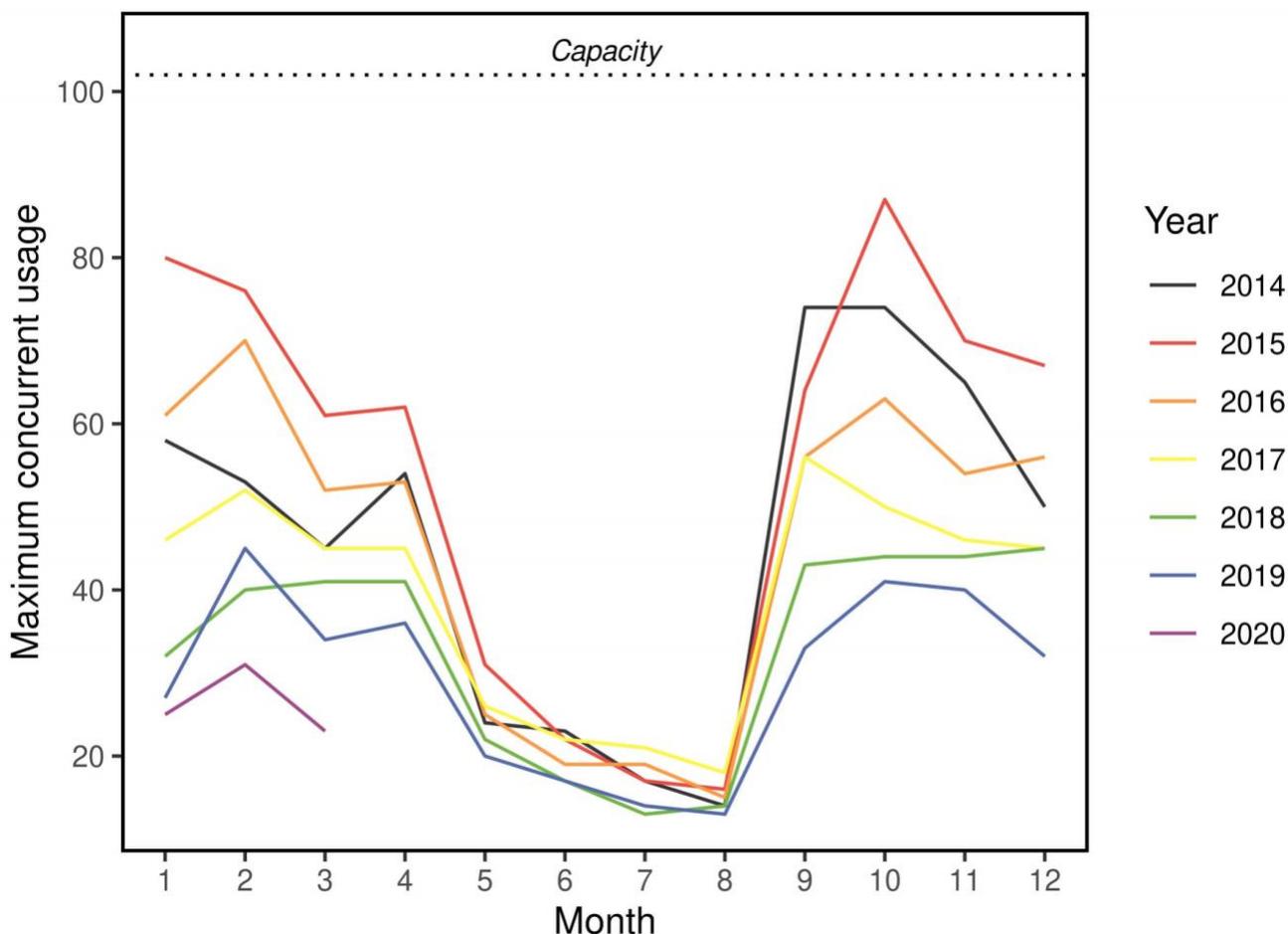
Compared to the first floor of McLennan, the semesterly rise-and-fall pattern is even more apparent, as is the year-over-year downward trend. Whereas 10 years ago the Cybertheque saw peaks of around 70 concurrent sessions, by 2019 that peak had fallen to approximately 45, representing less than half of the available workstations on that floor.

In deciding how many workstations to return to these two areas, we considered a number of factors. Clearly, the number of computers that had been deployed in 2019 was too high. While we were inclined to err on the side of having slightly more computers available than we thought we needed, we also needed to consider that the downward trend in the data was likely to continue

and perhaps even be exacerbated by concerns over hygiene and social distancing that emerged during the pandemic. In addition, the number of tables and their placement affected how many computers could be returned.

In McLennan, we looked for a configuration of approximately 40 to 55 computers that would fit on six tables placed in the center of the floor. The tables ultimately seated 52 computers, so that many were redeployed. In the Cyberthèque, we initially looked for a configuration of approximately 15 to 25 computers. This lower range was picked as a result of a coding error in our original R script involving timestamps and time zones (the original and corrected script is shown in the appendix) that showed recent peaks in the range of 20 to 25. We settled on 15 because that allowed us to fill the set of three tables near the entrance to the Cyberthèque. As it turns out, recent peaks were closer to double what we initially believed, around 40. Had we known that at the time, we would have increased the number of computers to deploy, perhaps around 20 to 35.

CONCLUSION

Utilizing maximum concurrent usage as a metric to decide the number of computers to deploy has been a success. In the subsequent years since this change, we have continued to monitor usage data and solicit feedback from students. Data have consistently shown occupancy rates for these clusters of workstations to be no higher than 70%, indicating that there has not been a significant shortage for student use. Furthermore, we have not received feedback that more workstations are needed. Indeed, as suspected, it appears that personal laptop use has only increased since the pandemic, although this has not been shown conclusively.

Moving forward, we hope to perform a similar exercise for all computer clusters across all of McGill University's libraries. In addition to tracking maximum concurrent usage, it would be valuable to investigate the reasons students and other users choose to use the public workstations. Further research could illuminate, for example, if the decreasing popularity of workstations is occurring at other institutions, if it is related to COVID-19 or other factors, or if socioeconomic considerations play an important role. In the meantime, other institutions can begin to measure maximum concurrent usage to assess the size of their own computer fleets.

APPENDIX

The following R code calculates maximum concurrent usage for each day and for each division (e.g., building or area) of your libraries. The code is in "base R"; no packages need to be installed.

```
# Replace with your library's CSV files
filenames  <- list.files(pattern = "library_logins_\\d{4}\\.csv")
logins <- do.call(rbind, lapply(filenames, read.csv))

# Make sure timestamps are converted to a POSIX class
# The original script had the following line:
# logins$end<- as.POSIXct(logins$end, format = "%m/%d/%Y %I:%M:%S %p")
logins$end<- as.POSIXct(logins$end, tz = Sys.timezone(), format =
    "%m/%d/%Y %I:%M:%S %p")

# If you have a begin or end timestamp and a duration (measured in seconds),
    calculate the other timestamp using addition/subtraction.
logins$begin <- logins$end - logins$l_duration

# Convert to a 'long' data frame
logins <- reshape(transform(logins, id = rownames(logins)), direction = "long",
    varying = list(c("end", "begin")), v.names = "time", timevar = "event", times =
    c(-1, 1))
logins$event <- as.integer(logins$event)

# Sort on the timestamp column
logins <- logins[order(logins$time), ]

# Create a date column
# The original script had the following line:
# logins$date <- as.Date(logins$time)
logins$date <- as.Date(logins$time, tz = Sys.timezone())

# Calculate maximum of the cumulative sum of the event (i.e., +1 or -1) column
agg <- aggregate(logins$event, by = list(logins$l_division, logins$date), FUN =
    function(x) max(cumsum(x)))
colnames(agg) <- c("l_division", "date", "max_occupancy")
```

ENDNOTES

[1] Patrick Tod Colegrove, "Editorial Thoughts: Rise of the Innovation Commons," *Information Technology and Libraries* 34, no. 3 (2015): 2–5, https://doi.org/10.6017/ital.v34i3.8919.

[2] Joseph D. Galanek, Dana C. Gierdowski, and D. Christopher Brooks, *ECAR Study of Undergraduate Students and Information Technology, 2018* (Louisville, CO: EDUCAUSE Center for Analysis and Research, 2018), 7, https://library.educause.edu/~/media/files/library/2018/10/studentitstudy2018.pdf.

[3] Judith Borreson Caruso and Shannon D. Smith, *The ECAR Study of Undergraduate Students and Information Technology, 2010 Roadmap* (Boulder, CO: EDUCAUSE Center for Analysis and Research, 2010), 3–4, https://library.educause.edu/-/media/files/library/2010/10/ecm1006-pdf.pdf.

[4] Galanek, Gierdowski, and Brooks, *ECAR Study of Undergraduate Students and Information Technology*, 10.

[5] Judi Briden and Ann Marshall, "Snapshots of Laptop Use in an Academic Library," *Library HI Tech* 28, no. 3 (2010): 447–53, https://doi.org/10.1108/07378831011076684.

[6] Graham Walton, "Will Smart Phones and Other Bring Your Own Devices (BYOD) Dominate How Academic Library Services Are Developed and Delivered for the Foreseeable Future?," *New Review of Academic Librarianship* 20, no. 1 (2014): 1–3, https://doi.org/10.1080/13614533.2014.875294.

[7] Walton, "Will Smart Phones," 2.

[8] Susan Thompson, "Student Use of Library Computers: Are Desktop Computers Still Relevant in Today's Libraries?," *Information Technology and Libraries* 31, no. 4 (2012): 20–33, https://doi.org/10.6017/ital.v31i4.2284.

[9] Zoe Chao et al., "Understanding User Experience in Bring Your Own Device Spaces in the Library: A Case Study of Space Planning and Use at a Large Research University," *Performance Measurement and Metrics* 20, no. 3 (2019): 201–12, https://doi.org/10.1108/PMM-07-2019-0027.

[10] Tony Diaz, "Use of Desktop Computers at the California Institute of Technology Libraries," *Issues in Science and Technology Librarianship*, no. 108 (2024), https://doi.org/10.29173/istl2852; Holt Zaugg, "Student Use of Public Access Computers in the Library: A 10-Year Comparison Study," presentation at the LibBMC 2025 conference, Liverpool, United Kingdom, June 25–27, 2025, https://scholarsarchive.byu.edu/facpub/7649.

[11] Christopher Cox, "Changed, Changed Utterly," *Inside Higher Ed*, June 4, 2020, https://www.insidehighered.com/views/2020/06/05/academic-libraries-will-change-significant-ways-result-pandemic-opinion.

[12] Dyani Lewis, "COVID-19 Rarely Spreads through Surfaces. So Why Are We Still Deep Cleaning?," *Nature* 590 (2021): 26–28, https://doi.org/10.1038/d41586-021-00251-4.

[13] Debbie Malone et al., *Factors Influencing the Number of Computers in Libraries: An Exploratory White Paper* (Chicago, IL: American Library Association, 2006), 8, https://www.ala.org/sites/default/files/acrl/content/aboutacrl/directoryofleadership/sections/cls/clswebsite/collpubs/white_paper_computers_in_libraries_april2006.pdf.

[14] Kathleen W. Weessies, "A Locational Analysis of Academic Library Computer Use," *Reference Services Review* 39, no. 3 (2011): 465–81, https://doi.org/10.1108/00907321111175868.

[15] Chao et al., "Understanding User Experience," 201–12.

[16] See, for example, Kim Griggs, "How to Build a Computer Availability Map," *Code4Lib Journal*, no. 12 (2010), https://journal.code4lib.org/articles/4067.