Graphics Press LLC P. O. Box 430 Cheshire CT 06410
What is Research?

THE START

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& 416A WP GC
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Non-Equilateral Regular Array
Prelude to Research - 1

How Does Humanity Itself Learn?

Ideas:

• Better to get your own that YOU are interested in
• Can come from you advisor as a last resort

Criticism: [Grownup mind set]

• Experts (advisor) provide only OPINION – theirs
• OPINION ≠ LAW OF NATURE
• You must teach your committee and your advisor
• You know the work better than they do
Notebooks:

• Wear clothes, shoes, and your notebook
• ?? $25 pocket recorder in your pocket & at bedtime ??

Experiment: Watch TV for 10 Minutes w/sound OFF

• Count scene changes / minute in an old movie
• Count scene changes / minute in a new adventure
• Your attention span has been rotted by TV
Conscious use of your unconscious

• Jacques Hadamard “The Psychology of Invention in the Mathematical Field” (~$9)
  Dover ISBN 0-486-20207-4

• Henri Poincare “Science and Method” (~$16)
  Dover ISBN 0-486-243269-6

• Arthur C. Clark “The Collected Stories” (~$18)
  “Technical Error” Pg. 68
Self Esteem - 1

Shopping Cart

• A middle aged woman conceived of a folded pocketbook w/frame & wheels that becomes a shopping cart (city type).

• Family and friends ridiculed idea.

• Did nothing.

• 20 Years later it became a $million seller.
Computer Mod of Sewing Patterns

• Middle aged woman conceived of using a standard sewing pattern and computing the changes for a specific person – a computer home application in era of large mainframes.

• Family and friends ridiculed idea.

• Did nothing.

• 50 Years later has it been done? Laser Patterns?
What Research IS & is NOT

**Characteristics of Research.**
- Intensely personal activity
- Discovery of new knowledge
- Societal benefits
- Publication of discovery
- *Creative in nature*
- Don’t know if it can be done
- Public activity & results

**Characteristics of Projects.**
- Teamwork allowed
- Use of known knowledge
- Benefits aimed at sponsor
- Publication not necessary
- *Derivative in nature*
- Know it can be done (P>.5)
- Proprietary activity & results
What Research IS

- **NEW:** Create a NEW Contribution.
- **VALIDITY:** (Prove it is correct)
- **RELIABILITY:** (It is a robust result)
  - Verifiable (Repeatable):
    You and others should be able to repeat your process or a different process and get your results.
What Research is NOT

Characteristics of NOT Research

- Loud Assertion w/o reference
- Argument by Authority
- Fact without reference
- Literature Search

- Presentation of the Known
- Opinion (even expert)
- Reference without vetting
- Library “Research”
Why We Do Research

1. Discover new knowledge
2. Solve meaningful problems
3. Find new relationships
4. Answer questions worth knowing the answers to
5. Fulfill a vision
6. May be useful

- Lipman Bers’ quote
- Eugene Wigner’s quote
- Albert Einstein’s Razor
Lipman Bers’ quote
[Personal Communication]

“There is an infinite number of true theorems. Work only on important ones.”

[Work on what looks like it will be “useful” elsewhere.]

Eugene Wigner’s quote

“The unreasonable effectiveness of mathematics.”

[Any mathematics is probably eventually useful.]

Albert Einstein’s Razor
Let beauty lead you.
5 Research Examples
4 Research Examples.

1. de Broglie’s Paragraph [Notice it in Nature]

2. My “Why IS That?” [Notice it in Form]


YOU Could Create New Technology
4 Research Examples.

A. First three of these are NOT DPS-like
   1. They are Mathematical/Physical in nature
   2. DPS-like is often not mathematical but could involve some basic statistics or optimization

B. 4 & 5 ARE DPS but not specific to it

C. The commonality is the difficulty defining the problem and finding the solution [50/50]

D. You will be getting more DPS-like examples in the future in this Research course
4 Research Examples

But First A Reminder About Critics

Das Ei Des Columbus - The Egg of Columbus
[I learned it in a Scientific German Course]

1. Columbus Returns & Reports

2. Committee of Great Men Reviews Results

3. “Trivial and Obvious”
   Go west and run into land – no big deal.

4. Columbus: “Make an egg stand on end.”
   <Crunch>

Notice the 18 years from 1905 to 1923 in the first example (de Broglie)
Let us consider a material moving object of rest mass $m_0$ moving with respect to a fixed observer with a speed $\nu = \beta c$ ($\beta < 1$). According to the principle of the inertia of energy, it should possess an internal energy equal to $m_0c^2$. On the other hand, the quantum principle suggests associating this internal energy with a simple periodic phenomenon of frequency $\nu_0$ such that

$$h\nu_0 = m_0c^2$$

$c$ being, as usual, the limiting velocity of the theory of relativity and $h$ Planck's constant.

This is the wave nature of matter (has a frequency!)

$$E = h\nu_0 \text{[photoelectric effect]} \quad \text{and} \quad E = m_0c^2 \text{[relativity]}$$

Einstein's Nobel Prize↑. Both are by Einstein! in 1905.

Schrödinger did Wave Equation in 1925
Prince Louis de Broglie

1. He added some more analysis of what is the particle’s wave frequency

2. He analyzed a light particle (slightly incorrectly) using basic relativity

3. He analyzed an electron in a circular orbit and showed the same results as Bohr & Sommerfeld (the Old Quantum Theory) and said he had derived optics of particles elsewhere – which he did

4. All in 4 pages [basic idea in 1st paragraph]
RADIATION — Waves and Quanta

Note of Louis de Broglie, presented by Jean Perrin.

(Translated from Comptes rendus, Vol. 177, 1923, pp. 507-510)

Let us consider a material moving object of rest mass $m_0$ moving with respect to a fixed observer with a speed $v = \beta c$ ($\beta < 1$). According to the principle of the inertia of energy, it should possess an internal energy equal to $m_0 c^2$. On the other hand, the quantum principle suggests associating this internal energy with a simple periodic phenomenon of frequency $v_0$ such that

$$\hbar v_0 = m_0 c^2,$$

$c$ being, as usual, the limiting velocity of the theory of relativity and $\hbar$ Planck's constant.
Prince Louis de Broglie

1. He was prepared in QM & Relativity

2. He was free to be “stupid – clever”

3. It took Einstein’s intervention to get him his degree (faculty of “Great Men” thought it was nonsense)

4. It took years until experiment proved him right (electron optics).

5. His article 1923; Schrödinger’s Wave Equation 1925; his Nobel Prize 1929
I noticed a strange relationship for the N-D cube array of length n. [I have ABD in Math - NYU]

This relates arrays to the binomial theorem.

This is a new geometric truth about array decompositions.

\[
T^n_n \sim n^n = ([n-1] + 1)^N = 3
\]

\[
\sum_{i=0}^{N} \binom{N}{i} (n-1)^i (1)^{N-i} \sim \sum_{i=0}^{N} \binom{N}{i} T_{n-1}^i
\]

NOTICE !!
Let Dim N = 2 and Length n = 3

\[
T_3^2 \sim 3^2 = (3 - 1 + 1)^2 = 9 = \sum_{i=0}^{2} \binom{2}{i} (3-1)^i (1)^{2-i} \sim \sum_{i=0}^{2} \binom{2}{i} T_{3-1}^i = (1)T_2^0 + (2)T_2^1 + (1)T_2^2
\]

1 scalar & 2 vectors of length 2

This is a “1st order” expansion because we can expand all of the non scalars by the same formula again.

Later we show that a 0-D scalar of length n IS a 0-D scalar of length 0

Example Of A 2-D (3x3) Matrix 1st Order Expansion

1 scalar 0-D element

1-D (2 element vector)

2-D (2x2 matrix)

Egg Crate View

1 scalar & 2 vectors of length 2

2-D Array of Length 3

Cell Count
The "Master Equation" is an expansion in Null Arrays (Arrays of length 0)

Example Of A 2-D (3x3) Matrix Full Recursion Expansion "Master Equation"

2-D Array of Length 3

\[ T_3^2 \sim 3^2 = 9 = (9)T_0^0 + (6)T_1^0 + (1)T_2^0 \]

ALL NULL ARRAYS 9 scalars, 6 vectors, one 2-D array all of length 0

Egg Crate View

"Dual" View

All arrayed as a 2-D Object
ERA / NERA Representations

RED is new is mine.

Holds for NERAs too.

\[ T_{1,2,3}^3 = (1 \times 2 \times 3) = 6 \]

\[(1 \times 2 \times 3) \approx \]
\[6T_0^0 + 11T_0^1 + 6T_0^2 + T_0^3 = (1T_0^0 + T_0^1)(2T_0^0 + T_0^1)(3T_0^0 + T_0^1)\]
THE MASTER EQUATION
(Example)

2x3x4 Full Decomposition to Null Arrays

There are 24 scalar cells. [0-D]

There are 26 vectors: [1-D]
  6 vectors front to back
  12 vectors top to bottom
  8 vectors right to left

There are 9 matrices (planes): [2-D]
  2 horizontal planes top to bottom
  3 vertical planes left to right
  4 vertical planes front to back

There is one 3-D Entity. [3-D]

There are no higher D Entities. [4...-D]

\[ T^3_{(2, 3, 4)} = T^0_0 (24) + T^1_0 (26) + T^2_0 (9) + T^3_0 (1) \]
RIF: **A Good Topic Should Be Rich in Further Questions**

1. What if \( N \) (dimension) is negative or complex?
2. What if \( n \) (length) is negative or complex?
3. Master equation allows subtraction of arrays - what’s this mean? Annihilation!
4. Generalization to ragged arrays?
5. What about arrays of arrays [= set theory]?
6. What about \( n \)-continuous arrays and quantum computing? [Master equation does hold!]
RIF: Work on what you know & like

0. I worked in APL development on and off for over 8 years.

1. I worked on this problem on and off for 10 other years.

2. I generalized it to N-D Bricks.

3. I found a master equation in null arrays (by recursion).

4. I developed an explicit algorithm for all sub arrays’ cells.

5. I developed code in APL, C++, and Java.

6. I found potential applications in Hyper cube machine architectures and data mining OLAP.
#3 Malcolm Cohen – Problem

[Private Communication] [Applied Physiological Psychologist]

- Some A4s crash (randomly) for no apparent cause
- Catapult off carrier & go immediately into water

“Data”

- “Artificial Horizon” gauge problem was fixed

[Therefore not the gauge]

Survey Data

- Artificial Horizon gauge not trusted
- Crashes only on moonless nights

[Therefore no visual cues – so what?]
Malcolm Cohen’s – Theory*

[Personal Communication]

• Douglas Skyhawk – (A4) has noted reliability
• Pilots can’t see outside and don’t trust gauge
• Some perception causes stick forward into water
• *It has to be a positional perception miscue*

* Cohen, M. M., Crosbie, R. J. & Blackburn, L. H.
Malcolm Cohen's Theoretical Model Based on Pilot's (Psychological) Perception

Real World

Catapult Force

Resultant Vector (Perceived Gravity)

Pilot

Actual Motion

Gravity

'Correct' by stick down to level out. Actual effect is to dive into water.

Toward Earth

Perceived World

What Pilot Thinks

Correct by stick down to level out

Climb too steeply, causes stall

Ronald I. Frank 2003
Malcolm Cohen’s - Solution

• Train pilots to understand incorrect perception
• Train pilots to trust artificial horizon gauge

Result

• No more crashes due to this cause
#4 Web Services &/or XML Languages

(NO LONGER Conjectural) [Applied Information Systems]

1. XML based.

2. Standards based.

3. “Applications” require defining general languages for new uses [language architecture == vocabulary].

4. Requires understanding of an application domain. Often used for app integration.

5. Limited window of opportunity for dissertation level work [2-3 years?].
WEB SERVICES 'STACK'
(Based on Deitel, Deitel, Duwaldt, Trees Pg. 103)
Using XML Languages

Vertical Language

SIF
(School Interoperability Framework)

Vertical Language

Vertical Language

e-Health

Web Services Technologies [All 3 are XML Languages]
WSDL, SOAP, UDDI

"Horizontal" XML Languages [ebXML]
(Cross Industry Business Processes)

Core XML Processing [First 3 are XML Languages]
(XML, XML Schema, XSL, DTD)

Web Framework {Not Necessary but Sufficient}
Internet Protocols, [HTTP on TCP on IP]
XML LOGICAL FLOW
(All Written in XML Except PARSER)

WHATS

WHICH WHATS + DATA

WHATS

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2 Current Dissertations (Examples of #4)
#1 Product Costing Framework

Best price subassemblies

1. WS / XML based – **Industry** Integration.
2. Standards based – some not yet in place
3. Needs **many** specific languages – some exist
4. Small restaurants as a real example
5. Dozens of DFDs and Use Case Diagrams
6. Very intricate NEW/USEFUL architecture
7. Literature search was global (UN a player)
#2 SARBOX Compliance Architecture

Enterprise Accounting / Auditing Integration

1. WS / XML based – Enterprise Integration.
2. Standards based – one new one
3. Needs one or two specific languages
4. Accounting Standards as a real driver
5. ~4/Ea. DFDs and Use Case Diagrams
6. Straight forward architecture
7. Literature search was US only
8. Virtual close is a side effect
Commentary & Advice
IT’S BEST TO WORK IN AN AREA YOU ALREADY KNOW AND LIKE OR WILL HAVE FUN LEARNING
Plan for reading / learning equivalent to 9 graduate credits (in one year)

Literature search is NOT Research!

Research is CREATIVE!
HAVE FUN

OR

You May Not Finish
Have a Vision

• It does not exist (show this)
• It can exist (argue this)
• It should exist (argue this)
• Make it exist (do this)
  • Feasibility is enough
Prepare for Failures and False Starts Along the Way

• Cape Canaveral, was Cape Kennedy

• Is Cape Canaveral

• Which was called “Cape Carnival”

Because of all of the early spectacular failures.
A GOOD TOPIC SHOULD BE RICH IN FURTHER QUESTIONS

so

YOU CAN CONTINUE PUBLISHING

IF YOU WANT TO
You don’t “get an idea” and just start writing.

You start writing and get ideas!

Your real problem is to find how you can create added value by solving a problem.
Being able to state a topic or an idea does not mean that you know what you are talking about - or better – that you are talking about what you know.

[RIF 2003]
About Dissertation Questions / Problems

1. Finding them is $\frac{1}{2}$ the effort

   *But more than $\frac{1}{2}$ the emotional pain*

2. The answer is $\frac{1}{2}$ the effort

   *But more than $\frac{1}{2}$ the fun*

3. Writing and production is $\frac{1}{2}$ the effort

   *But most of the real pain*
Previous Questions / Problems

1. Where do babies come from?
2. Where does blood come from?
3. What are stars?
4. Why are stars?
   • *25 WHYs and you get to GOD*
5. Why is the sky blue?
6. How can legacy systems be turned into a Web Service?
Einstein: About Research

“ If we knew what it was we are doing, it would not be called research.” *

* Quoted in Scientific American September 2002 Vol. 287 No. 3 (a special issue on Time) in the Antigravity column by Steve Mirsky.: “Einstein’s Hot Time” pg. 152.
Appendix 1
Process
Doing a dissertation is itself a project: apply your project management skills.

- Lay out a Gantt chart (back of the envelope)
- Do a work breakdown structure
- Constantly monitor actual against baseline
- Do an earned value analysis
  - (value added vs. time spent)

Don’t estimate your time to completion based on your writing schedule.
- Research time has to be factored in.
Writing about your own contribution is not a matter of just describing an idea. It is a matter of proving it or showing how to do it.

Ideas are ~~~$0.10/dozen.

Usefully articulated and proven ideas are not common.

Implemented ideas are rare.

Accepted ideas are extremely rare.
It is up to YOU to find a problem.

It is up to YOU to convince your advisor and committee that it is worth doing and worth THEIR time.

It is up to YOU to convince your advisor and committee that it is done.

It is up to YOU to convince your advisor and committee it is worthy.

Drs. don’t seek approval, they know & prove. Drs. don’t “piss & moan”, cry, yell, or try extortion.
We are here to help – not to do.

If you can’t find a problem, we will make suggestions, but you choose.

Learn from your advisors but don’t worship them.

It is up to YOU to do the work.
<table>
<thead>
<tr>
<th>It is up to YOU to <strong>schedule</strong>.</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is up to YOU <strong>control the process</strong>: i.e., initiate meetings, set goals, set criteria.</td>
</tr>
<tr>
<td>It is up to YOU to <strong>find help</strong> if needed.</td>
</tr>
<tr>
<td>It is up to YOU to recognize hand-waving bull.... from insightful analysis.</td>
</tr>
<tr>
<td>If you spent a lifetime being sloppy, we can’t cure you. Repent oh you sinners!</td>
</tr>
</tbody>
</table>

Drs. don’t suck up, they don’t have to. Drs. don’t try to fake it, they boldly take large slips in schedule.
Warning About “DATA”

Many uses mean SURVEY DATA

1. A few DPS dissertations use surveys
2. Most DPS dissertations do not
3. “DATA” might mean relevant examples
4. “DATA” might mean similar systems
5. “DATA” might mean previous work
6. “DATA” might mean environmental vars
From a Typical Social Science Research Methods Book*

1. A question is posed.
   In the mind of the researcher, a question arises that has no known resolution.

2. It's a matter of words.
   The researcher converts the question to a clearly stated research problem.

3. It's worth a guess!
   The researcher poses a temporary hypothesis or series of hypotheses.

4. The search is on!
   The literature is searched for a possible solution to the problem.

5. The search leads not here.
   Another avenue must be found to resolve the problem.

6. Data! Hard data! And nothing but the data!
   The researcher looks for data that may relate to the problem.

7. What do the data say?
   The data are analyzed to reveal their meaning.

8. The data speak!
   The researcher interprets the data and suggests a conclusion.

9. It's either... or...
   Either the data seemingly resolve the research problem, or they do not resolve it.

10. And, the hypotheses?
    Either the data support the hypotheses—or they do not.

[May not apply to your DPS]


1. Define the Question or Problem

2. Define Over-All Goal
   • Subdivide to N parts
     a. Posit solution part i
     b. Find solution part i
   • Repeat for all i in N

3. Evaluate Total Solution vs. Goal
   • Might find new problems facets
   • If Satisfied – Submit Thesis

4. Else Go to 1 using new insights
The Scientific Method [State Diagram]

- Ignorance
- Observation
- Test
- Hypothesis
- Prediction
- Falsification
- Verification

- Observations → Hypothesis
- Hypothesis → Prediction
- Prediction → Tests vs. Hypothesis
- Tests vs. Hypothesis → “PROOF”
- “PROOF” → Consistent
- Consistent → THEORY
- THEORY → Ignorance

- Modify Hypothesis
- Inconsistent

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Appendix 2
Psychology
Notice that this is very like iterative refinement in software development.

Beware the **ANXIETY BLOCK** in getting started. Just write something to start and “Plan to Throw One Away” as Brooks says in Chapter 11, MMM.

**JUST DO IT.**

Do something, anything – it doesn’t matter. Don’t think, do. Once started, correct your mistakes.
Once Started:

Beware **AVOIDANCE BEHAVIOR**

Procrastination is well known. BUT Substitution is more insidious: There are always more important or more pressing activities to substitute for your dissertation work.

**JUST DO IT.**

A little bit of continuous progress doesn’t interfere with life. YOUR life includes your dissertation. See step 1 in Appendix 6: Write for 15 minutes a day.
I. Bernard Cohen: About Your Dissertation

[He Had Many Many Dissertation Students]

[Science and Mathematics Historian]

[First American Doctorate in the History of Science]

“Don’t get it perfect; get it done.” *

* Quoted in a memorial article by one of his students: “I. Bernard Cohen (1914-2003)” By Judith V. Gabiner in the MAA Focus Vol. 23 # 6, August/September 2003 pg. 24.
Appendix 3 Proposal Outline
Proposal Outline [Not Unique][Short]

1. The **Problem** and its context [== Literature Search]
   1.1 Statement of the problem
      1.1.1 List of sub problems
   1.2 Problem context [Include USE CASES / DFDs]
   1.3 Limitations of scope
   1.4 Definition of terminology
   1.5 Importance of the work
   1.6 The relevant literature and background [see 4 below]

2 Proposed **Solution** (components and schedule)
   2.1 Solution description [== Your “value add”]
   2.2 Methodology and Work Breakdown Structure
      2.2.1 Repeat for each sub problem
   2.3 Initial schedule [Baseline for planning & monitoring]

3 The **Researcher** [YOU] (qualifications and background)
   3.1 What preparation does researcher already have
   3.2 What new knowledge or skills are required

4 **Bibliography** [Reference EVERY assertion you made]

5 **Appendixes** (supporting peripheral detail)
Appendix 4 Research Paper Outline
Research Paper Outline 1/4

(For Reporting On Someone Else’s Paper OR For Your Own)

1. Header
   • Topic
   • Title
   • Author(s)/Institution

2. Executive Introduction
   • "Tell 'em what you're going to tell 'em"
     • What will be the central contribution
     • Where does this fit into the Universe (context)?

3. Problem Statement
   • "Tell 'em"
     • Use Cases
4. **Current State of the Art/Science/Business**
   - "Tell 'em"

5. **Solution to Stated Problem**
   - "Tell 'em"
     - What is the central contribution
     - Use Case

6. **Methods Employed in Solution**
   - "Tell 'em"

7. **Results & Conclusion**
   - "Tell 'em"
8. Future Direction
   • "Tell 'em"

9. Summary
   • “Tell 'em what you told 'em“
   • What was the central contribution

10. References
    A. Every major statement or assertion needs proof or reference
       1. Peer reviewed journals
       2. Textbooks & Theses (especially recent versions)
       3. May use URLs but with land based source addresses
          [Indicate date YOU last accessed it]

    B. Your opinion must be clearly delineated as such and is weak
10. References (cont.)
   C. Your assertion without proof is useless and not accepted
   
   D. Commercial products and consultancies are weak to useless
   • Except for proof of current state of the Business

11. Appendices
Appendix 5
Typical Dissertation Outline
1. **Header**
   - Topic
   - Title
   - Author(s)/Institution
   - Your Copyright Notice
   - Committee Signature Sheet

2. **Abstract (<350 Words)**
   - "Tell 'em what you're going to tell 'em"
     - What will be the central contribution
   - Key Words for indexing

3. **Preface (Background of your work)**
   - Acknowledgements
4. Table of Contents

5. List of Figures [One figure can be the list of trade marks used]

6. List of Tables

7. List of Most Important Equations (if needed)

8. Introduction
   • Problem Statement
     "Tell 'em"
     Use Cases
   • Flow of Development
     Where you are going
Dissertation Outline 3 / 6

- **Methodology Overview**
  - How you will get there
- **Review of previous work** (outline only here)

9. **Background Material (if needed)**
   - To better understand the problem
   - More detail on the current state of the art (if needed)

10. **Solution to Stated Problem**
    - "Tell 'em"
      - What is YOUR central contribution
      - Use Cases
    - **Methods Employed in Solution**
11. Results & Conclusion
   • "Tell 'em"
   • So What (the importance of the results)

12. Future Direction
   • "Tell 'em"
   • Future research items

13. Summary
   • “Tell 'em what you told 'em“
   • Again: what was the central contribution and its value
   • Where to go from here
14. References

A. Every major statement or assertion needs proof or reference
   1. Peer reviewed journals
   2. Textbooks & Theses (especially recent versions)
   3. May use URLs but with land based source addresses
      [Indicate date YOU last accessed it]

B. Your opinion must be clearly delineated as such and is weak

C. Your assertion without proof is useless and not accepted

D. Commercial products and consultancies are weak to useless
   • Except for proof of current state of the Business
15. Appendices
   A. Supporting material only if it is hard to get
   B. Proofs or other mathematical work incidental to main flow
   C. Incidental historical information (for cultural literacy)
   D. Code or worked examples if too big for main text flow
   E. Releases if you are using other’s work
   F. List of the tools you used if they were unusual or if their output is central to your conclusions (it this latter case maybe it should be a Reference instead)
Appendix 6
Dissertation Production
Production of Text 1/2

1. BUY Strunk & White, (& Chicago Manual of Style), a good NEW Dictionary, and a good NEW Thesaurus (CD version is OK, even better)

2. Get your tools early, learn, and use them all along.
   - Word and PowerPoint {the Pace Dissertation Format}
   - Endnote (bibliography) {the Pace Dissertation Format}
   - Visio (DFDs, Use Cases, UML, ERDs)
   - PIM (for scheduling meetings and To Do’s)
   - Browser
   - Acrobat WRITER (for mandatory PDF final version)
   - H/S Data Connection (to committee & libraries)
   - .NET/C#/Java/XML/VB [if implementing] [MSDNAA]
1. Have a really good machine, OS, software, and printer set up BEFORE you start. **Keep it stable.**
   - **YOU and only YOU own, control, and use it.**

2. Backup often ALL files (set of 3 generation sets).
   - Keep at least one set off-site, best is 2

3. Get a BIG Thumb drive for moving copies to Pace

4. Try out 24 lb. bond on your printer early
   - Many cheaper printers can’t hack it

5. Learn how to change ink & fix jams
Production of Final Artifact

1. Be prepared to print a lot
   • Electronic files don’t get read

2. The final hand-in can take weeks
   • AFTER you are done.

3. The mandatory PDF of a your large .doc with many diagrams, figures, and other imbeds can take an hour + to run – don’t cut it off. [It can crash.]
Appendix 7
Maintain a Dissertation Notebook
(Writer’s Notebook & Process Log)
Date: October 28, 2005
From: Prof. Frank
To: DPS Research Seminar
Subject: Maintain a Dissertation Notebook
Reference: The Real World [Don’t do this = look foolish]

Buy A Bound (NO METAL SPIRALS) Computation
[~$12.00] or Lab Notebook [~$42.00] that has a left
margin set off, quadrille paper, and printed pagination.

This is THE ONLY PLACE ON EARTH THAT YOU WRITE,
DIAGRAM, OR DOODLE ABOUT YOUR Dissertation.

This is not a class notebook. It is not a personal diary.
It is not used for ANYTHING else. It is not your
dissertation, only a place to put ideas, thoughts and
data.
Every page is sequentially numbered. Each new topic or coding project starts with a line across the whole page and a date in the left margin with a short descriptive name in the margin or at top. Never remove pages!!!

You can make margin notes to keep track of the structure of the notes. For example, use circles & dates for TO-DO items. Cross them out when they are completed. If you need to, you can generate an index of topics and dates on the last few pages as you go along. This helps if you are jumping topics a lot.

Advisor and other meeting notes go in here, as do phone notes & #s and IDs of colleagues. No page-width line is put in until the start of the next topic. Interpolated sections from other topics are marked by a vertical mark in the margin, a blank area, and the name of the topic.

Paper is cheap.
You can scotch tape in small listings, or other documents from outside sources. There should be no other paper you use to write on - ever. Only IMPORTANT email (decision agreements) get pasted in. Write under your paste-ins what they are, just incase they fall out.

Put your name, advisor’s name, start date and leave a space for end date on the front outside. [You may generate more than one notebook.]

Put your address, phone number and email ID on the inside front cover so that when you lose it, the finder can contact you for pickup. Near your info, put a polite request to the finder to return your notebook - it can help. Label the book “Personal and Confidential” just to emphasize how you view it. Offer a small reward for its return.
If you have a patentable idea, document it in great detail with tutorial comments and immediately get (or leave space for quickly getting) two colleagues to read and UNDERSTAND the idea.

Then have them write, sign, and date a statement that they have read the idea and have understood it.

This is why the book must be bound, every page numbered, and every item dated - so that there can be no question about the idea pages being inserted at a later date.

You too can win a patent law suit for billions of dollars [lasers] based solely on this kind of documentation of a good idea.

If you pocket-record daily notes, they get written in THAT NIGHT if not immediately.
Adm. Grace M. Hopper’s–“Bug”

Notice: Pre-numbered quadrille paper notebook. Dated & topic header by time.
Appendix 8
12 Step Writing Process + Coplien’s Thoughts
12 Step Writing Process

From the
TOMORROW'S PROFESSOR(SM) MAILING LIST
(desk-top faculty development one hundred times a year)
Sponsored by
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- SUBJECT LINE: empty
- MESSAGE BODY: type unsubscribe tomorrows-professor
PUBLISH AND FLOURISH;
BECOME A PROLIFIC SCHOLAR

{Cope == Prolific not good per se}
Steps 1 - 6

Step 1. Write daily for 15 to 30 minutes.

Step 2. Record time spent writing daily, share records weekly. Do what works for you.

Step 3. Write from the first day of your research project. Always start with a discovery draft.

Step 4. Post your thesis on the wall, then write to it.

Step 5. Organize around key sentences (first sentence in the paragraph). Agrees.

Step 6. Use key sentences as an after-the-fact outline.
Steps 7 - 12

Step 8. Share later drafts with little-e experts and Capital-E Experts.

Step 9. Learn how to listen (the reader is always right).

Step 10. Respond to each criticism (changes in response to each of these reviewers).

Step 11. Read your prose out loud. Agrees.

Step 12. Kick it out the door and make 'em say "No." [perfectionism and fear of rejection]. Carefully chose your venues to drive down your acceptance rate to 10%.
Coplien’s Broader Scope Points - 1

1. **Write your name on your piece.**

2. **Quality before quantity. [Prolific is not good per se.]**

3. **Notebooks.**
   Take good research notes. They are just another research reference.

4. **Be a great reader.**

5. **Write a lot.**

6. **Know who your audience is.**

7. **Write with passion.**
8. Strive for publication in the archival literature (Journals).

9. Craft every work as a masterpiece. Use the review process for the long view of your publication goals.

10. Be attentive to good presentation.

11. Be brief.

12. Don't use a word processor.
Appendix 9
William Safire’s
‘Rules’ of Writing
[Highly Modified]
‘Rules’ of Writing 1/7

1. Remember to never split an infinitive.
2. The passive voice is to be ignored.
3. Do not put statements in the negative form.
4. Verbs has got to agree with their subjects.
5. Proofread carefully to see if you words out.
6. If you reread your work, you can find on rereading a great deal of repetition can be avoided by rereading and editing.
7. A writer must not shift your point of view.
8. And don't start a sentence with a conjunction.
‘Rules’ of Writing 2/7

9. [Never use a preposition to end a sentence with.]

10. If any word is improper at the end of sentence, a linking verb is.

11. Don't overuse exclamation marks!!

12. Place pronouns as close as possible, especially in long sentences, as of 10 or more words, to their antecedents.

13. Everyone should be careful to use a singular pronoun with singular nouns in their writing.

14. Writing carefully, dangling participles must be avoided.
‘Rules’ of Writing 3/7

15. Take the bull by the hand and avoid mixing metaphors.
   [Even if a mixed metaphor sings, it should be derailed.]

16. Avoid trendy locutions that sound flaky.

17. Always pick on the correct idiom.

18. The adverb always follows the verb.

19. Last but not least, avoid clichés like the plague; seek viable alternatives.

20. [Comparisons are as bad as clichés.]

21. [Avoid annoying alliteration.]
‘Rules’ of Writing 4/7

22. [Don't verb nouns.]
23. [Don't use no double negatives.]
24. [Don't use commas, which aren't necessary.]
25. [About those sentence fragments.]
26. [One-word sentences? Eliminate.]
27. [Never use a big word when a diminutive one would suffice.]
28. [Parenthetical remarks (however relevant) are (usually) unnecessary.]
29. [Be more or less specific.]
‘Rules’ of Writing 5/7

30. [Eschew ampersands & abbreviations, etc.]
31. [Analogies in writing are like feathers on a snake.]
32. [One should NEVER generalize.]
33. [Foreign words and phrases are not apropos.]
34. [Contractions aren't necessary and shouldn't be used.]
35. [Also too, never, ever use repetitive redundancies.]
36. [It's important to use apostrophe's correctly.]
37. [Correct spelling is essential.]
‘Rules’ of Writing 6/7

38. [Between you and I, case is important.]
39. [Use words correctly, irregardless of how others use them.]
40. [Understatement is always the absolute best way to put forth earth-shaking ideas.]
41. [Exaggeration is a billion times worse than understatement.]
42. [If you've heard it once, you've heard it a thousand times: resist hyperbole; not one writer in a million can use it correctly.]
‘Rules’ of Writing 7/7

43. [Eliminate quotations. As Ralph Waldo Emerson said, "I hate quotations. Tell me what you know."]
44. [Puns are for children, not groan readers.]
45. [Go around the barn at high noon to avoid colloquialisms.]
46. [Who needs rhetorical questions?]
Appendix 10
The Rest of the de Broglie Paper
For the fixed observer, the frequency \( v = \frac{m_0 c^2}{\hbar \sqrt{1 - \beta^2}} \) corresponds to the total energy of the moving object. But, if this fixed observer observes the internal periodic phenomenon of the moving object, he will see it slowed down and will attribute to it a frequency \( v' = v_0 \sqrt{1 - \beta^2} \); for him this phenomenon varies therefore like \( \sin 2\pi v' t \).

Now let us suppose that at the time \( t = 0 \) the moving object coincides in space with a wave of frequency \( v \) defined above and propagating in the same direction as it does with the speed \( \frac{c}{\beta} \). This wave, which has a speed greater than \( c \), cannot correspond to

\[ ^1 \text{Concerning the present note, see Brillouin, Comptes rendus, Vol. 168, 1919, p. 1318.} \]
transport of energy; we will only consider it as a fictitious wave associated with the
motion of the object.

I maintain that, if at the time $t = 0$, there is phase agreement between the vectors
of the wave and the internal phenomenon of the object, this phase agreement will be
maintained. In effect, at time $t$ the object is at a distance from the origin equal to
$v t = x$; its internal motion is then represented by $\sin 2\pi v_1 \frac{x}{v}$.

The wave, at this point, is represented by

$$\sin 2\pi v \left( t - \frac{x\beta}{c} \right) = \sin 2\pi v x \left( \frac{1}{v} - \frac{\beta}{c} \right).$$

The two sines are equal and the phase agreement is realized if one has

$$v_1 = v (1 - \beta^2),$$
a condition that is clearly satisfied by the definitions of $v$ and $v_1$.

The demonstration of this important result rests uniquely on the principle of special
relativity and on the correctness of the quantum relationship as much for the fixed
observer as for the moving observer.
Let us apply this to an atom of light. I showed elsewhere\(^2\) that the atom of light should be considered as a moving object of a very small mass (\(< 10^{-50} \text{ g}\)) that moves with a speed very nearly equal to \(c\) (although slightly less). We come therefore to the following conclusion: The atom of light, which is equivalent by reason of its total energy to a radiation of frequency \(\nu\), is the seat of an internal periodic phenomenon that, seen by the fixed observer, has at each point of space the same phase as a wave of frequency \(\nu\) propagating in the same direction with a speed very nearly equal (although very slightly greater) to the constant called the speed of light.

\(^2\) See *Journal de Physique*, 6-th series, Vol. 3, 1922, p. 422.
Let us consider now the case of an electron describing a closed trajectory with uniform speed slightly less than \( c \). At time \( t = 0 \), the object is at point \( O \). The associated fictitious wave, launched from the point \( O \) and describing the entire trajectory with the speed \( \frac{c}{\beta} \), catches up with the electron at time \( \tau \) at a point \( O' \) such that \( \overline{OO'} = \beta c \tau \).

One has then that

\[
\tau = \frac{\beta}{c} \left[ \beta c (\tau + T_r) \right] \quad \text{or} \quad \tau = \frac{\beta^2}{1-\beta^2} T_r,
\]

where \( T_r \) is the period of revolution of the electron in its orbit. The internal phase of the electron, when the electron goes from \( O \) to \( O' \), has a variation of

\[
2 \pi \sqrt{\frac{\kappa}{\ell}} \tau = 2 \pi \frac{m_0 c^2}{h} T_r \frac{\beta^2}{\sqrt{1-\beta^2}}.
\]
It is *almost necessary* to suppose that the trajectory of the electron will be stable *only if* the fictitious wave passing $O'$ catches up with the electron in phase with it: the wave of frequency $\nu$ and speed $\frac{c}{\beta}$ has to be in resonance over the length of the trajectory. This leads to the condition

$$\frac{m_0\beta^2c^2}{\sqrt{1-\beta^2}} T_r = n\hbar,$$

$n$ being integer.

Let us show that this stability condition happens to be that of the Bohr and Sommerfeld theories for a trajectory described by a constant speed. Let us call $p_x, p_y, p_z$ the momenta of the electron along three rectangular axes. The general condition for stability formulated by Einstein is in effect.
\[ \int_0^{T_r} (p_x \, dx + p_y \, dy + p_z \, dz) = n \hbar \] (n integer)

which, in the present case, can be written

\[ \int_0^{T_r} \frac{m_0}{\sqrt{1 - \beta^2}} (v_x^2 + v_y^2 + v_z^2) \, dt = \frac{m_0 \beta^2 c^2}{\sqrt{1 - \beta^2}} T_r = n \hbar, \]

as above.

In the case of an electron turning in a circular orbit of radius \( R \) with an angular velocity \( \omega \), one finds again for sufficiently small speeds the original formula of Bohr:

\[ m_0 \omega R^2 = n \frac{\hbar}{2\pi}. \]

If the speed varies along the length of the trajectory, one finds again the Bohr-Einstein formula if \( \beta \) is small. If \( \beta \) assumes large values, the question becomes more complicated and necessitates a special examination.
Pursuing research along these lines we have reached important results, which will be communicated soon. We are as of today able to explain the phenomena of diffraction and of interference taking into account the quantization of light.

\[3\] The case of quasi-periodic motion does not present any new difficulty. The necessity of satisfying the condition stated in the text for an infinity of pseudo-periods leads to the conditions of Sommerfeld.

Translated by Brigitte and Barton Lane and transcribed by Warren F. Davis, January, 1978.
Appendix 11
NERA Master Equation
[Applied to the (2x3x4) Array]
THE MASTER EQUATION
(for general regular arrays – a “generating function”)

\[(n_1 \times n_2 \times \cdots \times n_{N-1} \times n_N) \triangleq T^N_{(n_1, n_2, \ldots, n_{N-1}, n_N)} = \sum_{j=0}^{N} \left( \sum_{\binom{N}{j}} \left[ (n_{i_1}) \times (n_{i_2}) \times \cdots \times (n_{i_{N-j}}) \times (n_{i_{N-j}}) \right] \right) \]

\[T^3_{(2, 3, 4)} = T^0_0 (24) + T^1_0 (26) + T^2_0 (9) + T^3_0 (1)\]

\[(24 = 2 \times 3 \times 4) \quad (26 = 2 \times 3 + 2 \times 4 + 3 \times 4) \quad (9 = 2 + 3 + 4)\]

\[\begin{pmatrix} 3 \\ 0 \end{pmatrix} = 1, \quad \text{&} \quad C^3_3 \quad \begin{pmatrix} 3 \\ 1 \end{pmatrix} = 3, \quad \text{&} \quad C^3_2 \quad \begin{pmatrix} 3 \\ 2 \end{pmatrix} = 3, \quad \text{&} \quad C^3_1\]
What is Research?

THE END