THOMAS J HANRATTY: JUST A FEW MORE MEMORIES

Mark J McCready

RECOGNITIONS AND AWARDS

"Junior" (Allan P. Colburn Award), American Institute of Chemical Engineers, 1957
National Science Foundation Senior Postdoctoral Fellowship, 1962
Curtis W. McGraw Award, American Society for Engineering Education, 1963
William H. Walker Award, American Institute of Chemical Engineers, 1964
Professional Progress Award, American Institute of Chemical Engineers, 1967
Member, National Academy of Engineering, 1974
Honorary Doctorate Degree, Villanova University, 1979
Senior Research Award, American Society of Engineering Education, 1979
Shell Distinguished Professorship, 1981-1986
Distinguished Engineering Alumnus Award, Ohio State University, 1984
Ernest Thiele Award, Chicago Section AIChE, 1986
University of Illinois Senior Scholar, 1987
American Academy of Arts and Sciences, 1997
Lamme Medal, Ohio State University, 1997
First winner of The Multiphase Flow International Prize, 1998
Member, National Academy of Sciences, 1999
Doteur Honoris Causa, de Institut National Polytechnique de Toulouse, 1999
Recognization as one of the influential chemical engineers of the modern era
(post WW2/at the AIChE Centennial Celebration, Philadelphia, 2008
Winner of the J. Stanley Marehouse Award Villanova College of Engr., October 2, 2009
Villanova University College of Engineering J. Stanley Morehouse Memorial Award-2009

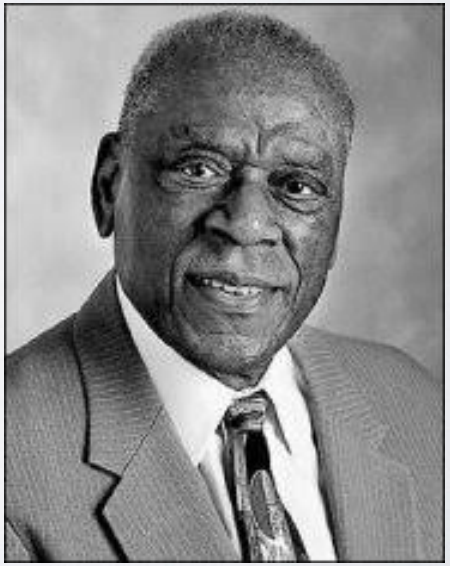
ACADEMIC ADMINISTRATION!

- Tom was the acting director of the School of Chemical Sciences for a period of a few months in 1999.

- In the end Chemistry and Chemical Engineering remained together in the School of Chemical Sciences and the "divorce" proceedings with Biochemistry was handled as graciously as it could have been!

CULTURE…

- I walked into Tom's office one day and he asked if I had been to the concert the night before
- I had missed what might have been William Warfield's last recital.
  - I'll bet it was really good!



https://www.youtube.com/watch?v=4XIEzY4tMyg

INFLUENCE ON STUDENTS

- In addition to all of us, and undergraduates who did research in his lab, there were many other Illinois students who he influenced
  - ~a few thousand undergraduate chemical engineers in CHE 371 or 380..
  - Some dozens in the "Senior Projects Lab"
  - I know one rather famous person — and one story

CHE 487

FLUID DYNAMICS

ChE 487
Spring 1988
Prof. T. J. Hanratty

1 unit

I. Introductory Remarks

- A. Application of Thermodynamics to Fluid Dynamics Problems
- B. Application of Newton's Second Law to a Flow Field
  - 1. Momentum Theorem
  - 2. Energy Theorem

II. Review of Uni-Directional Flow Problems and Newton's Law of Viscosit

- A. Pipe Flow
  - 1. Convention of Shear Stress
- B. Couette Flow Between Rotating Cylinders - Viscometric Equations
- C. Kinetic Theory Interpretation (Momentum Flux vs Shear Stress)

III. Development of the Equations for a 3-D Flow Field

- A. Continuity Equations
- B. Momentum Theorem Applied
  - 1. Body Forces
  - 2. Surface Forces
- C. Properties of the Stress Tensor, τ
- D. Velocity Gradient Tensor, $\varepsilon_{ij} + \Omega_{ij}$
- E. Generalized Constituative Relations
  - 1. Generalization of Newton's Law of Viscosity (for a Newtonian Fluid)
  - 2. Navier-Stokes Equations

IV. Status of Non-Newtonian Fluid Mechanics

- A. Non-Linear Effects
- B. Normal Stress Effects
- C. Viscoelastic (Time) Effects
- D. Maxwell's Linear Viscoelastic Model
- E. Reiner-Revlin Model
- F. Oldroyd's Convective Derivative

V. Discussion of the Navier-Stokes Equation

VI. Creeping Flow

- A. Flow Around a Solid Sphere (Stokes' Problem)
- B. Whitehead's Paradox (Regular Perturbation Technique)
- C. Stokes' Paradox (Flow Around a Cylinder)
- D. Recent Developments
  - 1. Oseens' Approximation (Cylinder and Sphere)
  - 2. Singular Perturbation Techniques

VII. Ideal Flow Theory - Euler Equation of Motion

- A. Assumption of Irrotationality
- B. Bernoulli Equation
- C. Incompressible Potential Flow Problems
  - 1. Flow Around a Sphere
  - 2. Wave Motion
- D. Two-Dimensional, Inviscid Flow (Complex Variables)
  - 1. Flow Around a Cylinder
  - 2. 2-D Vortex
  - 3. Flow around a Cylinder with Circulation
  - 4. Conformed Mapping
    - a. Flow Around a Cylinder
    - b. Flow Around a Flat Plate
    - c. Free-Streamline Problems
    - d. Schwarz-Christoffel Transformation - Flow Through 2-D Orifice

VIII. Boundary Layer Theory

- A. Physical Assumptions
- B. Equations of the Boundary (2-D)
- C. Typical Problem Definitions for BLT
- D. Remarks on Separation
- E. Examples of BLT
  - 1. Flow Over a Flat Plate
  - 2. Stagnation Flow
  - 3. Remarks on Similarity Solutions
  - 4. Blasius' Series Solution
    - a. Gortler's Expansion
  - 5. Integral Methods (Approximate Methods)
    - a. Flow Over a Flat Plate
    - b. Pohlhausen Method
    - c. Bohlen-Walz Improvement
- F. Numerical Solutions of the Boundary Layer Equations

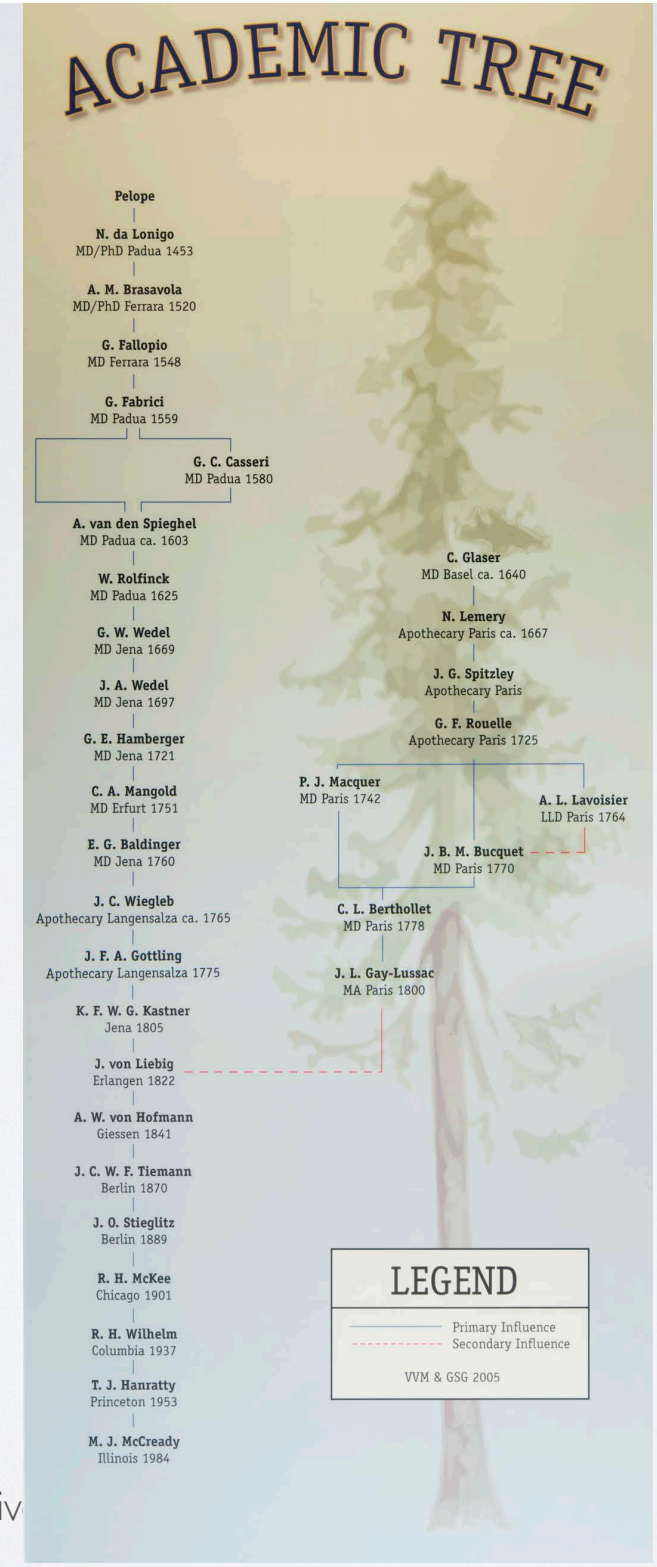
IX. Turbulence

- A. Reynolds Stresses
- B. Empirical Approaches (Mixing Length Theories)
- C. Dimensional Analysis Approach: law of the wall, defect law, overlap law
- D. Equation for Turbulent Energy
- E. Modern Methods for Predicting Reynolds Stresses
  - 1. Zero Equation Models
  - 2. One Equation Models
  - 3. Two Equation Models
  - 4. Direct Solution of the Equation for Reynolds Stress

X. Numerical Methods

TJH:klj
11/87

ACADEMIC LEGACY



Thanks to:
Vera Mainz
and Greg
Girolami

http://
www.scs.illinois.edu/
~mainzv/
Web_Genealogy/

chemeprof.com

ACADEMIC TREE

Pelope

N. da Lonigo
MD/PhD Padua 1453

A. M. Brasavola
MD/PhD Ferrara 1520

G. Fallopio
MD Ferrara 1548

G. Fabrici
MD Padua 1559

G. C. Casseri
MD Padua 1580

A. van den Spieghel
MD Padua ca. 1603

W. Rolfinck
MD Padua 1625

G. W. Wedel
MD Jena 1669

J. A. Wedel
MD Jena 1697

G. E. Hamberger
MD Jena 1721

C. A. Mangold
MD Erfurt 1751

E. G. Baldinger
MD Jena 1760

J. C. Wiegleb
Apothecary Langensalza ca. 1765

J. F. A. Gottling
Apothecary Langensalza 1775

K. F. W. G. Kastner
Jena 1805

C. Glaser
MD Basel ca. 1640

N. Lemery
Apothecary Paris ca. 1667

J. G. Spitzley
Apothecary Paris

G. F. Rouelle
Apothecary Paris 1725

P. J. Macquer
MD Paris 1742

A. L. Lavoisier
LLD Paris 1764

J. B. M. Bucquet
MD Paris 1770

C. L. Berthollet
MD Paris 1778

J. L. Gay-Lussac
MA Paris 1800

J. von Liebig
Erlangen 1822

A. W. von Hofmann
Giessen 1841

J. C. W. F. Tiemann
Berlin 1870

J. O. Stieglitz
Berlin 1889

R. H. McKee
Chicago 1901

R. H. Wilhelm
Columbia 1937

T. J. Hanratty
Princeton 1953

M. J. McCready
Illinois 1984

LEGEND

Primary Influence
Secondary Influence

VVM & GSG 2005

otre Dame

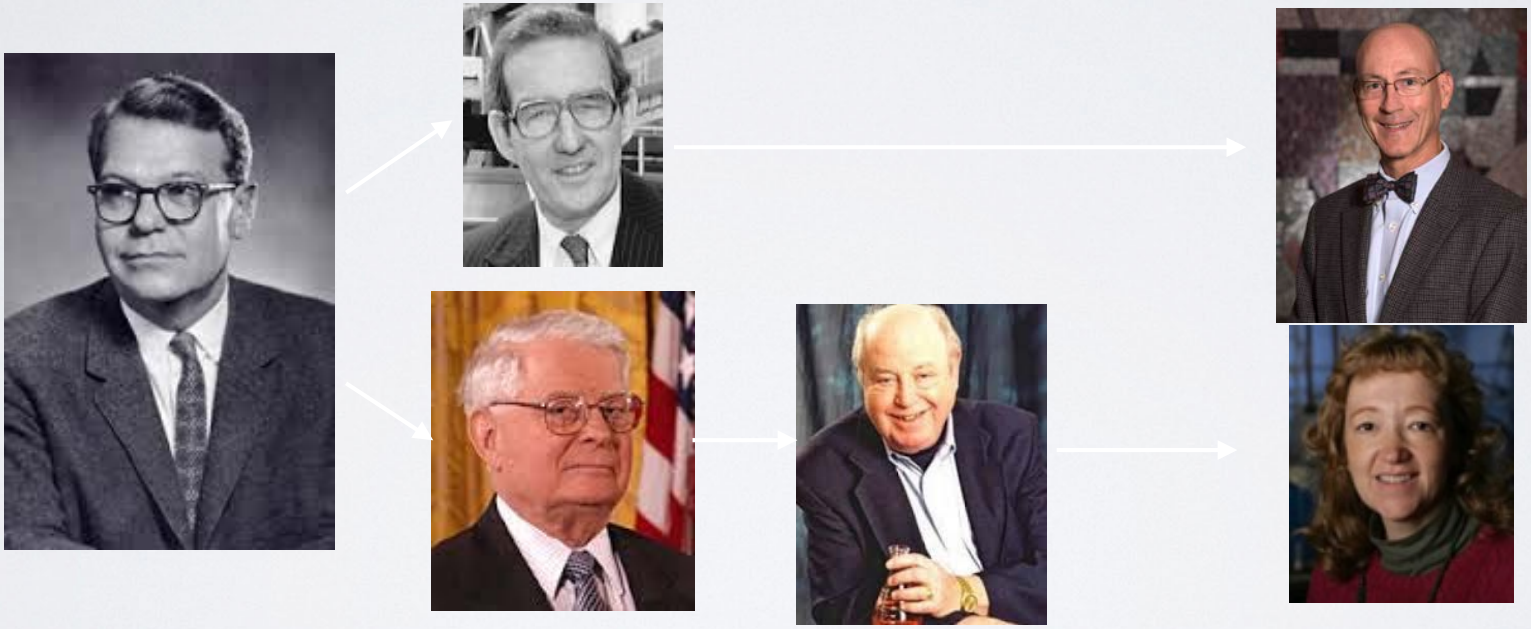
chemeprof.com

ACADEMIC DESCENDANTS

- **A. Karabelas**
  - S.V. Paras
  - A. A. Mouza
  - T. D. Karapanstsios
  - M. Kostoglou
- **K. K. Sikar**
  - T. Swaminathan
  - W. K. Kang
  - S. Farrell
  - G. Obuskovic
  - D. Chen
- **V. Bontozoglou**
  - M. Vlachogiannis
- **McCready**
  - (+ A. Varma)
    - B. Wilhite:
      - A. Suresh
      - B. V. R. Kuncharam
  - (+ D. T. Leighton)
    - M. R. King
      - M. J. Mitchell

FOR ALL OF US

- We can all make a difference personally…
  - If Newton had never lived, nothing in the world would be different*, may also be true about Einstein but…



* This same statement is not true in the creative arts. If Mozart had never lived, we would not have Don Giovanni and if Dickens had never lived… what we would watch at Christmas?