HSCI 1011
Digital World

Spring 2017 MW 12:20–1:10 pm West Bank Auditorium (room 020)
Plus one discussion section (scheduled W, Th, F) [3 credits]

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Essential knowledge and critical perspective to understand today's Digital World. The history and social impact of the digital revolution, including security, surveillance, "virtual reality," and the future of the Internet. HIS/TS approved.

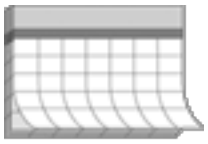
This course provides essential knowledge and critical perspective for students, citizens, and professionals to understand today's Digital World. It uses the conceptual practices and disciplinary outlook of history to understand the emergence, dynamics, and social impact of the digital revolution. Five three-week blocks are carefully constructed to provide needed historical depth on the complex social, cultural, political and technical dynamics of the digital world, while giving satisfying breadth and comparative scope. It complements existing offerings at the university including HSCI 1715/3715 (history of technology), HSCI 4321/CSCI 4921 (history of computing), CSCI 1001 (intro), and CSCI 3921W (ethical issues). There is no pre-requisite.

The aim is to provide a rigorous, historically informed perspective on the digital world as it is unfolding around us. While the United States historically played a large role in inventing and deploying digital technologies, this course adopts a thoroughly global perspective. So Russia's internet-content management and China's "great firewall" are treated along with Google, Facebook, and Twitter. A key theme is the "materiality" of the digital world: immense server farms in Oregon, Utah, Virginia, North Carolina and elsewhere are physically linked (by fiber optic cables) to create what we commonly call "the Internet."

The course draws on varied resources, including new research by internet historians, media scholars, privacy advocates, and internet-governance experts. It connects undergraduate education with cutting-edge scholarship and active research.

The five course themes are: [1] Structure of the Internet; [2] Compressing Reality; [3] Security and Surveillance; [4] Virtual Reality; [5] Future of the Internet. These five blocs offer a flexible structure that can evolve with current concerns and future opportunities.

REQUIRED READINGS include short essays, articles, primary sources, online resources. Required book is David Mindell's *Our Robots, Ourselves: Robotics and the Myths of Autonomy* (2015). Readings to be completed before that week's discussion section (see **Moodle**).



COURSE ASSIGNMENTS: five quizzes [45% of course grade]; discussion section [15%]; 5 short essays [15%]; final exam [25%]. Quizzes and final exam are "closed book." The last week of each theme: quizzes are Wednesday; short essay assigned Monday and due in your section. Percentage grading scale:

A	A-	B+	B	B-	C+	C	C-	D+	D	F
93	90	87	83	80	77	73	70	67	63	<60

REGULAR ATTENDANCE is necessary. Lectures, readings, and discussion sections are key to doing well in this course. You cannot simply take the quizzes and final exam. Missed quizzes may be made up — *if* you inform *me* of your absence (by email) *prior* to the Wednesday in-class quiz (each 3 weeks). Students devoting "0-2 hours/week" to this class cannot expect high grades. I expect 2 hours of reading/review *plus* 2 hours of studying each week.

OFFICE HOURS: by appointment (612/624-5050 or tmisa@umn.edu) in my West Bank office (Andersen Library 211) or anytime in the hour after lectures. An hour-long review session on Google Groups precedes each quiz and the final exam.

UNIVERSITY POLICIES: The University of Minnesota has a list of policy statements that it wishes all students to understand, especially first-year students who might not yet be familiar with them. There are eleven specific policy statements on Student Conduct Code (linked below); Use of Personal Electronic Devices in the Classroom; Scholastic Dishonesty (see below); Makeup Work for Legitimate Absences; Appropriate Student Use of Class Notes and Course Materials; Grading and Transcripts; Sexual Harassment; Equity, Diversity, Equal Opportunity, and Affirmative Action; Disability Accommodations; Mental Health and Stress Management; and Academic Freedom and Responsibility. Please review **this page**.

The University of Minnesota Student Conduct Code identifies "scholastic dishonesty" as grounds for possible separation from the University through suspension or expulsion. Copying notes, quizzes, assignments, or exams from any source -- in whole or in part -- is dishonest. If you commit scholastic dishonesty on a quiz, assignment, or exam in this class you will receive a *zero* on it. "Scholastic dishonesty in any portion of the academic work for a course will be grounds for awarding a grade of F or N for the entire course." Please talk to me, anytime, if you have any questions or concerns about scholastic dishonesty.

Students benefit greatly from contact with the Center for Writing, which offers on-line as well as in-person writing consultations through Student Writing Support.

This course encourages students' engagement in liberal education and satisfies HIS and TS (see complete CLE statement below). Far from standing "outside history," the digital world is deeply shaped by historical developments in computing, information theory, diverse institutions, globalization, and politics. These ongoing changes will shape the character of our society and culture -- now and in the future. Understanding the details of digital technologies can provide insight into cultural and political implications as well as possible alternatives.

THEME 1: Structure of the Internet

Originally the internet resembled a "mesh" with many connections between nodes; given this structure, it appeared the internet could not be centrally controlled (or surveilled) and was "stronger" than governments and traditional institutions. The "world is flat" and "death of distance" became popular slogans. Beginning in the late 1990s, however, the internet was reconstructed into a "tube" or "pipe" structure. Telecom companies ran fiber-optic cables, often in their existing telephone pipes. "New York City is a superhub for the Internet [because] a large number of the transatlantic cables make landfall close to the city," according to a National Academies report. The 9/11 attacks in New York knocked out the internet in South Africa. Similarly, commercial internet traffic across Minnesota was routed through Ameritech in Chicago until 2011.

1. *1/18*	The internet was born as a decentralized "mesh" with no single center
	Structure of ARPANET and Internet to 1990s. Decentralized networks, with no "center," are hard to manage and impossible to centrally control. Nation-states, old-style corporations, the global economy and society were changing.
2. 1/23	The internet around 2000 became more "tube-" or pipe-like
	Around 20 million miles of fiber-optic cables were laid in 2000, with telephone companies (telcos) largely re-wiring the commercial internet—often in the shape of the existing centralized phone system.
3. 1/30	No longer a "mesh," the "tube" internet is controllable—and surveilled.
	QUIZ on internet structure (mesh vs. tubes/pipes)

THEME 2: Compressing Reality

"Reality" in the everyday sense is complex, round, and messy; computing compresses letters, images, sounds and more to create a digital world—simple, square, orderly. Watching football on TV you occasionally see square pixels. Digital images and sounds are digitally processed data. Standards for digital images and sounds take us quite a way from a painter's brushstrokes or an oboe's vibrating reed. The compression of reality has upsides (access, alterability, and transmission) as well as downsides (loss of fidelity, misrepresentation, and saturation). Will the analog world, evoking memory and identity, be preserved only in digital sights and sounds?

4. 2/6	1960s ASCII encoded number and letters—hardwiring computers for English
	Computer code for numbers, letters, and images allows them to process complex entities. Mostly it works well and permits us to edit words, sounds, images. But some Xerox machines scramble numbers (*14* becomes *17* or *21*).

5. 2/13	Emerging technology of image- and audio-compression
	An accessible treatment of the science and technology of signal processing for mp3 audio (phone system, compression, "piracy"): how digital electronics squeezes 1000 songs or 10 movies onto your cell phone
6. 2/20	What is gained—and what is lost—when analog 'reality' becomes digital?
	QUIZ on digital compression and analog-digital

THEME 3: Security and Surveillance

Concern about "cyber-terrorism" since 2001 expanded the power of governments, worldwide, to collect and analyze digital information. The internet's "tubes" made pervasive surveillance practical (see Snowden revelations). Arab Spring activists in 2010-12, believing the internet was still a decentralized mesh, argued that "the power of the people" could be mobilized through social media and anonymous internet services. The future is formed by today's contests between rival advocates of privacy, security, and surveillance: some democracy and privacy advocates work toward strengthening anonymous internet use (such as TOR); others favor strengthened government surveillance techniques, such as deep packet inspection (DPI), to counter cyber-terrorism. Some experts think 95% of the internet consists of inaccessible "dark" or "deep" webs—where anonymous users, porn, botnets, Bitcoins, and even some legal activities flourish. Must "secure" digital networks be "surveilled" networks?

7. 2/27	Arab Spring relied on TOR to protect anti-government activists
	Activists and spies depend on TOR ('The Onion Router') for safe untraceable internet access. TOR, a product of US intelligence agencies, works by creating an anonymous network that disguises its users. Does it work?
8. 3/6	Governments use 'deep-packet inspection' to read internet traffic
	Computer scientists' data-mining techniques can analyze immense datasets. DPI uses similar techniques to access specific messages in the flood of internet traffic.
9. 3/20	What is a 'dark' web?
	QUIZ on TOR, DPI, surveillance techniques

THEME 4: Virtual Reality

Digital technologies have transformed media, military—and science: where it once investigated the natural world (atoms, oceans, solar systems) science now investigates artificial constructs such as buckyballs, quantum qubits, and information itself. Simulation models—of transportation systems, high-tech buildings, proteins, and sub-atomic particles—are now central to science and engineering. Links between "computer gaming" for entertainment (an industry now larger than music and movies combined) and the computer-graphics techniques common in science and the military. How have digital simulations transformed the daily practices of soldiers and citizens? How does simulation affect our understanding of the world—simulated experiences, faith in simulation, prescriptive and algorithmic models, digital "reality"?

10. 3/27	The military-entertainment complex created RTS, MMO, and FPS gaming
	An Army officer praised Atari's *Battlezone* (1980): "the same result ... for less cost." DARPA's SIMNET created several distinct genres of computer gaming, while training soldiers for combat; networks, graphics, Z-buffer displays
11. 4/3	Science no longer focuses on 'real' entities while engineers 'model' everything
	Simulation models in biology, chemistry, architecture, civil engineering and many other fields have displaced 'reality' with elaborately computed entities, which may have great predictive power and have changed science
12. 4/10	The emergence of virtual reality (at last)?
	QUIZ on emergence of gaming, simulation, virtual reality

THEME 5: Future of the Internet

The internet was largely a U.S. creation in the 1980s, but today in China alone there are 700 million internet users. From 1992 to 2016, U.S. Department of Commerce guided internet governance (e.g. ICANN, IETF, Internet Society). These institutions have resisted most efforts by the UN-backed Internet Governance Forum. One major change occurred in 2010 when ICANN permitted website addresses in non-Roman alphabets. Another change is the rise of *separate* internets: China has its own search engine (Baidu), e-commerce giants (Alibaba, Taobao, Tencent, JD.com), social media (Weibo and Renren), unusual internet censorship; and it is exporting its "great firewall." Western companies too sell surveillance tools to repressive regimes in Asia and the Middle East. How long will an open, uniform "world wide web" remain?

13. 4/17	The internet was originally governed (not controlled) by the U.S.
	For years, informal groups (under military funding) managed the internet. Governance became vested in the US-dominated IAB, IETF, and ICANN, cheered on by Internet Society, and nominally run by Commerce Department
14. 4/24	China has built a separate internet—independent from the world
	In 2014 China's online economy surpassed the US's. Homegrown companies (Baidu rivals Google) and unusual internet censorship (3 points connect China to the global internet) create an orderly, authoritarian, and stable internet
15. 5/1	Can the internet adapt to a global but divided world?
	QUIZ on future of the internet
	Final Exam is Tuesday, May 9 at 10.30 am – 12.30 pm

See appended Liberal Education statement

LIBERAL EDUCATION:

HSCI 1011 "Digital World" is designed to encourage students' engagement in liberal education through adopting a historically grounded approach to today's digital world. Far from standing "outside history," our present digital world has been deeply shaped by historical developments in computing, information theory, state- and corporate institutions, and globalization. Even more important, these changes are ongoing and will have significant consequences for the character of society and culture in the years and decades to come. A well-grounded liberal-education approach to the computer-driven digital economy and culture is, furthermore, a desirable experience for all student-citizens so they might effectively exercise citizenship rights and obligations as well as make informed assessments of future developments in technology and society.

This course deals with the "technology" of the digital world; it also examines and assesses the implications of digital technologies for fundamental human concerns, such as perception and identity; for politics and citizenship, including the character, availability, and diversity of information and the means for assessing it (digital divide); for understanding of cultural differences and similarities, a challenging feature in the globalized digital world; and for making collective choices about governance issues, involving one's own cultural values but also recognizing the significant variation in cultural values across the world today.

The course is centrally concerned with two Student Learning Outcomes, notably, **acquiring skills for effective citizenship and life-long learning** *and* **understanding diverse philosophies and cultures within and across societies**. These goals are elaborated further in the SLO statement. The availability, character, and trustworthiness of information is obviously critical to the health of democratic society. The extensive information available on the internet today is large in volume, but students in discussions and small-group exercises will learn and share means to assess its character and reliability as well as to appreciate the profound differences existing today in the different "internets" available in the world. This reflects significant cultural variations. While formal methods of technically sophisticated censorship are practiced in some places (China, some countries in the Middle East and Asia), information is also shaped by governments' state-directed "entertainment" (such as Russia) and focus on digital gaming celebrities (South Korean's notable gaming culture has multiple 24-hour cable TV channels and a national association devoted to professional computer gaming a.k.a 'e-sports'). Exploring and assessing citizenship and cultural variation is a natural means of discussing these core liberal education topics and concerns with today's students.

This course will be taught by regular faculty in the History of Science and Technology program, and offered on a frequent and ongoing basis. It is planned to be offered in the spring semester as student demand warrants.

It is natural in a course like this to actively engage students with direct learning about the digital world. Interactive visual tools exist (see telegeography.com and TraceRoute) to explore internet-cable connections between countries and examine real-time mapping of the internet. These tools can help students explore and visualize the "shape" of today's internet, with its surprisingly centralized structure and limited number of internet exchange points. Written work is formalized in five short reflection essays, five quizzes, and final exam.

HISTORICAL PERSPECTIVES:

Change over time and attention to specific and distinctive historical contexts is a fundamental aspect of this course. Precisely because we sometimes think "the internet" is a timeless creation, and that the "digital world" stands above and apart from history, this course will give students valuable historical insights into the emergence of digital technologies as well as the paths that were chosen (and some that were not taken up—or are yet to be created). Changes in the structure of the internet in the past 25 years are especially profound, with the internet undergoing several punctuated rounds of change (roughly, "mesh" to "pipes" with variants), a major theme of weeks 1-3. Also, despite early internet advocates' utopian dreams about "one world," today's internet is a means for expression by divergent subcultures ("splinternet" and "fake news"). There are profound national differences in how the internet and digital media are constructed and experienced. Examples include Russian state media creation and China's immense e-commerce economy, and intense internet censorship (weeks 13-15).

Understanding the conceptual methodologies of historical analysis, including historical frameworks to assess primary sources, assists students with real-world examples for more deeply appreciating liberal education themes. Historical concepts and methods from technology, computer, and cultural history, such as user-driven innovation, gender analysis, user heuristic, systems, technical culture, and consumption junction (respectively, Eric von Hippel, Ruth Oldenziel et al., Claude Fischer, Tom Hughes, David Nye, Ruth Cowan) provide rich interpretive frameworks.

Primary sources on the digital world are varied and richly textured, although they must be carefully analyzed. Students will compare maps of the early internet with latter-day maps of the fiber-optic cables that create the global internet, identifying choke points and possible vulnerabilities (weeks 2-3). Digitally processed images and sounds (jpeg and mp3 in weeks 4 and 5) are digital instances of "reality" that students can examine and assess. Many students bring background with computer gaming (weeks 10-11).

TECHNOLOGY AND SOCIETY:

This course confronts students with opportunities to recognize the ethical dimension of their everyday exposure to and immersion in the digital world. Awareness of computer user groups' key role in developing software (including open source) encourages students to consider their own roles, not merely as passive consumers of digital technologies and media, but also as active and attentive/selective users and creators. The rise of separate and divided digital experiences reinforces the point that shared responsibilities cannot be taken for granted. Examining social media and our role in creating and consuming social media fosters students' sense of their roles as historical agents.

Clearly, digital technology has had a profound impact on contemporary society. Students gain insight and appreciation of the underlying science and engineering through detailed examination of specific digital technologies, including [a] queueing theory that underpins internet traffic management (weeks 1 and 2); [b] information theory that supports the jpeg and mp3 encoding routines (weeks 4 and 5); [c] database and surveillance technologies as well as the anonymizing counter-measures (weeks 7 and 8); and [d] the modeling, simulation, and gaming technologies that may supplant analog 'reality' (weeks 10-12).

Students consider and discuss the role that different societies have in the development of internet and digital technologies. The "global internet" has significant variants based on geography, culture, and political values. Both the structure of and cultural practices on the internet are significantly different in diverse national and cultural contexts, a major theme of weeks 13-15.

Multiple perspectives on the impact of digital technologies are a natural point when considering the future of the internet. Some non-US countries resent the historical dominance of the US government as well as US-centered companies in managing and governing the internet. Efforts to wrest control away from the US have focused mostly on the UN-backed Internet Governance Forum (founded 2006). IGF's impact on internet governance, to date, has been modest, but that might change in the future.

Students can develop skills in assessing their own and others' perspectives on the internet. Privacy activists and computer-security experts have varied perspectives about assessing what directions the internet ought to take. Similarly, diverse perspectives abound in global internet governance. By engaging in critical evaluation of these debates, students will gain a valuable framework for evaluating present-day options and directions and thereby gain insight into evaluating technology in the future.