



# **Intro to InDesign**

Computing Club 11/5



"All the News That's Fit to Print"

# The New York Times

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\$2.50

**Late Edition**  
Today, cloudy, with storms and flooding, high 82. Tonight, cloudy, with storms and flooding, low 71. Tomorrow, rain, clearing later, high 79. Weather map is on Page B12.



Clothes washers work near a sewage pipe in the Ganges in Varanasi, India, where no city has a comprehensive treatment system.

## Malnutrition in Well-Fed Children Is Linked to Poor Sanitation

**By GARDINER HARRIS**  
**In India, Exposure to Bacteria Is Seen as Root of Problem**  
SHEOHAR DISTRICT, India — He wore thick black eyeliners to ward off the evil eye, but Vivek, a tiny 3-year-old living in a village of mud huts and diminutive people, had nonetheless fallen victim to India's great scourge of malnutrition.  
His parents seemed to be doing all the right things. His mother still breast-fed him. His family had six goats, access to fresh buffalo milk and a tub filled with hundreds of pounds of wheat and potatoes. The economy of the state where he lives has for years grown faster than almost any other. His mother said she fed him as much as he would eat and took him four times to doctors, who diagnosed malnutrition. Just before Vivek was born in this green landscape of small plots and grazing water buffalo near the Nepal border, the family even got electricity.  
So why was Vivek malnourished?  
It is a question being asked about children across India, where a long economic boom has done little to reduce the vast number of children who are malnourished and stunted, leaving them with mental and physical deficits that will haunt them their entire lives. Like almost everyone else in their village, Vivek and his family have no toilet, and the district where they live has the highest concentration of people who defecate outdoors. As a result, children are exposed to a bacterially brewed that often sickens them, leaving them unable to attain a healthy body weight no matter how much food they eat.  
"These children's bodies divert energy

## Seeking Soccer Respect, Qatar Looked Abroad

**By Steve Eder, Sean Boren, Christopher Herrera and Josh Williams**  
DOHA, Qatar — A little more than a decade ago, Andreas Blecher, then a director of one of Germany's Olympic training centers, arrived in the tiny Gulf nation of Qatar, wooed there by its royal family to help turn the hopeless national soccer program into something worthy of the world's respect.  
There were plenty of reasons this would be difficult — the country hardly has a tradition of soccer excellence, and its record of producing premier athletes in any sport is sparse. But there was one problem that seemed insurmountable.  
With a native population of only 200,000, Qatar simply did not have enough young players to form a team that could hope to compete with the likes of Brazil, Argentina and Germany.  
"We were trying to build a national program with a talent pool of the size of one you might find in a small United States city," Blecher said.  
One of his early hires was Josep Colomer, a former youth scout for F.C. Barcelona generally credited with discovering Lionel Messi, perhaps the best soccer player in the world, when Messi was a boy in Argentina.  
Colomer was known in soccer



Qatari players on the under-16 national team, Qatar, host of the 2022 World Cup, had developed players from other countries.

### INTERNATIONAL A4-12

**How Afghan Crisis Was Eased**  
A deal between Ashraf Ghani, below left, and Abdullah Abdullah after a contested election runoff came only after scrambling by negotiators, as a stretch in Afghanistan as any since the American invasion. PAGE A9



### NATIONAL A14-17

**Proposed Fix for Border Crisis**  
Two Texas congressmen plan a bill to make it easier to return migrant children to Central America. PAGE A14

**Cancer Therapy Questioned**  
Suppressing testosterone does not extend lives of patients with early-stage prostate cancer, a study finds. PAGE A18

### BUSINESS DAY B1-9

**Unusual Settlement for Citicorp**  
Citicorp's \$7 billion deal with the Justice Department shows how prosecutors are getting creative in holding the nation's big banks to account. PAGE B1

### NEW YORK A18-21

**Railroad Negotiations Falter**  
Days before a possible Long Island Rail Road strike, transit officials noted "a gulf" with the unions, which said they were preparing for a walkout. PAGE A18

### ARTS C1-8

**Finns Debate a Guggenheim**  
Expected costs have cut support for a planned museum in Helsinki. PAGE C1

### EDITORIAL, OP-ED A24-25

**Joe Nocera** PAGE A25

### THE UPSHOT

**Government Getting It Right**  
Mistrust of government remains widespread, but data-savvy policy makers are beginning to experiment with ways of finding out what works. PAGE A3

### SCIENCE TIMES D1-8



### ... Makes Perfect? It Depends

A paper about the merits of practice and talent when it comes to performance indicates that practice does not play an overwhelming role. These New York children rehearse anyway. PAGE D1

## Iran Outlines Nuclear Deal; Accepts Limit

**No Rise in Production for Several Years**

**By DAVID E. SANGER**  
VIENNA — Iran's chief nuclear negotiator, faced with an imminent deadline for an agreement with the West on the future of the country's nuclear program, said in an interview on Monday that Iran could accept a deal that essentially freezes its capacity to produce nuclear fuel at current levels for several years, provided it is then treated like any other nation with a peaceful nuclear program.  
The proposal, which Iran said was conveyed to the United States and five other world powers during closed-door negotiating sessions in Vienna, would effectively extend a limited series of concessions Iran made last November as part of a temporary deal to get negotiations started on a permanent accord. In return, Iran wants step-by-step relief from sanctions that have substantially weakened its economy.  
Offering a rare glimpse into the secret talks, Iran's foreign minister, Mohammad Javad Zarif, described a proposal that sought to satisfy Washington's aim to verifiably limit the amount and purity of nuclear fuel that Iran can produce for a well-determined number of years. Mr. Zarif is also trying to satisfy a military and clerical leadership in Iran that is determined not to dismantle existing facilities and intent on re-summing subordinated production in future years.  
"I'm not here to present maximalist positions," Mr. Zarif said in an interview in a 175-year-old neoclassical former palace, now a luxury hotel where the negotiators are living and working. "We're here to reach an agreement."

## A BOY SET ABLAZE: DETAILS EMERGING IN A REVENGE CASE

**KILLING OF PALESTINIAN**

**Shin Bet Says 3 Israeli Jews Spent Hours in Search of Victim**  
**By ISABEL KERSHNER**  
JERUSALEM — They cruised around the Arab neighborhoods of East Jerusalem for hours in the dark of night, three Israeli Jews: a man of 30, who was driving, and two of his relatives, youths about 17. They were looking for a victim, preferably someone lightweight, who could easily be pushed into the car.  
Though some of the details remain uncertain, at 3:45 a.m. on July 2, according to the Shin Bet, Israel's internal security agency, the three relatives, now murdered suspects who have yet to be identified, came across a slightly built Palestinian teenager who was alone: Muhammad Abu Khdeir, 16, who was waiting for his friends near the mosque on the main road of the well-to-do neighborhood of Shuafa, a few yards from his home.  
After forcing Muhammad into the car, a Hyundai, they sped off to a forest near the western entrance to Jerusalem. Muhammad was dragged from the vehicle and the victim bludgeoned him on the head a number of times with a wrench. The adult then set Muhammad on fire with the help of one of his young relatives. Leaving Muhammad to die, the three fled.  
Hours before Muhammad's killing, Israeli had buried the three teenagers, Eyal Yezli, 16, and friends Gilad Shaar and Nafiz Frankel, both 16, who had been abducted as they hitchhiked a road.  
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## Atlantic City Strives to Rise As Casinos Fall

**By CHARLES V. BAGLI**  
ATLANTIC CITY — Over the Fourth of July weekend, this town was packed. Hotel occupancy soared to 90 percent, and shoppers coursed through the outlet stores opposite Trump Plaza. At Revel, the city's newest casino resort, the lively, dressed-up crowd gazed out through the floor-to-ceiling glass to see the surfers riding the day's last waves onto the wide beach.  
But the booming weekend belied the wrenching problems plaguing this New Jersey resort. In the winter and even midweek in the summer, Atlantic City — battered by storms, declining property values and, increasingly, crumbling competition from gambling operations in neighboring states — is relatively quiet.  
"Since January, four of the city's 12 casinos announced plans to shut down if they failed to find buyers. In the latest blow, workers at Trump Plaza Hotel and Casino received notices on Monday that the white-owned complex with the bright red letters was expected to lock its doors as soon as Sept. 16. The Atlantic Club is

## She Fought Apartheid With Words

**By HELEN T. VERONIGOS**  
Nadine Gordimer, the South African writer whose literary ambitions led her into the heart of apartheid to create a body of fiction that brought her a Nobel Prize in 1991, died on Sunday in Johannesburg. She was 90.  
Her family announced her death in a statement.  
Ms. Gordimer did not originally choose apartheid as her subject as a young writer, she said, but she found it impossible to dig deeply into South African life without striking repression.  
And once the Afrikaner nationalists came to power in 1948, the scaffolds of the apartheid system began to rise around her and could not be ignored.  
"I am not a political person by nature," Ms. Gordimer said years later. "I do not suppose, if I had lived elsewhere, my writing would have reflected politics much, if at all."



## HARRY WINSTON

Callison starting from \$24,300

NEW YORK BEVERLY HILLS LAS VEGAS CHICAGO BAL HARBOUR SOUTH COAST PLAZA DALLAS HONOLULU

### CREDS

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42	ALAN SOKOLOFF
43	ANDREW SCHLES
44	ANDREW WATSON
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### Adventure Awaits

### The Calling of the Mountains

### Mountains are the beginning and the end of all natural things

### feature with photos

### Explore the nation

### LET'S GO ON A Roadtrip

### When you're out in the wilderness

### FULL TIME

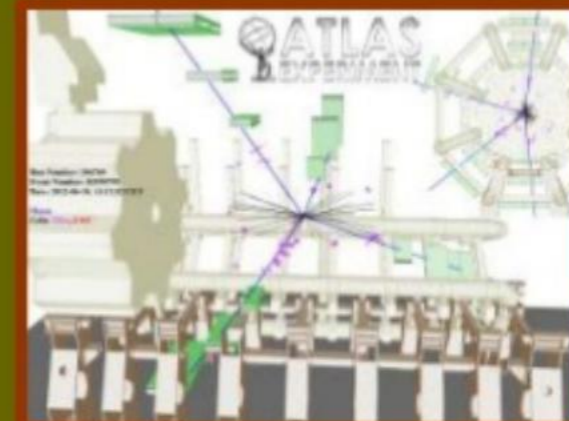
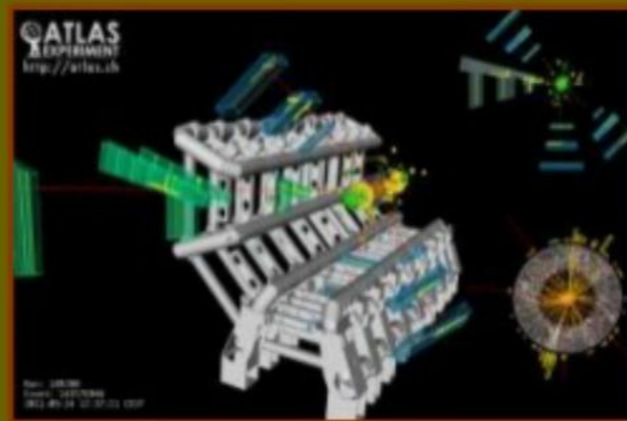
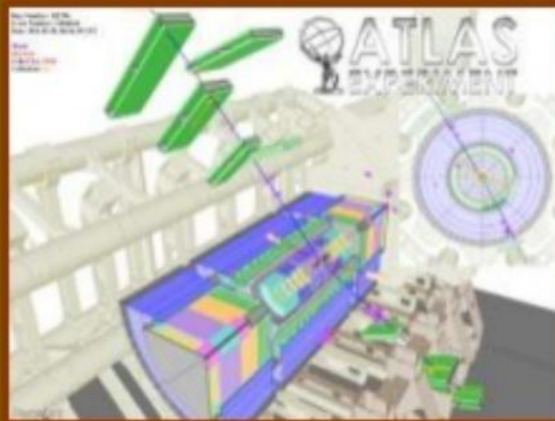
### EXPLORER

### All journeys have secret destinations

### Weekend Backpack

### Weekend Backpack

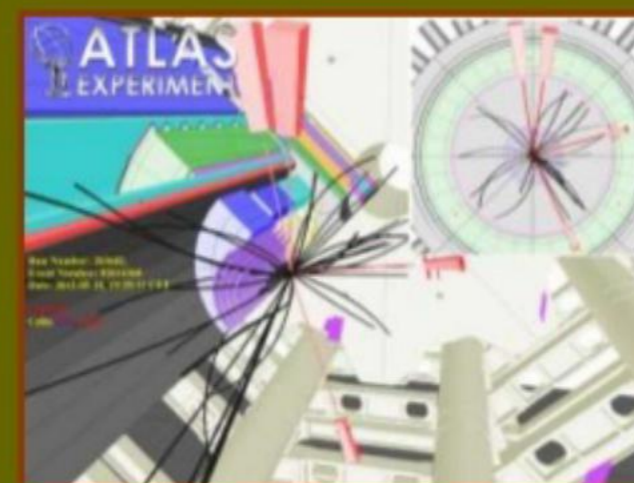
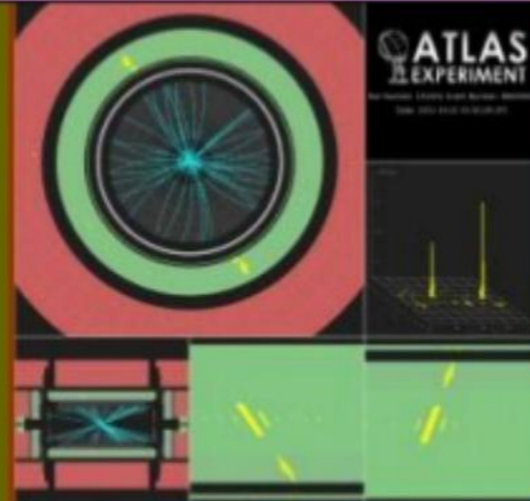
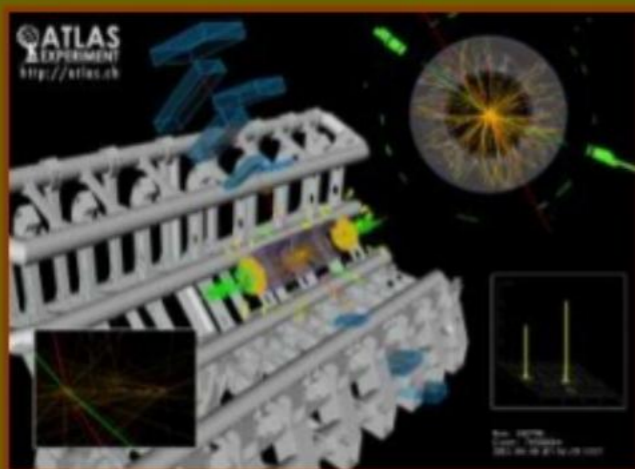
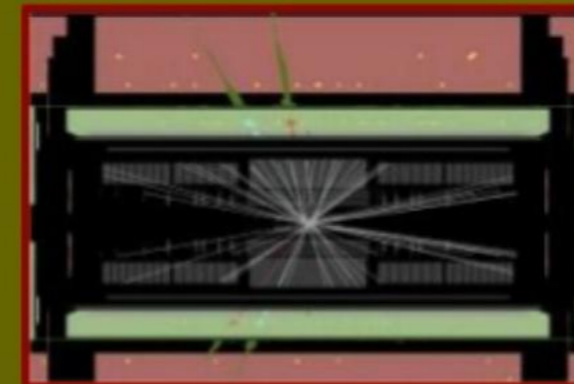




# Status of Standard Model Higgs searches in ATLAS

Using the full datasets recorded in 2011 at  $\sqrt{s}=7$  TeV and 2012 at  $\sqrt{s}=8$  TeV: up to  $10.7 \text{ fb}^{-1}$

Fabiola Gianotti (CERN), representing the ATLAS Collaboration







# O<sup>6</sup>-Benzylguanine Inhibits Tamoxifen Resistant Breast Cancer Cell Growth and Resensitizes Breast Cancer Cells to Anti-Estrogen Therapy

Judith Smith<sup>1</sup>, George C. Schindler<sup>1</sup>, Rafael Madros-Vidal<sup>1</sup>, Jessica Cohen<sup>1</sup>, Beth Isley<sup>1</sup>, Jonathan Thibault<sup>1</sup>, Eufemia A. Delvennegeal<sup>1</sup> and Nandini Kundu<sup>1</sup>

<sup>1</sup>Genet Research Institute of St. Andrew's Cancer Center Orlando - Case Western Reserve University (Health Sciences Center) - Cleveland, OH



## Abstract

Abstracts should be written in a concise and clear manner. The abstract should be written in a single paragraph, not exceeding 250 words. The abstract should be written in a single paragraph, not exceeding 250 words. The abstract should be written in a single paragraph, not exceeding 250 words.

Posters rarely need abstracts

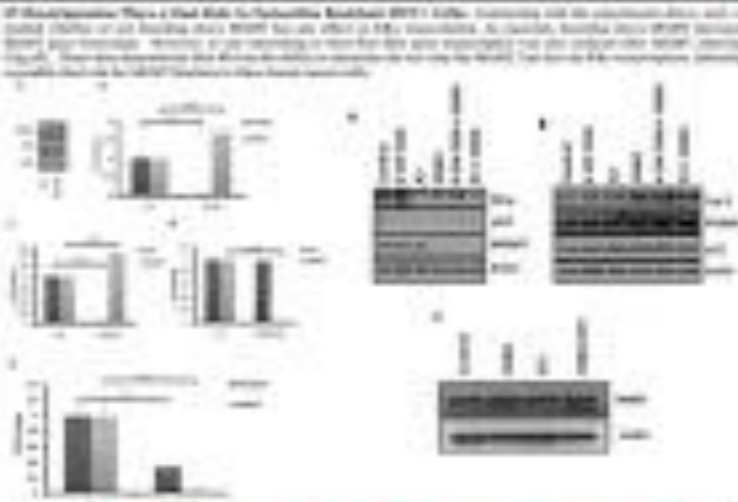
## Introduction

The introduction should provide a brief overview of the background and the objectives of the study. It should be written in a clear and concise manner, not exceeding 10% of the total word count. The introduction should provide a brief overview of the background and the objectives of the study.

Text dissolves into intimidating, boring gray

## Results

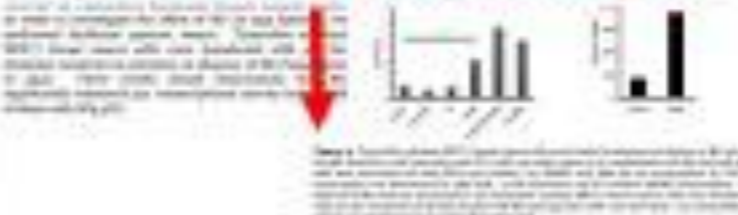
The results section should present the findings of the study in a clear and concise manner. It should be written in a clear and concise manner, not exceeding 40% of the total word count. The results section should present the findings of the study.



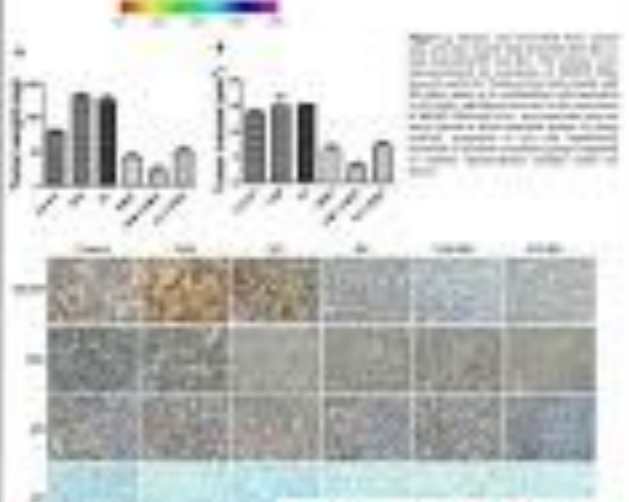
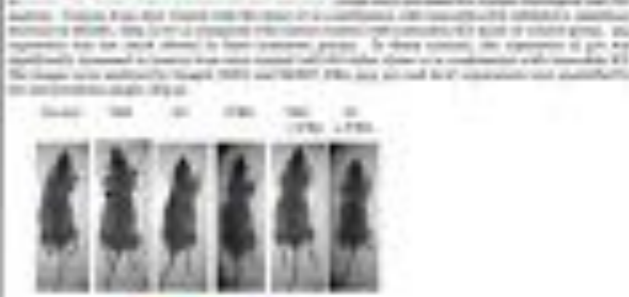
Too small and too much

The results section should present the findings of the study in a clear and concise manner. It should be written in a clear and concise manner, not exceeding 40% of the total word count. The results section should present the findings of the study.

Caption not aligned with figure



Crammed!



Crammed!

Conclusions  
Acknowledgments



# Anatomy of a #betterposter.

## Silent Presenter Bar

Concentrated summary of your intro, methods, and results that can be skimmed in 1-5 minutes. Located intentionally far away from the presenter's personal space. For when an attendee wants more detail but the presenter is busy (or they just don't feel like interacting).

**WHY:** Centralizing and succinctly summarizing the study details in a single column is fast & easy to scan without having to hunt around the poster for each section.

## Title

Authors

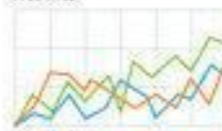
### Intro



### Methods



### Results



### Discussion

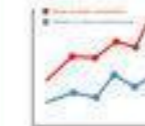


**Main finding** goes here,  
translated into **plain english**.  
**Emphasize** the important  
words.



Take a picture to  
download the full paper

## Extra Tables & Figures



## Ammo Bar

For all the figures and tables that you feel like you need to be able to point to if somebody asks you a hard question. Leave it messy! It's just for you to reference.

### WHY:

1. Lets you get the worries out of the way, so you can focus the rest of the poster on clearly communicating the need-to-know info to attendees.

2. Keeps the detail you need for questions closest to where you're standing, so you don't have to reach across the poster and block the view.



## QR Code to full paper

Point your phone camera at this and instantly download the full paper, a copy of the poster, the presenter's contact details...and/or even the data-set powering the study.

## Main finding

The key 'takeaway' of the study is central, translated into plain english. Research on usability writing suggests that casual language is interpreted faster than formal language.

## Focus area

Hardly "wasted", negative space maximizes signal-to-noise ratio and helps attendees quickly find the takeaway.



## PROBLEM

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# SCIENCE FAIR PROJECT

*By Neil Armstrong*

## PROCEDURE



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## RESULTS



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## CONCLUSION

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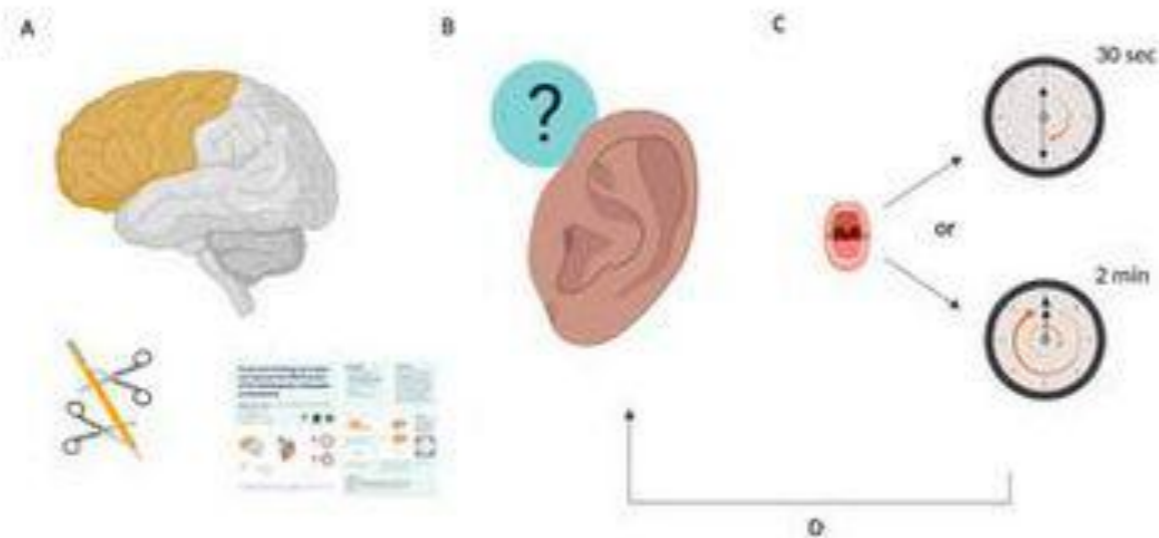


# Visual and UX design principles can improve the effectiveness of Morrison's Better Poster and poster presentations

Derek B. Crowe<sup>1</sup>, Melanie Rogala<sup>1</sup>, S.P. Margolis<sup>1,2</sup>, Luke H. Shaw<sup>1,3</sup>, David Sanchez<sup>1</sup>, Sarah Rutherford<sup>1</sup>, Amber V. Odhner<sup>1</sup>

<sup>1</sup>University of Rochester, Rochester, NY  
<sup>2</sup>Karlsruhe University, Ettlingen, Gethen  
<sup>3</sup>College at The Bog of Eternal Stench, Labyrinth

Correspondence: derek\_crowe@umc.rochester.edu



1. Plan, cut, edit, and distill your message. Write a brief, descriptive title. Use a layout that takes advantage of the whole poster. Prepare two versions of your poster: one a short one and a long one. 2. When another human seems like they might be interested in your work, ask to be sure. Then ask if they want the short letter or the long letter. Don't be afraid to ask questions to learn about your audience first. Use their background to change your talk up on the fly. They're not elevator pitches. 3. Oblige them. Use the graphical abstract for the short version and get into your data figures for the long version. 4. Listen to their verbal and non-verbal responses as you continue the conversation.

## Highlights

- A well-crafted message is more important than any layout design.
- Visual design strategies can be employed to incorporate lessons from Morrison's Better Poster without sacrificing valuable poster space.
- Posters are performances and audience members should have a voice in their experience.
- All academic disciplines can help us approach our world with curiosity.

## Summary

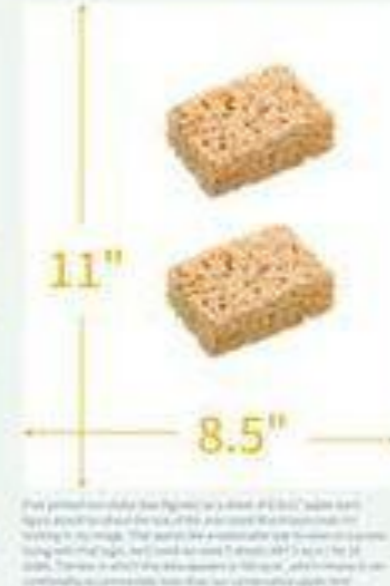
Mike Morrison's better poster style encourages scientists to distill their message, a critical step in creating effective posters. Dramatic physical layout constraints are the primary mechanism employed to help users consolidate their story, though this strategy costs a significant portion of the available poster space. Principles of visual design can guide users to achieve the same effective communication as intended by Morrison without sacrificing valuable real estate, as demonstrated here in a series of better poster layouts. These designs also incorporate user experience (UX) considerations of realistic time and social expectations during audience interactions at poster presentations. Multiple variations are offered in attempt to accommodate a wide variety of preferences and use cases. Also they're just some free powerpoint templates on a website; you monsters can do whatever you want with them.

## Let's choose a design that considers the preferences of presenters and audience members at poster sessions

What's the longest amount of time you'd want to spend talking with someone at your poster?



How often do you get a question about your poster?



## Methods

Given that most interactions will be much less than the 20 minute estimate, this amount of space should be more than enough to contain the data required to tell your scientific story. Don't fill space just because it's there; let your content dictate the form it requires.



10/20, 11x8.5. Poster made from paper that is approximately the thickness of a piece of paper.

## Design Invitations

1. If your title speaks for itself, don't bold keywords or phrases. Use the white borders as modular dividers to facilitate scanning. 2. Don't be afraid of leaving open space, as I have in the right of this section or above the third column. Play with the columns based on your figure aspect ratio. Use how the main title in this section and this box only span two of the three columns? It's easier to read a shorter line of text than a 30-70 character long. (Think of how many words span a page on a novel compared to how many words punch across the top of a science poster.) (More text, please, don't take this too seriously.)

# PROJECT TITLE HERE

# W

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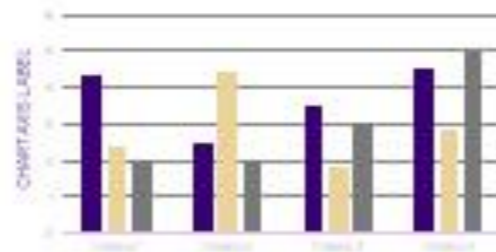


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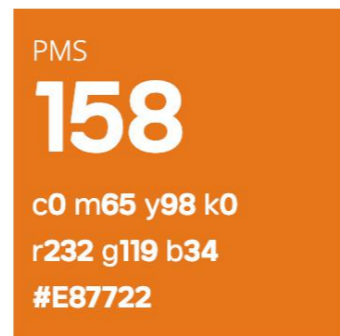
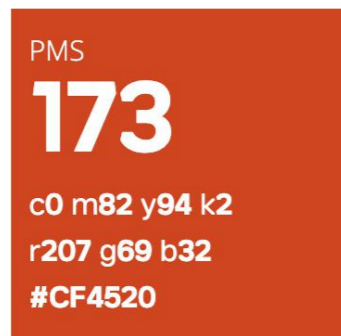
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# WCM Brand Guidelines

## Color Swatches

### Primary



## 1898 Sans Custom Font

**1898 Bold / *Italic***


**1898 Regular / *Italic***



# InDesign Settings

Make sure you set your file size as **36x48 INCHES**

PRESET DETAILS

Untitled-1 

Width  Units

Height  Orientation  Portrait  Landscape

Pages  Facing Pages

Start #  Primary Text Frame

Columns  Column Gutter

> Margins

> Bleed and Slug

Preview



## INTRODUCTION

### Gait Analysis

- Systematic study of locomotion
- Association with pathological conditions, movement disorders, and psychological conditions



### Ground Reaction Force (GRF)

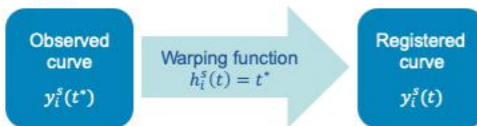
- Force exerted by the ground on a body
- Vertical GRF (VGRF)
  - Identify and reduce the risk of certain type of injury.
  - Discern onset and progression of musculoskeletal disease.
- Laboratory with force platforms and cameras placed on a treadmill

In-shoe sensor technology has been introduced recently.  
Would it be useful for gait analysis?

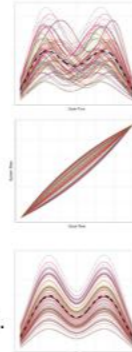
## METHOD

### 1. Curve Registration

- Remove the time shifts among in-shoe sensor curves.
- For the  $i$ -th stance of sensor  $s$ ,  $i = 1, \dots, I$ ,  $s = 1$  (heel), 2 (arch), 3 (ball), 4 (toe)



- Warping function: Stretch or compress time intervals
  - Clock time  $t^*$  (curve-specific) vs System time  $t$  (shared)
  - $h: [0, 1] \rightarrow [0, T]$  with  $h(0) = 0$  and  $h(1) = T$
  - Smooth & non-decreasing



- Iterative algorithm
  - 1) Calibrate the template curve and 2) Update warping functions.

### 2. Association in Phase Variability

- $H_0$ : No association in warping functions across sensors within stance.
- Test statistic: Mean pairwise correlation of warping functions within stance
- Permutation: Randomly permute the stance labels and calculate correlation.

### 3. Functional Regression

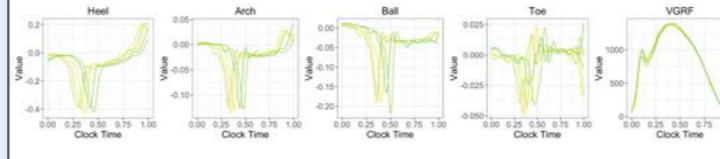
- Relationship between in-shoe sensors and VGRF curves
  - $GRF_i(t)$ : Measure of VGRF from the  $i$ -th stance
  - $y_i^s(t)$ : Registered in-shoe sensor curve for sensor  $s$
  - $\beta^s(u, t)$ : Coefficient related to the predictor measured over  $u$  to the response measured over  $t$

- Function-on-function regression

$$GRF_i(t) = \beta_0(t) + \int_0^1 y_i^s(u) \beta^s(u, t) du + \epsilon_i(t)$$

## DATA

- Data were collected in a biomechanics laboratory at BYU.
- Case study of three healthy female subjects
- (52, 60, 60) kg / (161, 165, 169) cm / Size 8 shoes / Age (18, 30)
- Standardized athletic shoes instrumented with the NCPF sensors
- Five different trials in a randomized order (4 minutes each) after a 15-minute warm-up run at 2.68 m/s:
  - Walking or running at 1.34, 2.23, 2.68, 3.13, or 3.58 m/s
- "Stance": From heel-strike to toe-off
- Three subjects completed 362, 321, and 308 stances, respectively.



## CONCLUSION

### Summary

- We examined both phase and amplitude variabilities in the in-shoe sensor data and illustrated the importance of aligning the observed curves via curve registration.
- We found a high correlation in phase variability across sensors within stance. This results shed light on the properties of the in-shoe sensors and may help to refine the development of this new in-shoe sensor technology.
- Our results from function-on-function regression models provide some evidence for a relationship between key features of in-shoe sensor and VGRF curves. They suggest the potential value of in-shoe sensors as a surrogate of VGRF measurements.

### Future Direction

- Our results are based on a limited case study.
  - : Including more subjects and stances is important to generalize our results.
- We focused on healthy subjects only.
  - : Including individuals with pathological / psychological disorders and investigating their time shifts will emphasize the clinical importance of curve registration and enhance the quality of gait analysis after preprocessing.

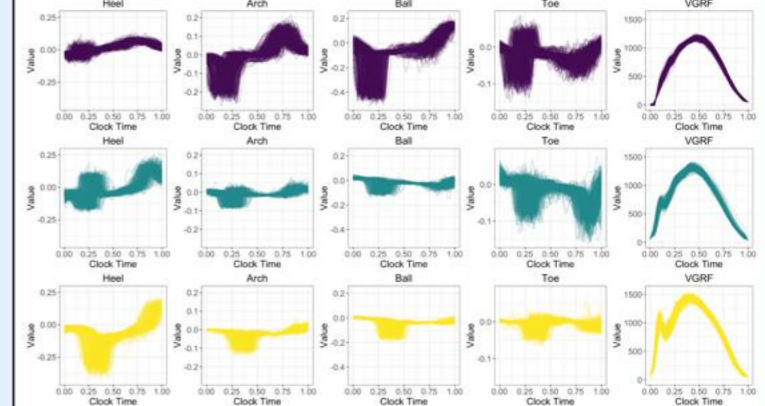
## SELECTED BIBLIOGRAPHY

1. (Curve registration) Anuj Srivastava, Wei Wu, Sebastian Kurtek, Eric Klassen, and J. S. Marron. "Registration of functional data using Fisher-Rao metric." *arXiv preprint arXiv:1103.3817* (2011).
2. (In-shoe sensor data) Parker G. Rosquist, Gavin Collins, A. Jake Merrell, Noelle J. Tuttle, James B. Tracy, Evan T. Bird, Matthew K. Seeley, David T. Fullwood, William F. Christensen, and Anton E. Bowden. "Estimation of 3D Ground Reaction Force Using Nanocomposite Piezo-Responsive Foam Sensors During Walking." *Annals of biomedical engineering* 45, no. 9 (2017): 2122-2134.

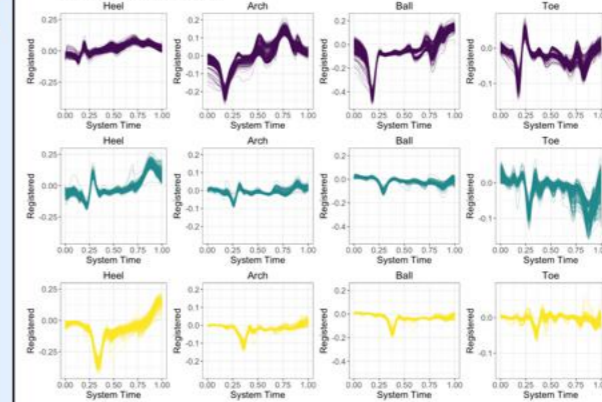
## RESULT

### 1. Curve Registration

- Before registration



- After registration



### 2. Association in Phase Variability

	Subject 1			Subject 2			Subject 3		
	Arch	Ball	Toe	Arch	Ball	Toe	Arch	Ball	Toe
Heel	0.617	0.240	0.094	0.268	0.264	0.411	0.378	0.280	0.238
Arch		0.315	0.125		0.262	0.258		0.337	0.300
Ball			0.501			0.239			0.276

### 3. Functional Regression

