

claudé shannon

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Shannon Centennial Symposium

Presented by Alfred Hero

The University of Michigan

Ann Arbor, MI

Sept 16, 2016

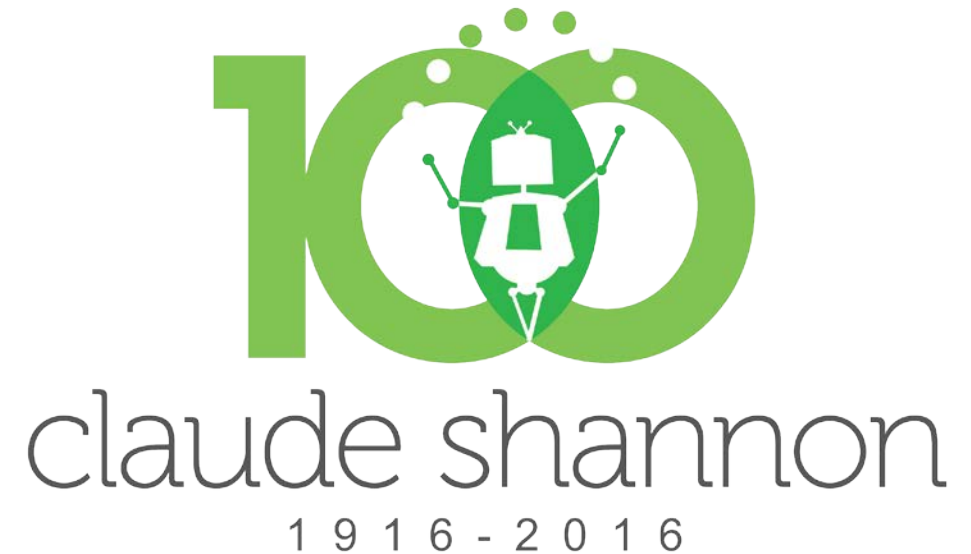
UM Organizing team (ECE)

Co-organizers

- Alfred Hero – MIDAS/ECE
- Hye Won Chung – ECE
- David Neuhoﬀ - ECE
- Sandeep Pradhan - ECE

On site staﬀ

- Alison Martin – MIDAS
- Shelly Feldkamp - ECE
- Student volunteers - ECE



Sponsors



UNIVERSITY of MICHIGAN ■ COLLEGE of ENGINEERING



Symposium Agenda

- 8:15 Light breakfast (Assembly Hall)
- 9:00 Introductory Remarks (Amphitheatre)
- 9:15 Plenary Talk I: Information Theoretic Limits for Randomness Generation, Abbas El Gamal, Stanford University
- 10:15 Break
- 10:45 Plenary Talk II: Around the Reproducibility of Scientific Research in the Big Data Era: What Statistics Can Offer? Emmanuel Candès. Stanford University
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- 1:45 Plenary Talk III: On Shannon's Channel and Capacity -- A Mystery in Three Acts, Michelle Effros, Caltech
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- 3:15 Plenary Talk IV: Remembering Shannon, Rob Calderbank, Duke University
- 4:15 Closing Remarks
- 4:30 Reception (Assembly Hall and Terrace)
- 6:00 End of Symposium

Shannon Centennial Celebration at Michigan

- Shannon Centennial Symposium, Sept 16 2016
 - Plenaries: Abbas El-Gamal (Stanford), Emmanuel Candes (Stanford), Michelle Effros (CalTech), Rob Calderbank (Duke)
 - Poster sessions and social activities
- CSP Shannon Centennial Seminar Series Fall 2016
 - 9/22 Bob Gray, Stanford
 - 9/23 Becca Willett, U. Wisconsin
 - 10/13 Bruce Hajek, UIUC
 - 10/27 Prakash Narayan, U. Maryland
 - 10/X Frank Kschischang, U. Toronto
 - 11/4 Yuejie Chi, Ohio State U.
 - 11/17 Dan Costello, Notre Dame
 - 11/21 Elza Erkip, NYU

Claude Shannon: Father of Information Theory, Founder of Digital Communications

- 1936: Shannon's application of Boolean algebra to switching circuits
 - enabled logic design and CAD tools
- 1948: Shannon's capacity and noisy channel coding theorems
 - enabled digital data transmission (reliable data storage, wifi, cellular and satellite comm)
- 1948: Shannon's source coding and rate distortion theorems
 - enabled data compression (image, audio, video coding)
- 1948: Shannon's pulse code modulation principles
 - enabled pulsed radar and digital communications
- 1949: Shannon-Nyquist sampling theorem
 - enabled AD/DA CODECs that underpin today's digital world
- 1949: Shannon's mathematical theory of secrecy systems
 - Established existence of unbreakable ciphers and enabled public-key RSA cryptography
- 1950: Shannon's computerized chess and maze solving algorithms
 - Inspired development of artificial intelligence and machine learning systems

Claude Shannon's places

- Petoskey MI: born on April 30, 1916
- Gaylord MI: where he spent his youth 1916-1932
- Ann Arbor MI: undergraduate at University of Michigan 1932-1936
- Cambridge MA: graduate student at MIT 1936-1940. PhD Thesis "An Algebra for Theoretical Genetics."
- Princeton NJ: National Research Fellow at Inst for Advanced Study 1940
- Murray Hill NJ: research mathematician at AT&T Bell Labs 1941-1956
- Cambridge MA: professor at MIT (RLE) 1956-1978
- Medford MA: died on Feb 24, 2001

C. Shannon in Gaylord MI

- Father: Claude Elwood Shannon was a lawyer/businessman from NJ
- Mother: Mable Wolf was school teacher/principal from MI
- Early hobbies: building wireless telegraph, radio controlled boats, and model planes
- Attended Gaylord Public High School 1929-1932

C. Shannon's parents in Gaylord MI

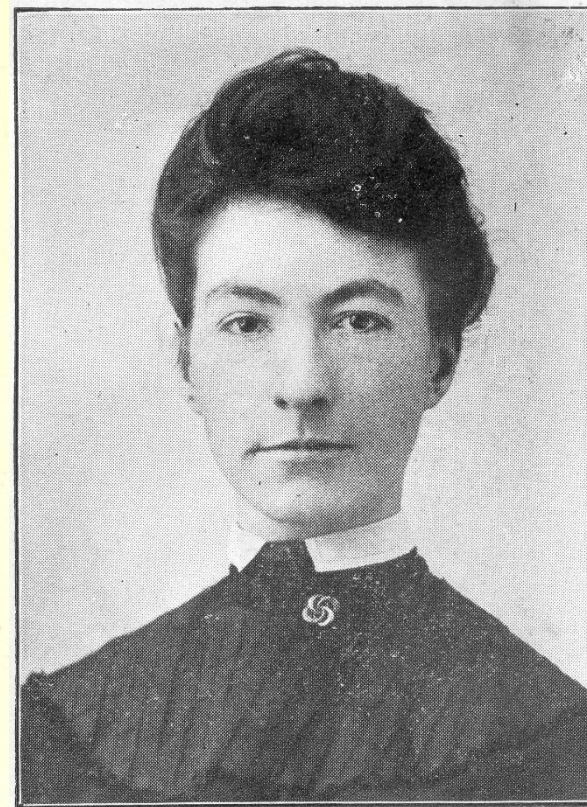


CLAUDE E. SHANNON
1913-1924

Hon. Claude E. Shannon Sr



Parents outside their business at 107 W. Main St



MABEL C. E. WOLF
PRINCIPAL GAYLORD HIGH SCHOOL

Mable Wolf Shannon

C. Shannon's grade school photo



Source: Otsego County Historical Society

Gaylord High School (1929-1932)

- C. Shannon was (unranked) in his high school cohort of 27 students
- C. Shannon's classes at Gaylord High:
 - English(4 semesters), Latin(2), Economics(1/2), History(2), Algebra& Geometry(3), Physics(2), Chemistry (2), Biology(2) and Civics(2)
- C. Shannon took first semester algebra in 8th grade
- C. Shannon's high school grades were mostly A's with a few B's
- Excelled in Latin, Algebra&Geometry, Physics, Chemistry and Biology
- Played horn in high school band
- Applied to UM in late summer 1932

C. Shannon at Gaylord High School



Shannon with E flat alto horn



High School Diploma

Claude Shannon's application to UM

PART I
GENERAL INFORMATION BLANK

Date August 30 1932

1. Name in full.....Claude.....Elwood.....Shannon.....
FIRST MIDDLE LAST

2. Home address: Street and Number.....
City Saylord State Michigan

3. List in chronological order all schools attended. Begin with the high school:

Name of School	Location	Dates of Attendance
<u>Saylord Public School</u>	<u>Saylord Mich</u>	<u>1920</u> to <u>1932</u>
.....	19... to 19...
.....	19... to 19...

Underline the High-School Course Pursued: College Entrance; Commercial; Manual Training; Agriculture;.....
(List any other)

4. a) Place of birth...Petersky Mich. Date of birth April 30 1916.
MONTH DAY YEAR

b) Date of graduation from High School...June 10, 1932



Claude Shannon's application to UM (ctd)

5. a) Check the *college and course* in which you plan to register.

LITERATURE, SCIENCE, AND THE ARTS

- ☐ *Literary* ☐ *Pre-Legal*
☐ *Scientific* ☐ *Pre-Medical*
☐ *Pre-Dental* ☐ *Literary-Nursing*
☐ *Pre-Forestry* ☐ *Pre-Business*

OTHER SCHOOLS AND COLLEGES

- ☐ ARCHITECTURE ☐ SCHOOL OF MUSIC
☒ ENGINEERING DENTISTRY
EDUCATION ☐ *Oral Hygiene*
☐ *Physical* ☐ UNIVERSITY HOSPITAL
☐ *Vocational* SCHOOL OF NURSING
☐ PHARMACY

b) Are you planning to become a teacher? *NO.*

c) When do you expect to enter? September, 193*3*... February, 193.....

6. a) 1) Father's name in full

Claude Cluwood Shannon

2) Living? *yes*

3) Place of birth *Axford, New Jersey*

4) Occupation *Lawyer*

5) High-school graduate? *yes*

6) College attended

7) Did he graduate?..... When?.....

6. b) 1) Mother's name in full

Mable Wolf Shannon

2) Living? *yes*

3) Place of birth *Lansing Mich*

4) Occupation, if she works.....

5) High-school graduate? *yes*

6) College attended *Mich. State Normal*

7) Did she graduate? *yes*... When? *June 1904*

7. Number of children in your family older than yourself? *one* Younger? *none*

8. Have you earned any money during your high-school course? *yes*... How? *peddling papers*
and delivering telegrams

Documenting Shannon's admission to UM

The above-mentioned student is admitted to the school or college checked:

LITERATURE, SCIENCE, AND THE ARTS		OTHER SCHOOLS AND COLLEGES	
<input type="checkbox"/> <i>Literary</i>	<input type="checkbox"/> <i>Pre-Legal</i>	<input type="checkbox"/> ARCHITECTURE	DENTISTRY
<input type="checkbox"/> <i>Scientific</i>	<input type="checkbox"/> <i>Pre-Medical</i>	<input checked="" type="checkbox"/> ENGINEERING	<input type="checkbox"/> <i>Oral Hygiene</i>
<input type="checkbox"/> <i>Pro-Dental</i>	<input type="checkbox"/> <i>Literary-Nursing</i>	EDUCATION	<input type="checkbox"/> UNIVERSITY HOSPITAL
<input type="checkbox"/> <i>Pre-Forestry</i>	<input type="checkbox"/> <i>Pre-Business</i>	<input type="checkbox"/> <i>Physical</i>	SCHOOL OF NURSING
		<input type="checkbox"/> <i>Vocational</i>	<input type="checkbox"/> PHARMACY
		<input type="checkbox"/> SCHOOL OF MUSIC	
<input checked="" type="checkbox"/> Certificate		<input checked="" type="checkbox"/> Public	
<input type="checkbox"/> Examination		<input type="checkbox"/> Private	

Deficient in

Date. 9/16/13 19.....

.....
REGISTRAR

9

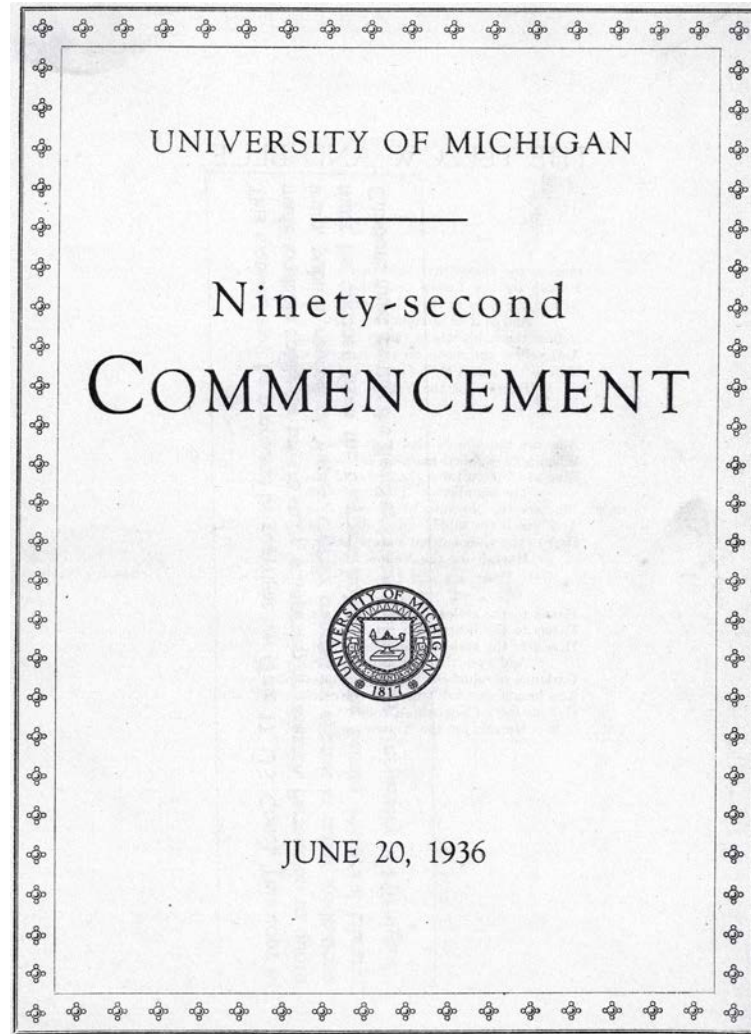
UM enrollment photograph (1932)



Shannon in Ann Arbor

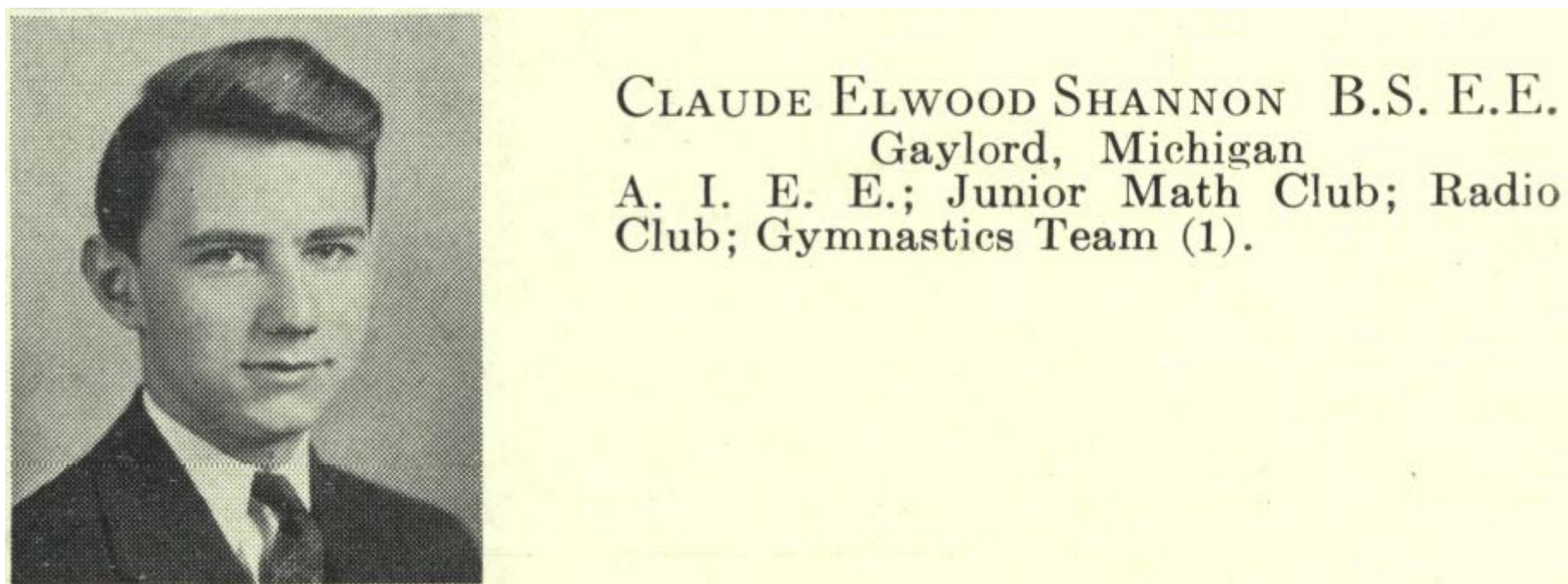
- UM CoE admissions committee recommended strong accept to (priority level 3 out of 4 possible levels)
- Enrolled at UM in Sept. 1932 at age of 16
- Majored in Electrical Engineering and Mathematics
- Excelled in his courses, especially EE and Math
- Activities
 - Radio club
 - Gymnastics team
 - Secretary of Junior Mathematical Society
 - ROTC (finished as 2nd Lieutenant)
 - Member of Phi Kappa Phi, Sigma Xi, AIEE
- Received Bachelors of Science (with Honors) in 1936

UM 1936 Commencement booklet

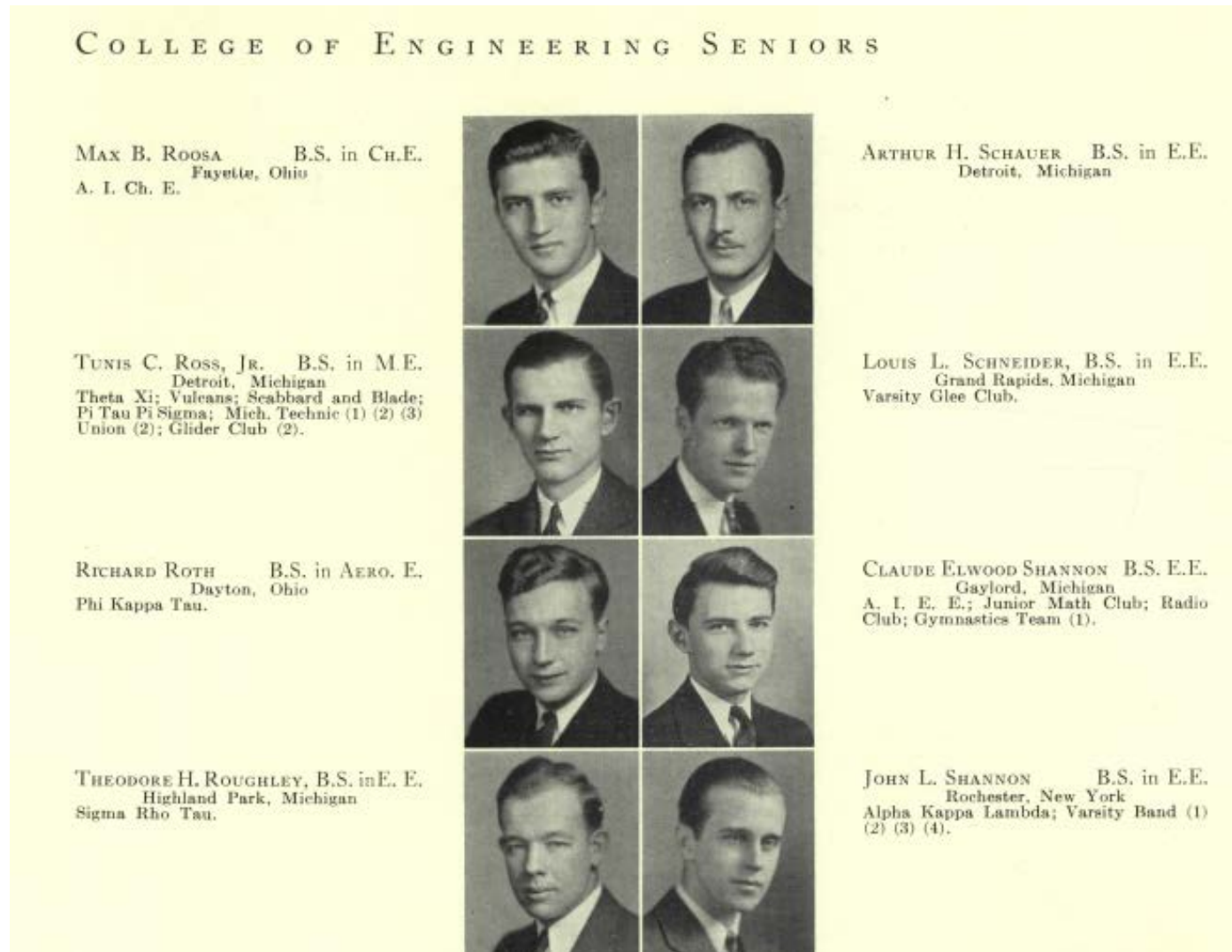


PHYSICS		
Carlyle Vivian Parker	Robert Ellis Reed-Hill	Francis Toussaint Worrell 3
MATHEMATICS		
George H. Atherton	John Robbins Kane	Claude Elwood Shannon
Ralph Benjamin Bodine	Raymond Herbert Layer	Jack Harold Sheets
Robert Lewis Camping	Robert Elke Pekelsma	William Oswald Wagenseil 9
MECHANICAL AND INDUSTRIAL ENGINEERING		
	Jerome Considine Fayram	1
GEODESY AND SURVEYING		
§Robert James Jagow		§Russell Edward Mason 2
AERONAUTICAL ENGINEERING		
Robert William Allred	Charles Raymond Hagler	Robert Elke Pekelsma
§Robert John Auburn	Reeve Robinson Hastings	§William Fredrick Reuther
Donald Leon Bard	Rufus Dale Keiser	§Edwin Wilson Richardson
Philip Edgar Rowland Brice	Lyle A. LaCroix	Roy Joe Sandstrom
Redwald Dale Bushell	Tex Segur Lines	Nelson Norton Shapter
Robert Lewis Camping	Lester Walter Lueking	Jack Harold Sheets
Charles William Donker	William Meek McCance	§Robert Munger Stevens
§Allen Francis Donovan	Robert Morris McFarlane	Glenn Earl Vescelus
§William Howard Eason	Charles Fortney Marschner	Francis Lloyd Wallace
Eugene Cameron Frost	Marvin Lowell Michael	Max Wender
Eugene Kline Gray	John Cox O'Connor	Hadley Kelsey Wiard 33
NAVAL ARCHITECTURE AND MARINE ENGINEERING		
§Philip Henry Clark	Albert Louis Hartsig, Jr.	§Clifton Francis Haughey 4
§Murdock Mack Earle		
CHEMICAL ENGINEERING		
Donald Moseley Bachelor	Morris Behr Heimann	John Pelle Nielsen, B.S. in Chem., <i>Michigan College of Mining and Technology</i>
Francis William Bell	Harold Malcolm Hertz	Ward Lowell Paine
Robert Ellis Clark	Conrad Elim Holben	John Henry Reifel
Alfred Edmund Dakingsmith	§Edwin Day Howell	Max Burton Roosa
William Wittwer DaLee	Kenneth Leroy Hulsing	Gunther Gustav Schmidt
Robert James Daverman	§Howard James Jackson	Sterling Joseph Spleet
John Witman Dersch	Warren Stanley Kahlbaum	Robert Lewis Taylor
Barry Lewis Dittmore	Harry Burton Kellogg	George Washington Tourtellot
Wilfred Carlton Dresser	Roger Wayne Kolderman	Robert Robinson Warner
Roy Woodford Emerson	Raymond Herbert Layer	Robert Bruce Waters
§Charles Augustus Framburg, Jr.	Warren Henry Mayo	Roland Milton Waters 36
Herbert John Arthur Goldsworthy	Robert Eschenburg Merrill	
	John Clarke Moore	
ELECTRICAL ENGINEERING		
Edward Paul Baker	Emanuel Feinberg	§Wray Hess Reger, B.S., <i>West Virginia University</i>
Rupert Benstead Bell	Soong Huang, B.S., <i>St. John's University</i>	Robert Glen Rogo
Ralph Benjamin Bodine	Roger Laurensen	Newell Donovan Saigeon
§Robert Franklin Bowker	Robert Eugene Leahy	Arthur Harold Schauer
§Harold James Bowman	Adolph Lovoff, B.S.E.E., <i>Law- rence Institute of Technology</i>	Louis Leonard Schneider
Richard Doolittle Brewer	Willard Fraser Miles	Claude Elwood Shannon
Everett Clifton Brill	Darr Miller	John Loron Shannon
George Grant Crewson, Jr.	Richard Francis Morairty	Roger Charles Shurtum
James Richard Davey	James Daniel Nicholls	Frank William Shutko
Sheldon Lincoln Drennan	George Yoshio Ohara	Louis Smullin
Charles Edward Drew	Elliott Howard Otterbacher	§Julian Leal Steffenhagen
Charles Harry Egeler	Carlyle Vivian Parker	Willis Richard Welton
Hayden Wiley Evans, A.B., <i>Ohio Wesleyan University</i>		Robert MacKay Wopat 38

UM graduation yearbook photograph (1936)



Shannon's UM graduation yearbook (1936)



Claude Shannon's legacy lives on at UM

- Claude E. Shannon Endowed Professorship: John Hayes, CSE
- Researchers in computing, communications, information theory
 - Achilles Anastasopoulos, ECE
 - Harm Derksen, Mathematics
 - John Hayes, CSE
 - Al Hero, ECE/CSE/BME/Stats, MIDAS
 - Mingyan Liu, ECE
 - David Neuhoff, ECE
 - Long Nguyen, Statistics
 - Seth Pettie, CSE
 - Sandeep Pradhan, ECE
 - Yaoyun Shi, CSE
 - Wayne Stark, ECE
 - Vijay Subramanian, ECE
 - Demos Teneketzis, ECE
 - Kim Winick, ECE
 - Jun Zhang, Psychology/Math
 -
- Shannon statue (one of six)

UMs Claude Shannon Statue (EECS Building)



Sculptor Eugene Daub at work



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Wrapup

- Thanks to our sponsors



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Wrapup

- Thanks to staff who were here today
 - Alison Martin
 - Shelly Feldkamp
 - ECE student volunteers
- Thanks to those working behind the scenes
 - Alison Martin
 - Catherine June
 - Dan Meisler
 - Ann Riggs

Safe travels!

