How do you write and present research well? 15—Prepare to say less than you prepare

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Abstract

Q15 If you speak too quickly, the delegates in the audience may lose interest because they can't follow what you're saying. If you speak too slowly, their minds can wander and you might see them heading for the exit or reaching for their electronic devices. What is the optimal cadence in words per minute of a presentation?[1, 2]

(a) less than 90
(b) between 90 and 130
(c) **between 120 and 160**
(d) more than 160

ANSWER TO QUESTION 15

(a) Anything less than 100 wpm is too slow. An audience loses interest when an orator speaks slowly and monotonously.
(b) Speaking at between 90 wpm and 130 wpm is borderline acceptable depending on whether or not the orator speaks enthusiastically. It is a good pace if the speaker takes occasional pauses.
(c) From 120 wpm to 160 wpm is an ideal pace (combined with pauses and enthusiasm).
(d) Remember English is a second and even third language for many in the audience. Following what the speaker says and what is on the slides requires concentration. Given that most people read text at a rate of 200 wpm to 240 wpm, having to both read the slides and listen to a speaker at similar rates becomes exhausting. A 20 min talk at 200 wpm amounts to the number of words in a scientific article!

We speak too rapidly when we want to say more than we have time for. People need time to grasp a single new concept so imagine (remember) how it feels when presenters overwhelm them (you) with multiple concepts in a presentation (or in a single slide), particularly after several presentations.

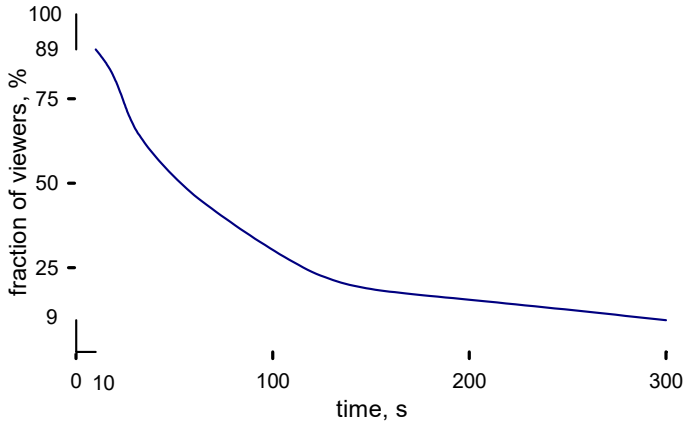


Figure 1: Viewers' attention spans drop exponentially while watching YouTube videos.[3]

Scrutinize the audience and how the people react to other speakers. Invariably you have too much to say. So, even though you prepared and practiced, prepare to say less than you planned. Your goal is for them to remember your research, not that you did a lot of it.

Presenters, speakers and professors must contend with the human brain's inability to focus. The attention span of healthy teenagers and adults ranges from 5 min to 20 min.[3] However, lecturers compete with smartphones, tablets, laptops, and overstimulated audiences. YouTube videos maintain only 50 % of their viewers beyond 60 s (Figure 1).[3]

Speakers must deliver their message precisely, concisely, and vigorously to keep the audience engaged.

CONTENT

Target content to reach the median technical level of your audience, which we categorize as:

Specialists Even at specialized conferences (< 150 delegates), not everyone is familiar with your expertise. Give context; students and researchers in related fields will appreciate it.

Multidisciplinary CSChE, AIChE and ACS conferences have thousands of attendees that cover many research areas. Dedicate as much as 50 % of your presentation's time to the introduction and context. Leave the fine details to a poster session. Assert rather than justify.

Public Making your research accessible to management, technicians, or family and friends requires even more introduction. Eliminate jargon and express the ideas with analogies. Popular 3-minute presentation competitions focus on developing these skills, to mimic the elevator pitch you give to management.

You succeed if your audience understands what you are saying, but individuals learn at different rates: sensory learners appreciate descriptions of methodological details; evocative images stimulate visual learners; concrete, structured facts hook inductive learners; global learners appreciate context and examples. Adapting sections of your presentation to the various learning styles helps you connect with the audience.[4] Consider including Aristotle's three modes of persuasion: ethos, pathos, and logos. Establish ethos at the beginning by establishing yourself as an expert. The role of pathos role is to motivate your audience. Most of the discussion should rely on logos where data and facts substantiate the conclusions.

Well-organized, targeted slides complement rather than detract from discourse. Aim for 9 to 13 slides in a 15 min presentation and 20 to 25 slides for a 30 min presentation. Slides are visual aids to what speakers assert, so minimize words (successful TED talks have less than 40 for the first 10 slides[5]) and favour images and graphs.

Within the first 60 seconds (the average attention span of a YouTube viewer) and two slides, hook the audience: state the problem, state the solution. Give the conclusion at the beginning, in the middle, and at the end. Make the title slide concise and visually attractive (Figure 2):

- a six-word title (emulate TED talks[5, 6]);
- an evocative image of the key result, process, product, or experiment;
- the conference logo; and,
- the authors and affiliations (acknowledge multiple authors after the conclusions if they are more than 5).

While we recommend that papers be concise (*Shave your text with Occam's Razor*[7]) and that you minimize metadiscourse (*Do not metastasize your text with metadiscourse*[8]), in presentations, repeat your message (since the audience does not have the benefit of an article to flip through) and tell them what you are going to say (signpost): Prepare the audience to hear what you are going to tell them later on. Psychologically we are predisposed to enjoy hearing something we knew was coming—we like to feel smart and in tune with the presenter. The generic table of contents slide is not an example of where the audience feels smart. It is a waste of time and with 15 min, there is no time to waste. Never start a presentation with this generic nonsense:

- Context
- Objectives

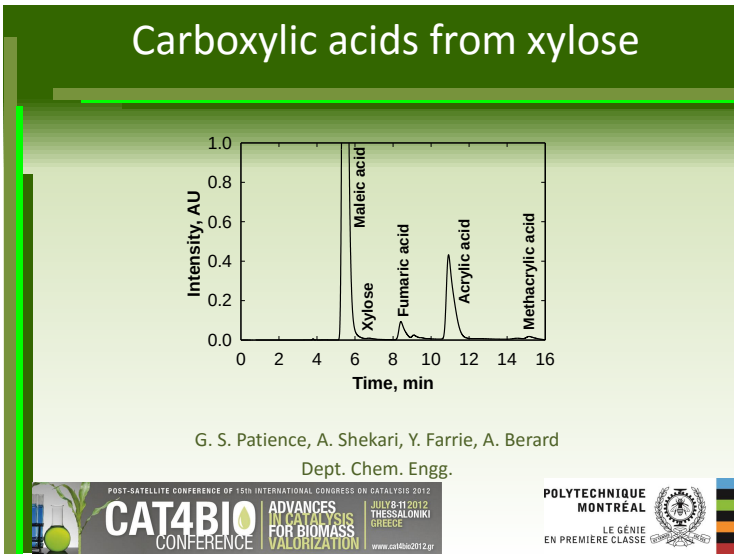


Figure 2: Carboxylic acids from xylose is a short title. The HPLC trace demonstrates the data. The author's names, affiliations, and the logo of the the conference complete this title slide. We began the presentation stating *Here is our only experimental point: We atomize a xylose solution into a gas-solids fluidized bed with vanadium pyrophosphate. The catalyst partially oxidizes it to carboxylic acids.*[?]

- Literature review
- Experimental methods
- Results and discussion
- Conclusion and future work

An executive summary (second slide) describes the context, states the problem you are solving, highlights results and explains their significance—much like an article's graphical abstract and highlights. An audience follows presentations with taglines and numbered slides (Figure 3) better than those without. The keywords in the tagline must represent the paper, not the generic subjects.

Spend the next 3 min to 5 min elaborating the context. Even in specialized conferences, assume the audience is competent, but unfamiliar with your field. Minimize jargon and define technical terms. Make slide titles informative (even sentences): substitute background for a word that represents current technologies, challenges, or performance criteria.

Favour images over text. Slides are a visual support; they should not distract the audience with detail—audiences assume that you have followed adequate protocols to derive your results, and can ask you for more information during or after the question period. With this in mind, use graphs, tables, videos and (sparse) animations to support your results. Curate the results you choose to present, asking yourself whether they are necessary to the story you are trying

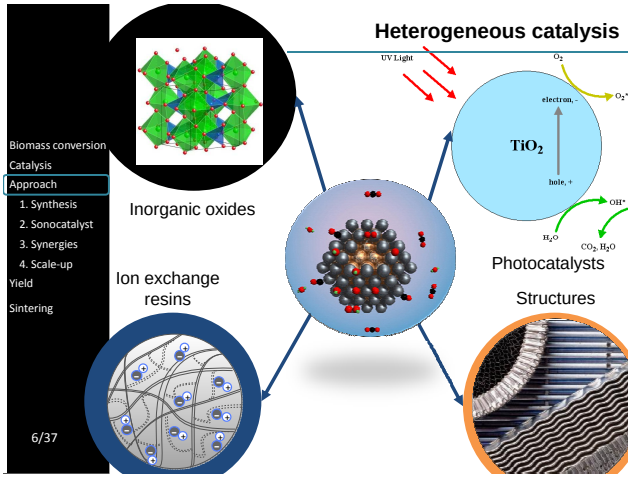


Figure 3: This demonstrates a dynamic tagline (blue rectangle framing the word *Approach* on the left tag line) that moves as the speaker changes topic. The page number and total number of pages in the presentation are the bottom left. The slide begins with the image at the centre and with each click another circle pops up. Some of the text on photocatalysis is too small. This is close to the limit of the number of images and text on a slide.

to convey. Supplementary slides substantiate claims and assertions that will be interesting to a few after the talk. More data does not mean better work.

The final slide confirms what you have stated throughout; it should not be a shocking revelation. It repeats the message and can even be an exact copy of the executive summary. Remind the audience of the importance and originality of the work, and highlight unfinished or ongoing elements. Resist introducing new data or alternative interpretations, but consider identifying the implications with respect to other fields and resulting opportunities. Acknowledge the support you received from your research team (show a picture of the group), from organizations that funded the work and/or institutions that participated (logos are sufficient).

FORMAT

Formatting will distinguish good presentations from great ones. Large font size, big images, contrast, and colors make the difference. Keep slides simple and animate them (sparingly) to emphasize important concepts (you do not work at Lucasfilm). Limit text to keywords and sentence fragments shorter than six words. The minimum text size is 20 pt with at most three font sizes, except reference footnotes (14 pt to 16 pt). Bulleted lists are boring. Substitute them with images and animate these so they appear progressively, so as not to overload the audience (Figure 3).

Tables are hard to read, graphs are better. If numerical values are essential, add them to the figure or limit the table to no more than 6 rows and 6 columns, and highlight the important points using color, bold fonts or by framing or shading a cell, column or row.

Even graphs overwhelm audiences: a slide has too much information if it takes more than 4 s to understand.[9] Divide slides into quadrants so you can gradually add related content (Figure 4). If you add a footer at the bottom edge of your slide (tagline, slide number, institutional logo, date, name), it should not occupy more than 5 % of the space.

Another technique for presenting sequential text or images is to gray out the previous text or images and showing the new content.

Remember that plot dimensions for papers are too faint for presentations—lines, text and symbols must be double the weight/size for a presentation.[10, 11] The ink-efficiency of symbols is better than that of text—T, °C rather than Temperature, °C; t, s rather than Time, s—but when you present a graph, explicitly state the axes. Captions and titles are unnecessary text.

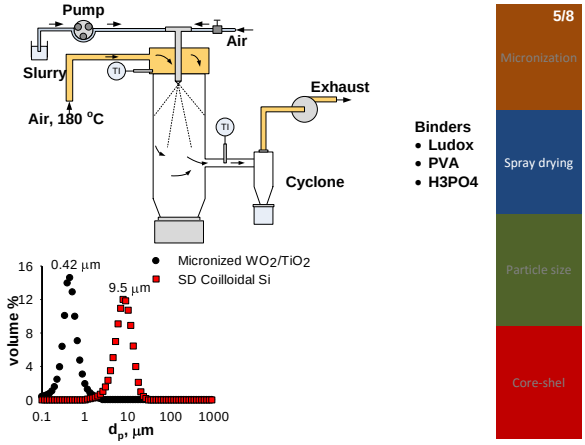
Apply institutional templates for new presentations to save time. Objects in a presentation represent your ideas and work—color and contrast enhance the perception and cognition of an object.[12] In other words, colors stimulate the mind, so choosing them is important. Black on white is boring; too many colors overstimulates; monochromatic, split complementary, and analogous colour schemes are attractive.[2] Many people have red-green colour blindness so green vs red contrasts are invisible to them. Further, projector brightness is never guaranteed.

DELIVERY

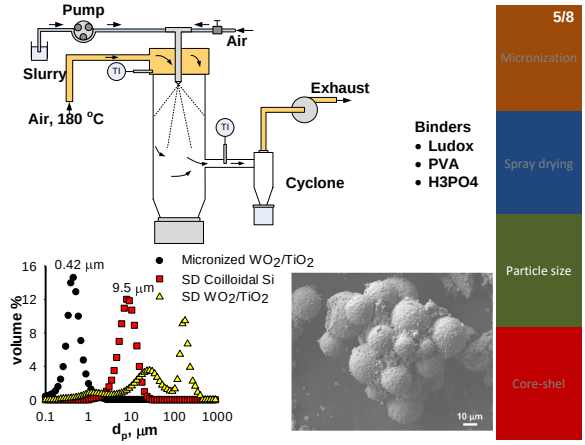
Rehearse presentations out loud (rather than whispering to a screen) and practice varying the pace, taking pauses, and changing the tone. Target 120 wpm to 160 wpm. Stand while rehearsing and ideally in front of people. Videos of these sessions identify idiosyncrasies (um, uh, you know).[9] Smile and speak enthusiastically to convey your passion for your work—this is contagious and the audience will share your excitement. Rehearsing also ensures you respect the time limits (no one wants to see a chairperson waving their hand at them to stop). Exceeding the alloted time is disrespectful to the audience and the next speakers, particularly in conferences with parallel sessions.

The first minute is the most stressful. The chairperson introduces you, your institute and the title. Rather than repeat this, to reduce the stress start with simple statements like *I am happy to be here*, or *what a fantastic conference venue*, or say something about what the previous speaker or someone else at the conference talked about. This establishes a conversational, relaxed tone and helps connect you to the audience through a shared experience.[13]

Slides are visual supports, people have come to hear you talk. But just because you have said something does not mean that they agree, understand or remember. Key features to remember while you practice and present:



(a)



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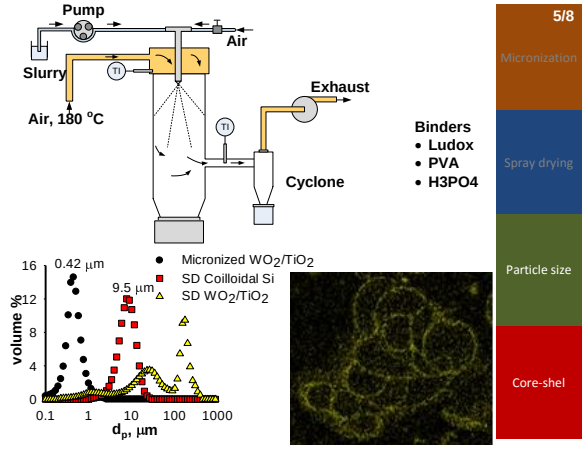

(c)

Figure 4: In this series, we add one or two elements to the slide, which gives the audience more time with the content. Start with only the schematic of the spray dryer. With the first click, the graph appears with one or two traces (a). After the second (or third) click, the PSD of the spray-dried catalyst appears (yellow line). In (b), an SEM image at the bottom left demonstrates that the particles agglomerate. Finally, in (e), the EDX image replaces the SEM and shows that the surface of the spherical particles in the agglomerate are enriched in Si.

- Repeat what you think is important;
- Ask rhetorical questions;
- Emphasize original research with a pregnant silence (1 s to 2 s);
- Glance at the screen occasionally but focus your eyes mostly on the audience and individuals;
- Rather than scanning the room as you talk, select several individuals in different parts of the room and move your gaze from one to the other as you speak;
- Project your voice to convey confidence, even with a microphone;
- Good posture also projects confidence;
- Gesturing conveys enthusiasm;
- Walk from one side of the screen to the other while highlighting your work and approach the audience rather than constraining yourself to the podium; and,
- If using a laser pointer, avoid the fly on the wall effect by applying the Skywalker method: grab the pointer with both hands to steady the beam.

After your brilliant exposé, the next challenge is to respond to questions. All questions are good, even if they are adversarial (at least someone was listening). Respond only when the person has finished speaking.[14] Repeat the question out loud so everyone hears it, and at the same time you test whether you understood it. Ask the chairperson for help if it is unclear.[15] When you understand the question, first thank the person, then, whatever you say, be polite. The people in the audience are potential collaborators, employers, or reviewers of journal articles and grant proposals. When you are unsure how to respond, admit it and ask to speak with the person after the session. Alternatively (preferably) there is nothing wrong with admitting that you do not know.

CONCLUSIONS

The audience recalls most of what you say at the beginning of the presentation (primacy effect) and at the end (recency effect). For them to retain what you say in the middle, you must *repeat* the key message, *personally involve* them, or present something *unusual*.[16]

We consider that content, format and delivery are the three categories to judge presentations on (Table 1). The speaker makes the content accessible to most people in the audience and at the end, most will remember what it was about. Throughout the talk the speaker convinces us that it is original. The slides complement what the speaker says. They are not overloaded with data and text—9 to 13 slides for a 15 min talk and 20 to 25 slides for a 30 min talk.

Table 1: Judging criteria

Category	Quality	Expectations		
		Exceeds	Meets	Below
Content	Accessible Memorable Original			
Format	Images Text Animation Colours			
Delivery	Enthusiastic Confident Respects time Q&A			

Most of the slides have pertinent images (less than 4) and text is sparse (font size at least 20 pt). Finally, the speaker engages the audience with enthusiasm and confidence.

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