Real-Time Hydraulic Modeling

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STANFORD UNIVERSITY

THOMAS LUND-HANSEN,
REO

IDEA 2019 Campus Energy Conference, New Orleans

on 13:52
on 13:52 Scenario 1 on 14:52

Search

Engineer

Views

Extents
Plant

Static themes

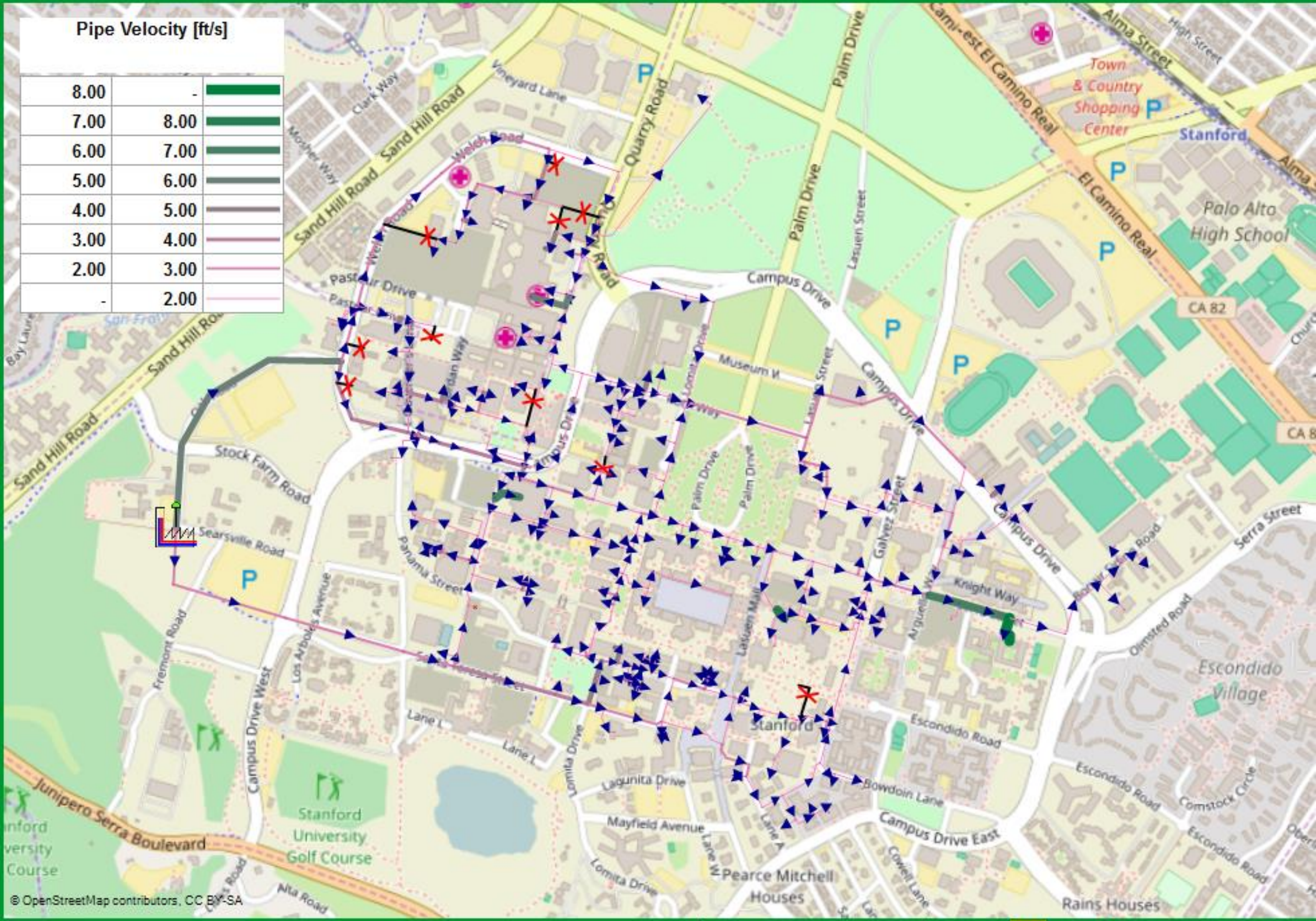
Boundary Conditions
Elevation
Peak Demand
Pipe Diameter
Standard

Dynamic themes (calculated)

DP Map
Flow
Friction Loss as Power
Pipe Heat Loss Supply
Pipe Velocity
Pressure Gradient
Temperature Supply (calculated)
Transport Time

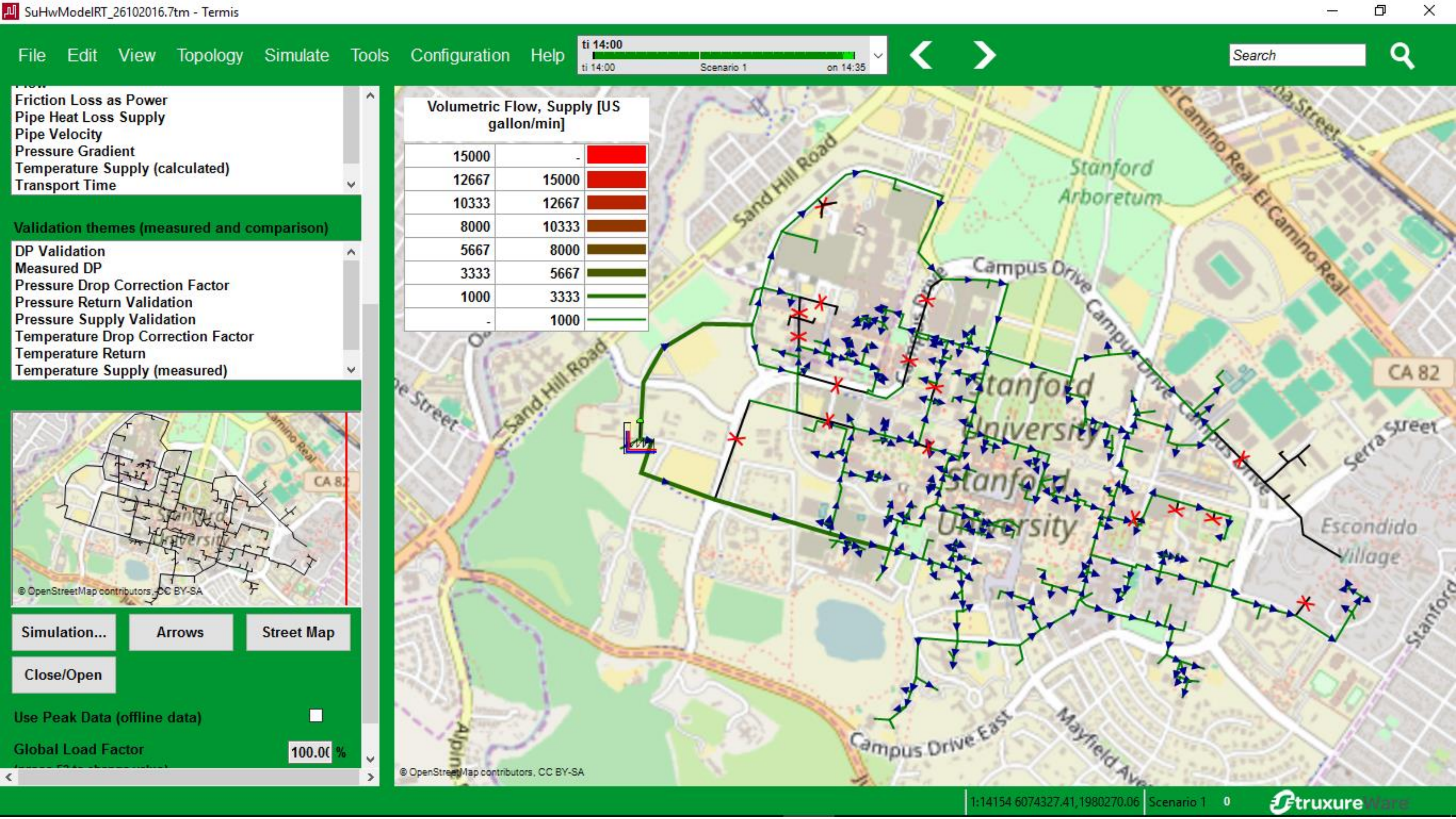
Validation themes (measured and comparison)

DP Validation
Measured DP
Pressure Return Validation
Pressure Supply Validation
Temperature Return
Temperature Supply (measured)
Temperature Supply Validation



1:12211 6073405.92,1983902.93 Scenario 1 1

truxureWare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File
Edit
View
Topology
Simulate
Tools
Configuration
Help
ti 14:00
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Scenario 1
on 14:35
Search
Friction Loss as Power
Pipe Heat Loss Supply
Pipe Velocity
Pressure Gradient
Temperature Supply (calculated)
Transport Time
Validation themes (measured and comparison)
DP Validation
Measured DP
Pressure Drop Correction Factor
Pressure Return Validation
Pressure Supply Validation
Temperature Drop Correction Factor
Temperature Return
Temperature Supply (measured)
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Simulation...
Arrows
Street Map
Close/Open
Use Peak Data (offline data)
Global Load Factor
100.0(%
Volumetric Flow, Supply [US gallon/min]
15000 -
12667 15000
10333 12667
8000 10333
5667 8000
3333 5667
1000 3333
- 1000
Sand Hill Road
Stanford Arboretum
El Camino Real
Campus Drive
Stanford University
CA 82
Serra Street
Escondido Village
Campus Drive East
Mayfield Ave
© OpenStreetMap contributors, CC BY-SA
1:14154 6074327.41,1980270.06
Scenario 1
0
truxureWare

Contents

This presentation is a Stanford University case study showing the results and value of hydraulic modeling for building the business case, design and real-time hydraulic for the operational phase of a new low temperature hot water system and chilled water system. Stanford University invested USD $500 million in transforming their energy systems to one of world leading low temperature hot systems and chilled water systems.

Hydraulic modeling was a critical component in this process and Termis real-time hydraulic modeling has become a critical component to maintain top efficiency to pay back the investment as a decision support tool. Real-time hydraulic modeling is used for the day-to-day operational management, troubleshooting, engineering, planning for changes and additions of new buildings. The investment of real-time hydraulic modeling solution has paid itself back in less than 24 months.

This presentation is a hands-on experience and includes demo to serve as an inspiration for all utilities interested in transforming their energy systems and to improve the efficiency of their energy systems.

Real-Time Live Modeling versus Static Modeling - 101

Thomas provide content

Stanford Energy System Innovations (SESI)

From 1987-2015

- Stanford relied on a natural gas-fired CHP plant for virtually all its energy demand which produce 90% of Stanford's GHG emissions.
- Consumed 25% of the campus' potable water supply.

2015 Central Energy Facility (CEF)

- The new CEF includes three large water tanks for thermal energy storage
- High voltage substation that receives electricity from the grid.
- Heat recovery system that takes advantage of Stanford's overlap in heating and cooling needs.

SESI project converted the heat supply of all buildings
from steam to hot water

Thermal Energy System

Stanford provides heating and cooling to the campus and Medical Center buildings and facilities through extensive hot and chilled water loops that originate at the Central Energy Facility (CEF).

- Underground hot and chilled water supply and return piping that circulate from the CEF for more than 20 miles around campus.
- Underground piping system is ductile iron piping with some small branch lines using PVC. Typical building laterals are 4”-6”
- Peak cooling loads from 50 tons for smaller buildings up to 800 tons for research centers and 2000-4000 tons for main hospitals,
- Peak heating loads that range from small buildings that draw less than 500k BTUs to the campus swimming pools, which can draw up to 10 million BTUs.

Thermal Energy System

- Chilled and hot water enter each building from underground into the basement mechanical room where the flow, as well as supply and return temperatures are measured, resulting in an energy use rate in cooling tons and btus, respectively.

- In the building mechanical rooms, secondary pumps then send the water on to cooling and heating equipment throughout the building.

- Both the hot and chilled water systems are closed loop, with water makeup for leakage and treatment being done centrally at the CEF.

Modeling Background, Status, Overall Plan, Results, Saving and Benefits

Phase 1 – 2011 to 2015:

The Termis offline (static) hydraulic modeling software was used by Stanford for planning and engineering; in particular to verify the work of the external consultant of the steam to hot water conversion program

Phase 2 – 2016 to OCT 2016:

The Termis real-time solution proof of concept in a trial system environment was successful completed for both the hot water and chilled water system.

Phase 3 – NOV 2016 to JAN 2017:

Business case preparation and deployment plan for the Stanford Termis real-time modeling systems and the use of it

Phase 4 – JAN 2017 – On-going:

Acquisition of the Termis real-time software licenses and annual technical support & software updates service agreement. Start the use for engineering and planning – Escondido Dormitory Building Complex

Phase 5 – JAN 2017 – DEC 2017:

Roll the Termis system into an LBRE-IT production environment

-> Escondido Dormitory Building Complex Challenge and the day-to-day use

Escondito Dormitory Complex Challenge

Background, challenge, solution + photo. Prepare Termis modeling screenshots as back-up to demo.

Results, benefits and savings

During proof of concept in 2016 and through FEB 2018, real time data has been obtained and analyzed reflecting unknown issues and detailed What-If scenarios of adding new buildings and changes in the distribution system including valve management

Termis is a valuable tool to lower cost of operations and maintenance for both HW and CW systems as well as for any engineering related to these distribution systems

Termis is a valuable tool with potential for optional additional efficiency and optimization features enabling the highest possible efficiency and lowest possible cost

Results, benefits and savings

- Hydraulic Modeling for design new hot water system - Offline data
  - Overview and collection of all relevant data
  - Applying loads from existing Building System
  - Design network, plants and operational parameters

- Improving operational conditions by real-time modeling
  - Real capacity and capability versus design
  - Improving / maintaining dT at a high level
  - Dispatch strategy to ensure low dP to minimize pumping
  - Management of piping losses
  - Identify system bottlenecks
  - Measurements; accuracy watch-dog and location
  - Managing campus building expansions
  - Managing valves and by-passes
  - Visual overview

Estimated cost savings of $300,000

Optional additional efficiency and optimization features enabling the highest possible efficiency and lowest possible cost

Background, Status, Overall Plan, Results, Saving and Benefits

Next steps for 2019-2020:

Phase 6:

Enable management, operational, and maintenance staff to use the Termis System Thin Client HMI (View Only) as well as tablet and smartphone devices.

Phase 7:

Follow-up, evaluate and improve phase 6. Study of optimization and efficiency opportunities for such as dynamic supply pressure and supply temperature reset in advisory mode. In addition study the benefits and savings of load forecasting based production scheduling.

Phase 8:

Potential implementation of the recommendations of Phase 7

“Real-time hydraulic modeling - Stanford University Case Study”

- Hot water and chilled water -

Questions?

Dan Arellano, Stanford University
Thomas Lund-Hansen, REO

IDEA 2019 Campus Energy Conference, New Orleans

Contact details:

Dan Arellano, Stanford University:

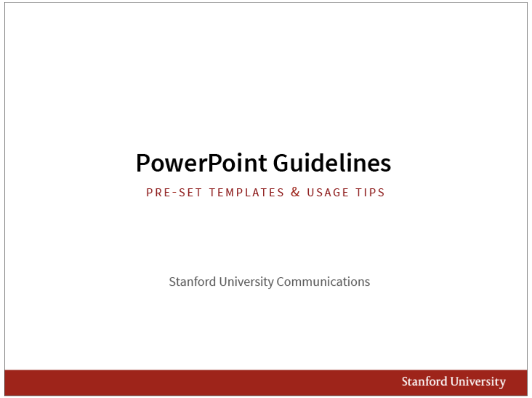
Thomas Lund-Hansen, REO:

Thank you!

Title Slides

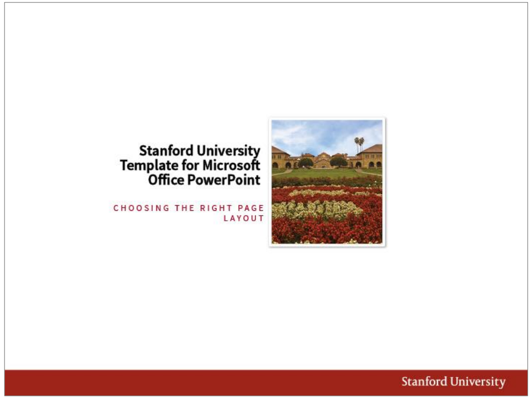
Presentation title slide

- Used as the opening slide for presentations, this layout has a white background, and a red bar along the bottom.



Divider Slide

- Used to mark different sections or topics in a presentation, this layout has a white background, and a red bar along the bottom.

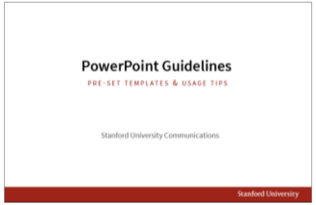


Slide Layouts

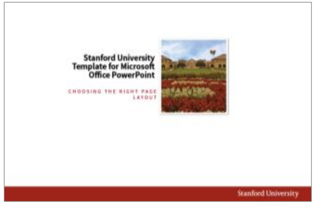
Options

- Slide layout options include:
  - Title slide
  - Divider slide
  - Full screen (one content box)
  - Two content boxes arranged vertically
  - Two content boxes arranged horizontally
  - Three boxes (one large, two small)
  - Four content boxes

- Seven slide layouts are available in two backgrounds.

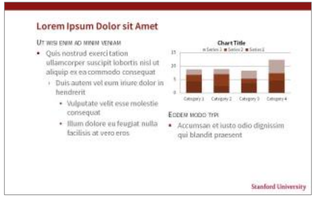


TITLE SLIDE



DIVIDER SLIDE

ONE CONTENT BOX



THREE CONTENT BOXES

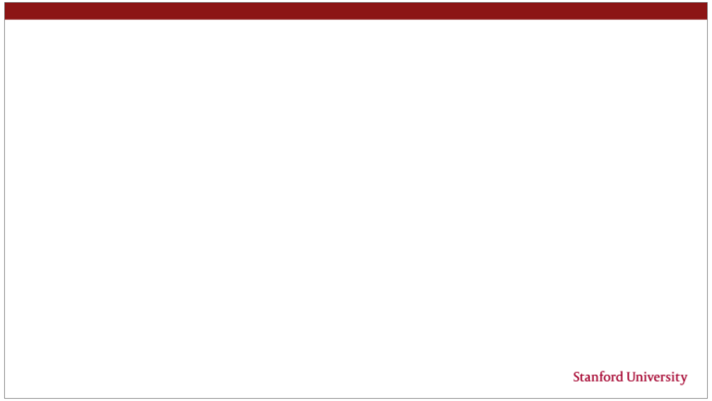
TWO VERTICAL CONTENT BOXES

FOUR CONTENT BOXES

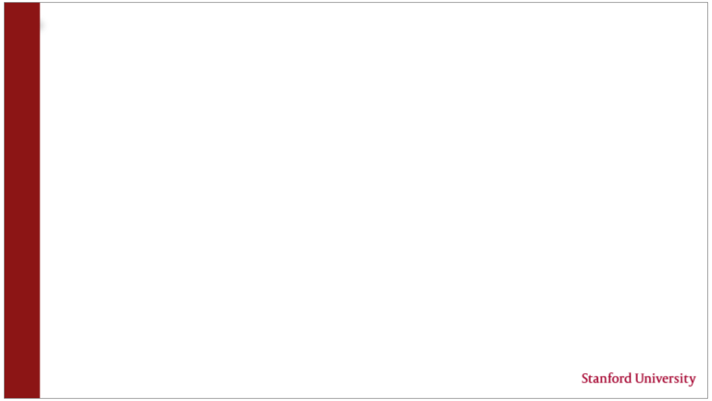
TWO HORIZ. CONTENT BOXES

Two Background Options Are Available for Content Layouts

Top bar with white background



Side bar with white background



Slide Layouts

Which to use?

- The page numbering and title on every layout is in the same place, whether the red bar is across the top or along the left side.
- While it is preferable to have all slides in a presentation use either the top bar layouts or the side bar layouts, it is possible to mix them.
- The content boxes can contain text, tables, charts and graphs, SmartArt graphics, or images
- When inserting content from other PowerPoint files, remember to apply a slide layout and check that all content is using the master boxes

Stanford University Design Elements for PowerPoint

MAINTAINING THE
STANFORD LOOK & FEEL

Slide Fonts, Slide Transitions

FONT=ARIAL, FOR ALL TEXT

- This is a font that are on most Windows and Mac platforms so there will be no font conflicts.
  - Use bold sparingly; use italics for quotes and publication titles only; avoid underlines

SLIDE TRANSITIONS

  - For consistency, the transition for all slides is set to Fade Smoothly on click

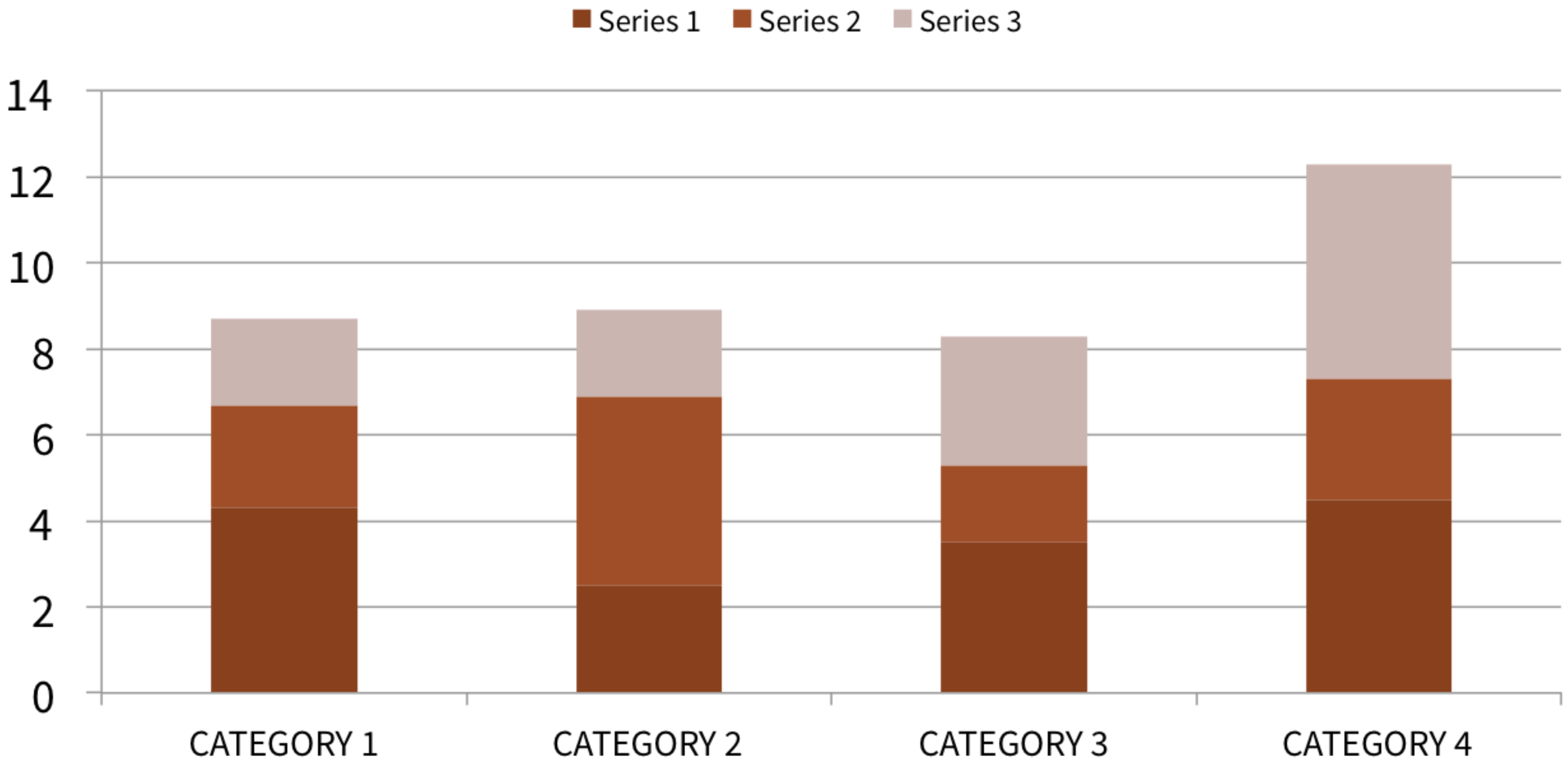
Stanford University Color Palette

Background 1 | Text 1 | Background 2 | Text 2

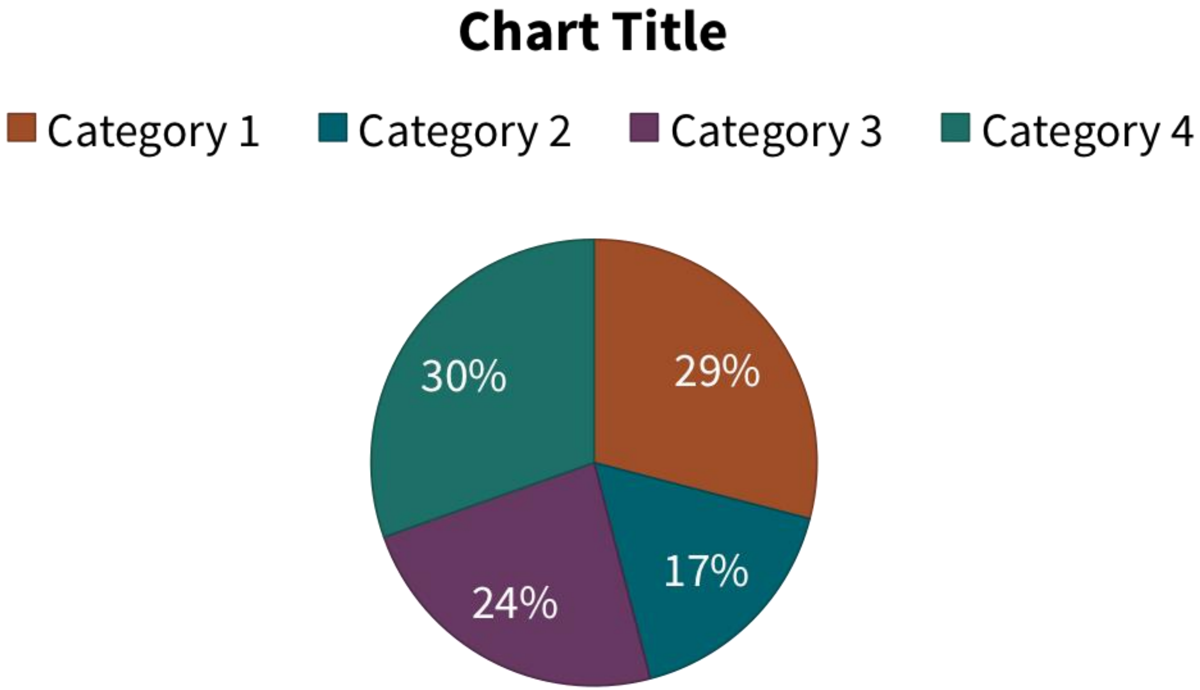
Accent 1 | Accent 2 | Accent 3

Accent 4 | Accent 5 | Accent 6

Sample Stacked Bar Graph—Use Document Theme Colors



Sample Pie Chart



Unit name org chart

October 2013

- **Lorem Ipsum**
  Title lorem Ipsum lorem ipsum
  - **First Lastname**
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  - **First Lastname**
    Senior Director
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ORG Codes
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IPSUM: Lorem Ipsum lorem
LOREM: Lorem Ipsu