**PREPARATION OF EFFECTIVE SCIENTIFIC TALKS**

J.D. Callen  
University of Wisconsin–Madison

Theses:

- Giving good scientific presentations (talks or posters) is important.
- There are a number of elements involved in preparing effective scientific talks.

Outline:

- Importance
- Steps In Talk Preparation
- Talk Organization
- Preparation Of Visuals  
  Some key points and examples
- Special Considerations For Poster Sessions
- Summary
Giving Effective Talks Is Important

- Your Important Results Should Be Communicated To The Scientific Community
  
  If results are not important, why is talk/poster being given?

- Your Professional Reputation Will Depend In Large Part On How Well You Communicate Your Key Results
  
  If your colleagues cannot understand your work, they will have little appreciation of it or your contributions to it

- Competing Ideas Are Often Forcefully Presented
  
  Major laboratories have presentation courses, talk rehearsals, etc. to hone their talks
A Number Of Steps Should Be Followed In Preparing A Talk

- Consider Audience, Level And Mode Of Presentation
  
  Specialists, generalists, etc.
  Oral, poster, demonstration, etc.

- Decide On Presentation Thesis
  
  What do you want listener to learn from talk (prepare summary and presentation thesis visuals first!)?

- Prepare Visuals To Develop Sequentially The Key Points Of The Presentation Thesis
  
  Say only what needs to be said — eliminate irrelevant information
  Put work in proper context for full spectrum of prospective audience
  Take out or explain jargon, especially local jargon

- Give Rehearsal Before Colleagues
  
  Revise as necessary
Talks Should Be Tightly Organized

- **First Visual**
  
  Title, author, presentation, abstract (if appropriate), thesis, brief outline

- **Second Visual (if not covered on first visual)**
  
  Presentation thesis

- **Third Visual (if not covered on previous visuals)**
  
  Outline of points to be made to support presentation thesis

- **Fourth, ⋯ Visuals**
  
  Development of key points that substantiate presentation thesis

- **Last Visual**
  
  Conclusion or summary that should follow from presentation thesis and body of presentation

- **In Oral Presentations Allow About One Minute Per Visual**
Effective Visuals Have 5 Components

(Outline of topics covered in most of remainder of this talk)

- **A Title That Is A Thesis**
  
  What is to be learned from this visual?

- **No More Than Six Major Points**
  
  More will seldom be absorbed by audience

- **Large, Clearly Readable Lettering Separated By Adequate Spacing**
  
  Key points should be obvious, not buried

- **Self-Explanatory Major Elements**
  
  Audience should be able to grasp major points without verbal explanation

- **Maximum Use Of Graphs Or Pictorials**
  
  “A picture is worth 1000 words”
Every Visual Should Have A Thesis

- A Thesis Takes The Form Of A Simple Declarative Sentence With An Action Verb
  The titles of these visuals provide examples

- A Thesis Makes A Statement
  It is a statement of the point made or proved on the visual — “message” of the visual
  It is not simply a label — e.g., not “graph of y versus x,” “this is a horse”

- Limit The Thesis To 10 Words Or Less, If Possible
  More words usually just indicates verbosity

- The Major Points Developed In A Talk Should Be Obvious From Reading The Theses (Titles) Of The Visuals
  The titles of the visuals should provide the observer with an outline of the key points of the talk
  They should also lead to the conclusion(s) presented on the last visual
Too Much Information On A Visual Tends To Obscure The Basic Message Which Is Being Presented On A Visual

- Most People Do Not Absorb More Than Six Facts From Any One Visual
- Putting More Facts On Any One Visual Tends To Confuse The Basic Message
- It Is Difficult To Compress A Lot Of Information Onto One Visual
- It Is Better to Limit The Amount Of Information On A Visual To Only The Critically Important Issues
- By Putting Too Many Points On One Visual, One Tends To Confuse Trivial Points With Important Ones
- One Should Decide Which Are The Important Facts Germane To The Thesis Of The Visual And Limit The Visual To Those Facts
- Major Facts Can Be Amplified By Subfacts
  - Subfacts can be indicated by a different typeset or capitalization
- If Too Many Facts Are Presented On A Visual The Audience’s Long Term Memory May Be Dominated By A Trivial Fact
- The Various Facts On A Visual Should Be Presented Hierarchically With The Major Facts Obviously Dominant And The Minor Ones Subordinate
- Ample Space Should Be Left Between Separate Points So They Don’t Become Blurred Together
- Major Points Should Be Explained In As Simple And Clear A Form As Possible

Example of a bad visual—far too much stuff on one visual
Use No More Than Six Statements Or Concepts Per Visual

- Audience’s Short Term Memory Saturates At About Six Facts Per Visual

- More Will Confuse The Audience And Obscure Your Message

- Worse, A Trivial Fact May Replace An Important One In The Audience’s Long Term Memory

- Statements Or Concepts Discussed At Each Level Of The Hierarchy Of Visual Elements Should Be Of Comparable Importance
  
  Subordinate points can be distinguished by indentation, a smaller font, or less capitalization

JDC/Effective Talks — 8/5/02, p8
Visuals Should Be Very Readable

- Use Large, Clearly Readable Lettering
  Maximum should be about 10 lines of up to 30 letters per line

- Provide Adequate Spacing Between Major Elements
  Otherwise points get blurred visually and conceptually

- Make Key Points Obvious Visually
  Subordinate points should be indented, have smaller letters, not be capitalized, etc.

- Present Major Elements Clearly
  Use simple statements, formulas, graphs, etc. and only those necessary to elucidate the key points
Major Elements Of Visuals Should Be Self-Explanatory

- Material Is More Understandable If Audience Can Independently Comprehend The Major Elements
  
  Talk structure should reflect logic of critical scientific elements and their interrelationships

- Message Should Be Apparent Without Speaker’s Verbal Presentation
  
  Key points of talk should be apparent from visuals themselves
  
  People don’t always listen carefully to what the speaker says

- Audience Tends To Read Past Speaker’s Present Point In Presentation
  
  Did you read this before I said it?
Develop Analog Graphics For Many Of Your Visuals

- Audience Recall Of Analog Graphics (Curves, Sketches, Graphs, Bar Charts, etc.) Seems To Be Unlimited

- Reinforcement Of Facts And Ideas By Use Of Pictorials Improves Audience Recall By A Factor Of 10

- Analog Graphics Improves Retention Of Facts And Ideas Over Use Of Statements And Equations

JDC/Effective Talks — 8/5/02, p 11
Terrible Experimental Data Illustration

No title, no labels, no indication of what the data represent or why there is a line on the graph

How is viewer supposed to figure out what the speaker wants to convey?
Graph of \( n \) Versus \( p_o \)

Poor Experimental Data Illustration

Title is only a label, not thesis of visual — it only tells us “this is a graph”

Labeling is not helpful — case 1, 2?, what are \( n, p_o \)?

Not clear what message of this graph is — the author can plot points near a line on \( n \) vs. \( p_o \) graph?
Plasma Density Increases Linearly With Filling Pressure

Better Experimental Data Illustration

Simple declarative title with action verb that is thesis of graph
Axes and points are labeled physically and understandably
Graph supports declarative title — no more or less information than necessary
Density Conservation Equation:
\
\begin{align*}
\frac{\partial f}{\partial t} + \frac{v}{|v|}n \cdot \nabla f + \nabla_D \cdot \nabla f &= C(f) \\
\frac{\partial f}{\partial t} + \frac{\partial f}{\partial s} + \frac{\partial f}{\partial \nu} &= C(f) \\
\epsilon \sim \frac{\nu}{\nu_D} &<< 1, \; f = f_0 + \epsilon f_1 + \cdots \\
\epsilon^0 : \frac{\partial f_0}{\partial s} &= 0 \\
\epsilon^1 : \frac{\partial f_0}{\partial t} + \frac{m}{\epsilon^2} \left[ \frac{\partial J^{**} \partial f_0}{\partial \alpha} - \frac{\partial J^{**} \partial f_0}{\partial \beta} \right] &= \langle C(f_0) \rangle \\
\langle A \rangle &\equiv \int \frac{ds}{|v||}, \; J^{**} = \int ds \cdot [v + \frac{e}{mc} \tilde{A}] \\
\end{align*}

Mirror-trapped particles: $J^{**} = \int ds v_{\parallel} = J(\alpha, \beta, E, \mu)$
\[
\delta \sim \frac{\nu}{\nu_D} &<< 1, \; f_0 = f_0^0 + \delta f_0^1 + \cdots \\
\delta^0 : \frac{\partial J^{**}}{\partial \alpha} - \frac{\alpha \partial J^{**}}{\partial \beta} = 0 \Rightarrow f_0^0 = f_0^0(E, \mu, J) + g(E, \mu) \\
\delta^1 : \frac{m}{\epsilon^2} \left[ \frac{\partial J^{**} \partial f_0}{\partial \alpha} - \frac{\partial J^{**} \partial f_0}{\partial \beta} \right] &= \langle C(f_0^0) \rangle \\
\]

Toroidally-passing particles: $J^{**} = \int ds \cdot \left[ v_{\parallel} + \frac{e}{mc} \tilde{E} \right] = J + \frac{e}{mc} \tilde{E}$
\[
\delta \sim \frac{\omega_D}{\nu} &<< 1, \; f_0 = f_0^0 + \delta f_0^1 + \cdots \\
\delta^0 : \langle C(f_0^0) \rangle = 0 \Rightarrow f_0^0 = f_{Max}(E, \alpha, \beta) \\
\delta^1 : \frac{m}{\epsilon^2} \left[ \frac{\partial J^{**} \partial f_0}{\partial \alpha} - \frac{\partial J^{**} \partial f_0}{\partial \beta} \right] &= \langle C(f_0^0) \rangle \\
\]

Density Conservation Equation:
\[
\begin{align*}
\frac{\partial}{\partial t} \int B m^2 \sum_{\sigma} \int \frac{dE d\mu B m^2}{|v||} f + \int \frac{dE d\mu B m^2}{|v||} \left[ \frac{\partial f}{\partial \alpha} \frac{\nabla f}{B} + \nabla_D \cdot \nabla f \right] &= 0 \\
\text{or,} \quad \frac{\partial n(\alpha, \beta, t)}{\partial t} + \frac{2\pi}{m^2} \sum_{\sigma} \int dE d\mu m e \left[ \frac{\partial J^{**} \partial f_0}{\partial \beta} - \frac{\partial J^{**} \partial f_0}{\partial \alpha} \right] &= 0 \\
\text{or,} \quad \frac{\partial n(\alpha, \beta, t)}{\partial t} + \frac{1}{\epsilon^2} \int B m^2 \sum_{\sigma} \int dE d\mu m \frac{\partial J^{**} \partial f_0}{\partial \beta} - \frac{\partial J^{**} \partial f_0}{\partial \alpha} \right] &= 0 \\
i.e., \quad \frac{\partial n(\alpha, \beta, t)}{\partial t} + \frac{1}{\epsilon^2} \int \frac{dE d\mu m e f_0}{\partial \alpha} + \frac{\partial f_0}{\partial \beta} \left[ \frac{\partial J^{**} \partial f_0}{\partial \alpha} + \frac{\partial J^{**} \partial f_0}{\partial \beta} \right] &= 0 \\
\end{align*}
\]

Bad Theory Visual — no thesis title, too much information that is not well labeled or clearly explained


**EBT Neoclassical Transport Theory For Field Error Effects Done With Multiple-Time-Scale Expansions**

- **Beginning Point Is Gyrophase-Averaged “Drift-Kinetic” Equation**
  \[
  \frac{\partial f}{\partial t} + v_{||} n \cdot \nabla f + v_{D} \cdot \nabla f = C(f), \quad n \equiv \frac{B}{B_{0}}
  \]
  - Parallel motion ("bounce" motion)
  - Drift motion
  - Collisions
  - Unit vector along \( B \)

- **Magnetic Field Unit Vector Is Split Into “Perfect” And “Field Error” Parts**
  \[
  n = \frac{B}{B_{0}} = \frac{B_{0} + \tilde{B}}{B} \approx \frac{B_{0}}{B_{0}} + \frac{\tilde{B}}{B_{0}} = n_{0} + \frac{\tilde{B}}{B_{0}}
  \]
  - "perfect” closed field line magnetic field
  - "field error”

- **Various Frequency Scales Emerge From Drift-Kinetic Equation**
  \[
  \frac{\partial f}{\partial t} + v_{||} \frac{\partial f}{\partial s} \sim \omega_{bf} + v_{||} B \cdot \nabla f \sim \omega_{Df} + v_{D} \cdot \nabla f \sim \omega_{Df} = C(f) \sim \nu f
  \]
  - Frequencies:
    - Bounce
    - Drift
    - Drift
    - Collision

Better Theory Visual — thesis at top, steps explained and reasonably spaced
Poster Presentations Have Additional Special Requirements

• Authors Are Usually Provided With A White Thumb-tack Board About 4’ by 8’

<table>
<thead>
<tr>
<th>TITLE OF TALK IN LARGE LETTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract (enlarged)</td>
</tr>
<tr>
<td>Thesis</td>
</tr>
<tr>
<td>Outline</td>
</tr>
</tbody>
</table>

• Audiences

Window-shoppers (they usually read (at most) title, first visual and summary) — what’s new, noteworthy?; what subject area is being discussed?
Serious customers (if title, first visual and summary are compelling they may look at entire poster) — what’s new, same?; what are details of work done?

• Special Requirements

Large, easily read title (1” lettering or greater)
Enlarged copy of abstract
Brief summary at end in large lettering that can be quickly read by the window-shoppers and understood by serious customers
Signup sheet for copies of poster on right side of board

JDC/Effective Talks — 8/5/02, p17
Giving Good Scientific Presentations (Talks Or Posters) Is Important

Your scientific results need to be effectively communicated
Your professional reputation will be based largely on the presentations you give

Scientific Talk Preparation Has A Number Of Key Elements

Consider audience, level and mode of presentation

Develop a presentation thesis

Prepare visuals to prove thesis

thesis heading, 6 points or less, readable, self-explanatory, graphs

Include summary at end

Rehearse before colleagues

Summary