March 2, 2020

Remzi Arpaci-Dusseau
Professor and Department Chair
UW-Madison Computer Sciences

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Dear Remzi:

I write to formally request ***emeritus status*** upon my retirement from the University of Wisconsin-Madison this summer with my last day on the payroll being August 16, 2020. I started at Wisconsin on January 1, 1988. I believe that my 100000.1_{two} years (32.5_{ten} years) have been to both UW's and my benefit. I feel blessed by my time at this great university.

When I started, the following were non-existent or in niche use: world-wide web, laptops, broadband, and smartphones. Universities had no general email, course web pages, or social media presence. Companies like Amazon, Facebook, and Google could not exist. It has been a privilege to witness and modestly contribute to the last three decades of change by advancing computer hardware as the platform for information technology wizardry.

On the next page to explain my research, I include the press release from my 2019 **ACM - IEEE CS Eckert-Mauchly Award** for *seminal contributions to the fields of cache memories, memory consistency models, transactional memory, and simulation.* It is the highest award in computer architecture and hardware and represents a lifetime of achievement. Note that "memory" refers to *computer* memory.

On the final two pages, I summarize some of my UW accomplishments in the third person.

Sincerely,

Mark D. Hill

John P. Morgridge Professor
Gene M. Amdahl Professor of Computer Sciences
Professor of Electrical and Computer Engineering (by courtesy)
Chair of Computing Community Consortium (CCC)
ACM Fellow & Fellow of the IEEE
Eckert-Mauchly Award, 2019
CV: http://www.cs.wisc.edu/~markhill/markhill_cv.pdf

Prof. Mark D. Hill
Computer Sciences Department University of Wisconsin-Madison 1210 W. Dayton Street Madison, Wisconsin 53706
Phone: 608-262-2196 Fax: 608-262-9777 E-mail: markhill@cs.wisc.edu Web: http://www.cs.wisc.edu/~markhill

Mark D. Hill – ACM-IEEE CS Eckert-Mauchly Award (2019)

https://awards.acm.org/award_winners/hill_2155109

For contributions to memory consistency models and memory system design.

ACM and IEEE Computer Society named Mark D. Hill, a professor at a professor at the University of Wisconsin—Madison, the recipient of the 2019 Eckert-Mauchly Award. Hill was cited for contributions to the design and evaluation of memory systems and parallel computers. Widely regarded as the leading memory systems researcher in the world today, Hill made seminal contributions to the fields of cache memories, memory consistency models, transactional memory, and simulation. Hill's work with over 160 co-authors, which has received more than 20,000 citations, has been guided by the tenet that researchers should develop designs and models. The Eckert-Mauchly Award is considered the computer architecture community's most prestigious award.

In the 1980s Hill developed the "3C" model of cache misses. A "cache miss" is an instance when data requested for processing by software or hardware is not found in the computer's cache. Cache misses can cause delays as the program or application must then access the data elsewhere. Hill's 3C model classified these misses into "compulsory misses," "capacity misses," and "conflict misses." The model was influential, as it led to important innovations such as victim caches and stream buffers and is now a standard concept in computer architecture textbooks.

Many regard Hill's work in in memory consistency models as his most significant contribution. With his student Sarita Adve, he developed SC for DRF: a consistency model using sequential consistency (SC), where data races can be avoided (data race free, or DRF). Hill's SC for DRF model has had significant impact for computer architects, especially as multiprocessors became ubiquitous and architects had to reason about which memory consistency model to use in their architectures and implementations. Years after Hill developed SC for DRF, it became the basis of Java and C++ memory models and, more recently, is being used with graphics processing units (GPUs) to understand memory consistency with heterogeneous processors.

Hill's third major contribution is his work in transactional memory, a technique to minimize blocking due to critical sections. With David Wood he developed the LogTM transactional memory system, one of the first and widely-cited approaches to transactional memory. For the first time, this system enabled transactions to overrun their buffer and cache capacities, making transactions significantly easier for programmers to implement.

Hill (with David Wood and others) also made significant contributions to the evaluation of parallel computers. The Wisconsin Wind Tunnel project, for instance, pioneered fast parallel simulation running on parallel machines. Other important tools Hill has produced to evaluate memory systems and parallel computers include his Dinero cache simulator, as well as the GEMS full system simulator and gem5, which have been cited over 3,000 times by researchers and practitioners. BadgerTrap, one of his most recent tools, studies virtual memory behavior. Hill has also had significant influence on virtual memory implementation. For example, he proposed the idea of "page reservation," which is now used in Linux.

Hill will be formally recognized with the award at the ACM/IEEE International Symposium on Computer Architecture (ISCA) to be held June 22-26 in Phoenix, Arizona.

ACM and IEEE Computer Society co-sponsor the Eckert-Mauchly Award, which was initiated in 1979. It recognizes contributions to computer and digital systems architecture and comes with a $5,000 prize. The award was named for John Presper Eckert and John William Mauchly, who collaborated on the design and construction of the Electronic Numerical Integrator and Computer (ENIAC), the pioneering large-scale electronic computing machine, which was completed in 1947.

Mark D. Hill – 1988-2020 Summary

Research. Professor Hill's research targets computer design and evaluation.[1] He has contributed to parallel computer system design (e.g., memory consistency models and cache coherence), memory system design (caches and translation buffers), computer simulation (parallel systems and memory systems), software (e.g., page tables and cache-conscious optimizations), and deterministic replay and transactional memory. For example, he is the inventor of the widely-used *3C model* of cache behavior (compulsory, capacity, and conflict misses) and co-inventor of the memory consistency model *sequential consistency for data-race-free programs* that serves as a foundation for the C++ and Java multi-threaded memory specifications. Hill's work is highly collaborative with over 160 co-authors and especially his long-time colleague David A. Wood.[2] Professor Hill's research has been well funded with tens of millions of dollars (not inflation adjusted) from about 50 grants and donations, mostly from the US National Science Foundation (NSF) and mostly to UW.

Publications. As Google Scholar attests (https://scholar.google.com/citations?user=7lVfIWYAAAAJ) and his CV attests, Professor Hill has co-authored more than 150 peer-reviewed papers, is co-inventor of 40 patents, has earned 28K citations, has three papers with more than 1000 citations, and has an H-index over 80. Notably, he also co-authored a 2011 monograph, *A Primer on Memory Consistency and Cache Coherence*, downloaded (perhaps redundantly) over 10,000 times by both academia and industry, with the second edition released in February 2020.

Teaching / Education. Professor Hill has been a dedicated and effective classroom teacher in courses from the freshman to the advanced graduate level. The courses that he has most commonly taught are: CS/ECE 252 Introduction to Computer Engineering, CS/ECE 354 Machine Organization and Programming, CS/ECE 552 Introduction to Computer Architecture, CS/ECE 752 Advanced Computer Architecture I, and CS/ECE 757 Advanced Computer Architecture II (a.k.a., Parallel Computer Architecture). He most enjoyed exposing freshman and sophomores to fundamental computer architecture ideas (why base two and how instructions and data are fungible) in 252 and awakening parallel computer research potential in 757. Professor Hill's student evaluations were strong in a department that values teaching with typical scores out 1-5 for *recommend instructor* being 4.4-4.6 for 252 and 4.6—5.0 for 757. His teaching and research were enhanced by sabbatical visits to Google (2018), Advanced Micro Devices (2011), University of Washington (2011), Columbia University (2010), Universidad Politècnica de Catalunya (2002-03), and Sun Microsystems (1995-96).

Advising. Professor Hill has advised or co-advised twenty Ph.D. graduates, mentored many others in his research group co-led with other professors, and has served in numerous Ph.D. committees in CS and ECE. A former UW CS student—who earned a Ph.D. with another professor—wrote: *Congratulations on the Eckert-Mauchly award! Although the citation focuses on research, I especially admire your impact on turning students into colleagues. You are an inspiration to us all!*

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[1] Paper title word cloud: http://pages.cs.wisc.edu/~markhill/papers/markhill_eckert-mauchly_2019_keywords.png
[2] Coauthor word cloud: http://pages.cs.wisc.edu/~markhill/papers/markhill_eckert-mauchly_2019_coauthors.png

Internal Service. Professor Hill's most important internal service is serving as CS ***Department Chair from July 2014 to June 2017*** with several notable accomplishments. First, he worked with then Deans Wilcots & Scholz to get a commitment to grow CS much larger that the then 34 faculty. Second, he managed the hiring of nine faculty in the two years CS was authorized to hire. Third, he oversaw continued expansion of CS enrollment and majors with key work also done by Associate Chair Michael Swift and others. Fourth, he encouraged and expedited the complete revamping of CS's introductory curriculum (the first in decades) to better match the 21st Century. Finally, he husbanded $15M in donations to the department with Jody Andruss and Dean Scholz.

External Service. Professor Hill's most important external service is serving the information technology community and the nation via the ***Computing Community Consortium*** (CCC) as Executive Committee member (until 2016), Vice Chair 2016-2018, and Chair 2018-2020. *CCC's mission is to catalyze the computing research community and enable the pursuit of innovative, high-impact research. CCC conducts activities that strengthen the research community, articulate compelling research visions, and align those visions with pressing national and global challenges. CCC communicates the importance of those visions to policymakers, government and industry stakeholders, the public, and the research community itself.*

Several items are of note. First, Professor Hill is Principal Investigator of an $8.5M *Computing Community Consortium III* grant and 2019 $1M supplement from NSF to the Computing Research Association. Second, CCC/AAAI's 2019 *A 20-Year Roadmap for Artificial Intelligence Research in the US* is having profound effect in Washington DC, including being cited by the new $200M (up to $120M first year) *National Artificial Intelligence (AI) Research Institutes*, by NSF, and by four other agencies. Third, Professor Hill has supervised or co-authored over a dozen CCC white papers, attended and shepherded over a dozen CCC workshops, and had high-level meetings with agencies, congressional staffers, and the White House Office of Science and Technology Policy (OSTP). Fourth, the 2012 CCC whitepaper he led—*21st Century Computer Architecture*—has been annually cited by NSF in the *Exploiting Parallelism and Scalability* and *Scalable Parallelism in the Extreme* programs that have been awarded $16M/year ($90M total), and cited again by the new *Principles and Practice of Scalable Systems* program that promises up to $87M more in the 2020s.

Honors. As mentioned, Professor Hill's most important external honor is the ACM - IEEE CS Eckert-Mauchly Award, 2019, *for seminal contributions to the fields of cache memories, memory consistency models, transactional memory, and simulation*. It is the highest award in computer architecture and hardware and represents a lifetime of achievement. Other important external recognition includes being named an ACM Fellow (2004) *for contributions to memory consistency models and memory system design*, being elevated to a Fellow of the IEEE (2000) *for contributions to cache memory design and analysis*, winning the second ACM SIGARCH Alan Berenbaum Distinguished Service Award (2009), winning an NSF Presidential Young Investigator award (1989), having eight papers selected for IEEE Micro's annual Top Picks in computer architecture, and in 2017 having a paper [Hill & Marty, *Amdahl's Law in the Multicore Era, 2008*] selected as one of the seven Most Influential Papers from IEEE Computer's First 50 Years.

At UW-Madison, Professor Hill's highest honors are twofold. First, in 2013 he was awarded a WARF Named Professorship that he named after UW-Madison Ph.D. and computer pioneer Gene M. Amdahl (of Amdahl's Law mentioned in the previous paragraph). Second, in 2015 he was named to a John P. Morgridge Endowed Chair in Computer Sciences at UW-Madison. Professor Hill's other important UW-Madison awards are: Kellett (2010), Vilas Associate (2006), and Romnes Fellow (1997).