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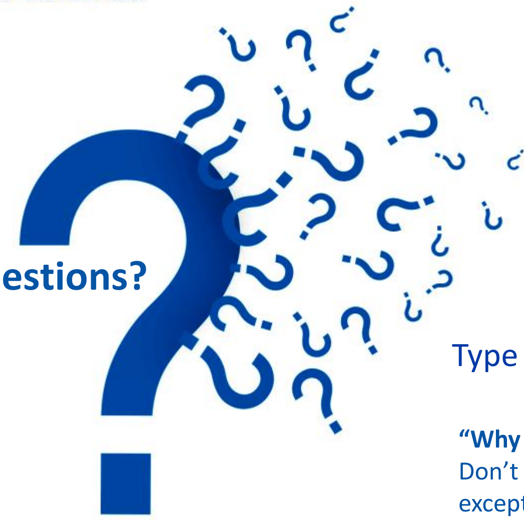

Have Questions?

Type them into questions box!

“Why am I muted?”
Don’t worry. Everyone is muted except the presenter and host. Thank you and enjoy the show.

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Hundreds of presentations from the best and brightest minds that chemistry has to offer are available to you on-demand. The Library is divided into 6 different sections to help you more easily find what you are searching.

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Learn how to write better abstracts, deliver more engaging presentations, and network to your next dream job. Brush up on your soft skills and set a new career path by mastering what can not be taught in the lab.

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The Drug Design Delivery Series has built a collection of the top minds in the field to explain the mechanics of drug discovery. Discover the latest research, receive an overview on different fields of study, and gain insight on how to possibly overcome your own med chem roadblocks.

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Feeling burdened by all that molecular weight? Listen to experts expound on the amazing side of current hot science topics. Discover the chemistry of rockets, how viruses have affected human history, or the molecular breakdown of a hangover.

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How do ideas make it from the lab to the real world? Discover the ins and outs of the chemical industry whether you are looking to start a business or desire a priceless industry-wide perspective.

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Live Broadcasts of ACS Webinars® continue to be available to the general public several times a week generally from 2-3pm ET!

A **collection of the best recordings** from the ACS Webinars Library will occasionally be rebroadcast to highlight the value of the content.

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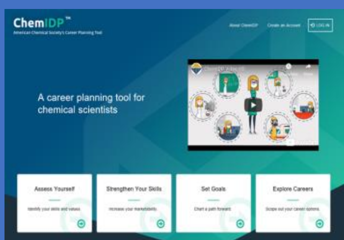

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Whether you are just starting your journey, transitioning jobs, or looking to brush up or learn new skills, the **ACS Career Navigator** has the resources to point you in the right direction.

We have a collection of career resources to support you during this global pandemic:

Professional Education

Virtual Career Consultants

ACS Leadership Development System

Career Navigator LIVE!

ChemIDP

College to Career

ACS Webinars

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Visit www.ACS.org/COVID19-Network to learn more!

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Join us in our efforts to increase the diversity of chemistry.

Valued donors like you have sustained ACS educational programs that are welcoming students from diverse backgrounds into our profession.

www.acs.org/donate

ACS Office of Philanthropy
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A Career Planning Tool For Chemical Scientists

ChemIDP is an Individual Development Plan designed specifically for graduate students and postdoctoral scholars in the chemical sciences. Through immersive, self-paced activities, users explore potential careers, determine specific skills needed for success, and develop plans to achieve professional goals. **ChemIDP** tracks user progress and input, providing tips and strategies to complete goals and guide career exploration.

https://chemidp.acs.org

ACS Department of Diversity Programs

Advancing ACS's Core Value of Diversity, Inclusion & Respect

We believe in the strength of diversity in all its forms, because inclusion of and respect for diverse people, experiences, and ideas lead to superior solutions to world challenges and advances chemistry as a global, multidisciplinary science.

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@ACSDiversity

ACS Diversity

ACS Voices Diversity Podcast

acsvoices.podbean.com/

www.acs.org/diversity

26th ANNUAL
GREEN CHEMISTRY & ENGINEERING CONFERENCE

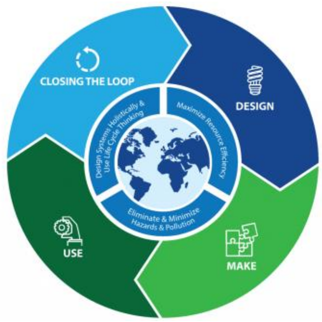
Thinking in Systems: Designing for Sustainable Use
June 6-8, 2022 / Reston, VA, USA

ACS Green Chemistry Institute
Chemistry for Life®

In order to highlight the importance of this approach to chemistry and engineering and to facilitate critical discussions on these topics, the theme of each GC&E Conference focuses on one of the stages of the chemical life cycle; put simply: **Design, Make, Use, and Closing the Loop.**

Key Dates

- **January 3, 2022**: Call for Abstracts opens
- **February 14, 2022**: Call for Abstracts closes
- **February 15, 2022**: Early Registration & Housing Open
- **April 30, 2022**: Early Registration Closes
- **May 1, 2022**: General Registration Opens
- **May 14, 2022**: Housing Deadline
- **June 6-8, 2022**: Conference



Join us June 6-8, 2022

The 26th Annual Green Chemistry & Engineering Conference will be held in Reston, Virginia, June 6-8, 2022. For virtual participants, we will be offering a selection of online sessions both prior to and during the conference.

Early registration opens on February 15, 2022.

Early Bird Registration
Feb. 15 – April 30

Full	$575
One Day	$295
Student*	$200

Regular Registration
May 1 – June 8

Full	$675
One Day	$375
Student*	$250

Virtual Registration
Feb. 15 – June 8

Regular	$50
Student*	$25

*Student registration includes all full-time students.

Full Registration provides full access to all in-person technical sessions, receptions, meals, and networking events (except ticketed events), plus all virtual content.

One-Day Registration provides full access to one day of the in-person conference plus all virtual content.

Virtual Registration provides access to a selection of content that will be provided via live stream in advance of and/or during the conference.

"Premier forum of both academic and industrial advances in green chemistry and sustainability."

Jane Wissinger Professor of Chemistry, University of Minnesota

"I think that the Conference was great, and the level of interaction with speakers and other participants really exceeded my expectations!"

2020 virtual GC&E Conference attendee

https://www.gcande.org

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ACS
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Date: Wednesday, November 17, 2021 @ 2-3:30pm ET
Speakers: Stephanie Vivod, NASA John H Glenn Research Center and Christopher Wohl, NASA Langley Research Center
Moderator: Sadeq Malakooti, NASA John H Glenn Research Center

Register for Free!

What You Will Learn:

- How copoly (carbonate urethane) materials can create reusable materials applications
- Surface engineering of existing and novel polymers that will mitigate lunar dust adhesion
- The exciting future of polymer aerogels for space exploration

Co-produced with: ACS Division of Polymer Chemistry

Date: Thursday, November 18, 2021 @ 2-3:15pm ET
Speaker: Elizabeth Tomasino, Oregon State University
Moderator: Brian Guthrie, Cargill

Register for Free!

What You Will Learn:

- What are the compounds associated in smoke and smoke taint in wine
- How smoke taint compounds end up in wine
- How individuals perceive the aroma and flavor of smoke

Co-produced with: ACS Division of Agricultural & Food Chemistry

Date: Thursday, December 2, 2021 @ 2-3pm ET
Speakers: Javier García Martínez, IUPAC and Rive Technology / Laura-Isobel McCall, University of Oklahoma / Diego Solis-Ibarra, Universidad Nacional Autónoma de México / Corinna Schindler, University of Michigan
Moderators: Jessica Marshall and Mitch Jacoby, Chemical & Engineering News

Register for Free!

What You Will Learn:

- What were the hottest trends in chemistry research during 2021, according to the experts
- What areas of chemical research do experts think will make the news in 2022
- What molecules caught C&EN editors' attention this year

Co-produced with: Chemical & Engineering News

www.acs.org/acswebinars

ACS Chemistry for Life®

Co-produced with the ACS Green Chemistry Institute

Bringing Systems Thinking into the Classroom

FREE Webinar | TODAY at 2pm ET

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THIS ACS WEBINAR WILL BEGIN SHORTLY...

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ACS Chemistry for Life®

Bringing Systems Thinking into the Classroom

KATHERINE AUBRECHT
Associate Professor, Department of Chemistry, Stony Brook University

JOHN RANDAZZO
Assistant Professor, Department of Chemistry and Biochemistry, North Park University

DAVID CONSTABLE
Science Director, Green Chemistry Institute, American Chemical Society

Presentation slides are available now! The edited recording will be made available as soon as possible.

www.acs.org/acswebinars

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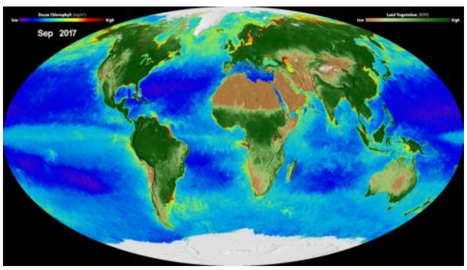
Systems Thinking

Systems thinking is a holistic approach for examining complex, real-world systems, in which the focus is not on the individual components of the system but on the dynamic interrelationships between the components and on the patterns and behaviors that emerge from those interrelationships.

York et al. J. Chem. Educ. 2019, 96, 2742.



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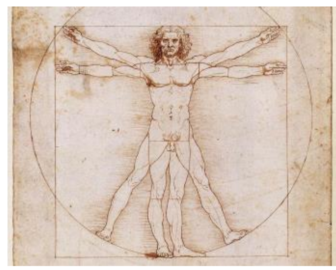

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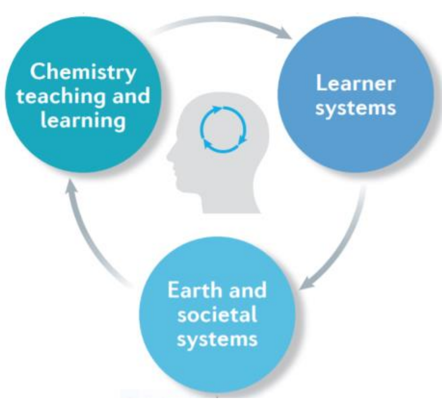
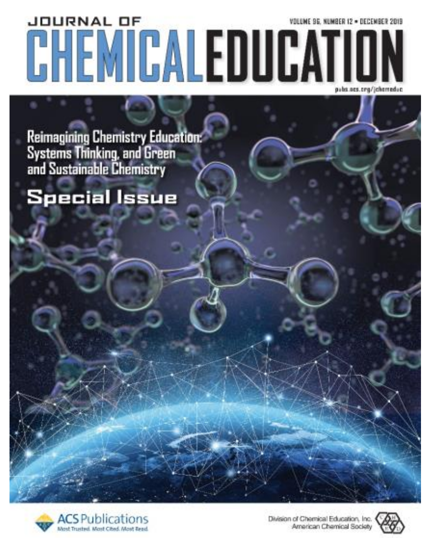
Systems Thinking in Chemistry Education



Mahaffy et al. Nature Reviews Chemistry, 2018



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Potential benefits for students taking chemistry courses

- Make students aware of chemistry's role and potential role in solving grand societal challenges
- Increase motivation to learn chemistry content
- Better able to see connections between chemistry and other disciplines
- Increased focus on critical thinking and problem solving
- Counterbalance reductionist approaches, which though useful can result in fragmented knowledge that is siloed by discipline

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Systems thinker in chemistry education can:

York, S.; Orgill, M. J. Chem. Educ. 2020, 97, 2114.

- Recognize a system as a whole, not just as a collection of parts.
- Examine the relationships between the parts of a system and how those interconnections lead to cyclic system behaviors.
- Identify variables that cause system behaviors, including unique system-level emergent behaviors.
- Examine how system behaviors change over time.
- Identify interactions between a system and its environment, including the human components of the environment.

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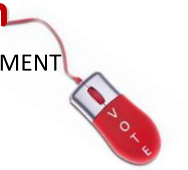
Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



How familiar are you with systems thinking and its use in chemistry education?

- It's new to me
- I have heard of it
- I can describe aspects of it
- I am developing systems thinking oriented learning materials
- I use it in my courses

** If your answer differs greatly from the choices above tell us in the chat!*

Systems thinking underpins green and sustainable chemistry

Where did the materials come from?

What happens to the waste?

What will happen to the molecule or material at the end of its use?

How much energy is needed? Where does that come from?

What is the toxicity of the chemicals being used, of the products, and of the waste?

Who might be exposed and what steps are being taken to reduce risks?

What is the utility of this molecule or material- practical and/or furthering knowledge?

What are chemistry students being taught and mentored to be concerned about?

https://www.stonybrook.edu/commcms/chemistry/news/photos#

ACS GCI project aims to develop green and sustainable chemistry modules with a systems thinking lens

- ACS GCI is leading a 3-year project for higher-ed general chemistry and organic chemistry instructors to develop modules focused on green and sustainable chemistry and systems thinking for dissemination to the broader community.
- Module developer teams are focusing on individual chemistry topics.
- The idea is to reframe core chemistry topics from a systems thinking and green chemistry perspective rather than introduce extensive “new” material.
- Explicit focus on United Nations Sustainable Development Goals (UN-SDGs) and green and sustainable chemistry.
- Our role is to develop an introductory module for this project.

https://www.acs.org/content/acs/en/greenchemistry/students-educators/module-development.html

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Development teams will create modules to benefit students and instructors

Project overview:
- Each team consists of two instructors and an assessment consultant.
- Teams meet regularly throughout the year to develop module materials, e.g., slides, assignments, activities, and assessments.
- Teams are tasked with developing two modules, each covering one fundamental topic in the chemistry curriculum.

Project goals:
- Teach green and sustainable chemistry design
- Empower students to address important, complex problems
- Encourage interdisciplinary practice
- Foster cross cultural and societal perspectives
- Improve student learning, interest, and retention

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Project has a three-year timeline with several checkpoints

Overall Timeline:

Pilot first modules	Fall 2021 / Spring 2022
Pilot second modules	Fall 2022 / Spring 2023

Each module also has its own timeline with checkpoints

Phase I: Development of materials

- Initial plan
- Outline
- LOs
- Summative assessment
- Check ins with assessment consultant
- GCI check in
- Review against rubric
- Revision to pass rubric
- Iterate

Phase II: Piloting

- Implementation notes
- GCI check in

Phase III: Post pilot revisions

- Outline
- More check ins
- Workshop / peer recommendations
- GCI and assessment consultant approval
- Prepare for publication

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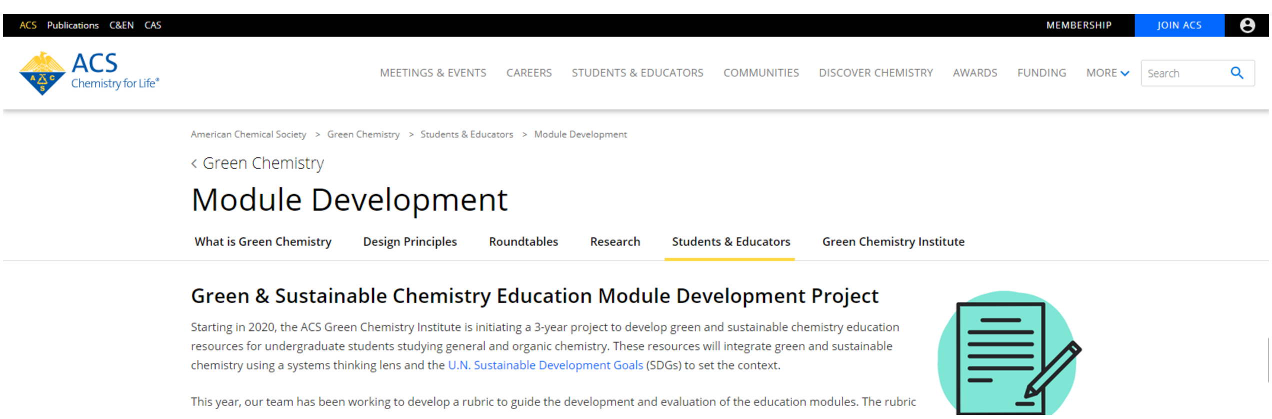
The module development page lists all participants

https://www.acs.org/content/acs/en/greenchemistry/students-educators/module-development.html



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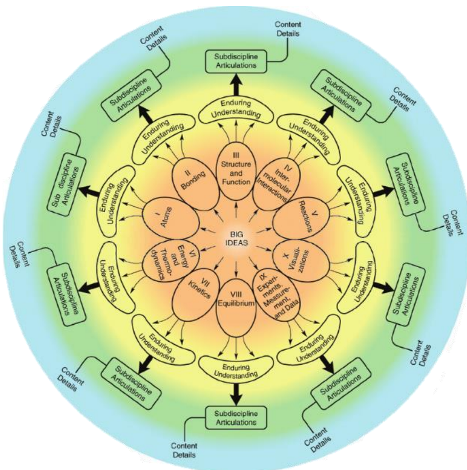
Connect foundational chemistry concepts to grand challenges



https://sustainabledevelopment.un.org/

Holme et al. J. Chem. Educ. 2020, 374.
Murphy et al. J Chem. Educ. 2012, 715.

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Green and Sustainable Chemistry Modules in Development

General Chemistry
electronic structure and periodic properties
stochiometry
intermolecular forces
gas laws
thermochemistry
equilibrium
electrochemistry

Organic Chemistry
functional groups
green chemistry principles in synthetic design
S_N1 and S_N2 reactions and organohalides
electrophilic aromatic substitution reactions
pericyclic reactions
acyl substitution reactions
polymer synthesis and degradation

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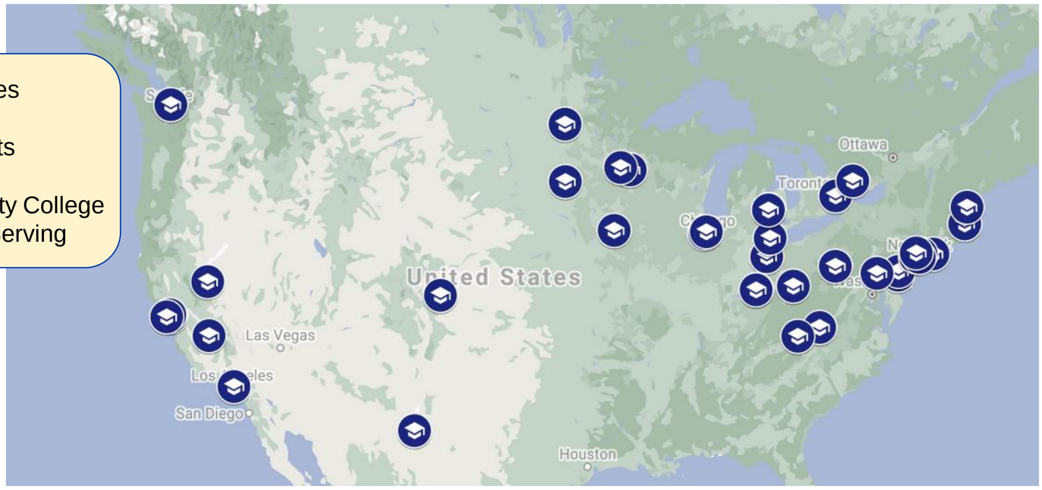
Institutional Diversity

Institution Types
- R1
- Liberal Arts
- PUI
- Community College
- Minority Serving



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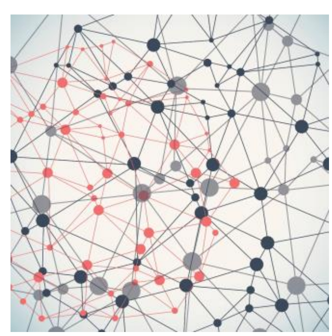
We were tasked with developing an intro module for the ACS-GCI systems thinking project

- It became apparent early on that instructors and students would want an intro to systems thinking

- **Our module aims to introduce:**
  - The overall concept of systems thinking
  - Key vocabulary
  - Common concepts and visualizations in systems thinking
  - How to apply systems thinking to chemistry topics



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We aim for our module to be useful to a wide variety of classroom settings

- Module is meant to be modular – can be applied to different classes, different points in the semester, and using the most relevant pieces
- Consistently use common terminology – builds the foundation for future systems thinking material
- Mixture of in-class and at-home activities
- Variety of activities – e.g., solo, small group, think-pair-share, guided worksheets, etc.
- Trying to emphasize relevance to chemistry
- Tied into sustainability and UN SDGs
- Connections to other classes (bio, phys, eng)
- Hope students will carry concepts throughout students' academic journeys – Gen Chem, Organic, etc.

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Units in our Introductory Module

1. What are systems and what is a systems thinking approach to complex phenomena?
2. Why Is systems thinking valuable in chemistry and in learning chemistry?
3. Spatial and temporal scales and system boundaries
4. Feedback loops
5. Stock-flow diagrams and systems dynamics models
6. Applying systems thinking to grocery bags: identifying environmental impacts and potential leverage points

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Unit 1: What are systems and what is a systems thinking approach to complex phenomena?

Learning Objective:
Define fundamental systems thinking terminology

Match the following terms with the definitions below and rate your level of confidence in your answers

A. System
B. Component
C. Coupling
D. Stock or reservoir
E. Emergent attribute
F. State
G. Reinforcing feedback loop
H. Flux or flow
I. Sink
J. Source
K. Perturbation
L. Balancing feedback loop
M. Boundary

1. ________ A set of elements or parts that is coherently organized and interconnected in a pattern or structure that produces a characteristic set of behaviors, often classified as its "function" or "purpose"
Confidence in this answer: ___Very high; ___ High; ___ Medium; ___ Low; ___ Very low

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Unit 2: Why is systems thinking valuable in chemistry and in learning chemistry?

Learning Objective:

Discuss how systems thinking guides chemistry in contributing to attaining the United Nations Sustainable Development Goals (UNSDGs)

https://sustainabledevelopment.un.org/

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UNSDG Activity

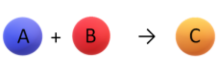
Example problems from the activity:

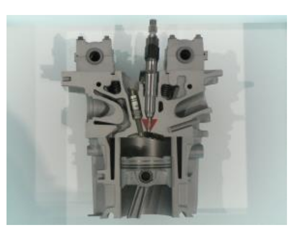
- Identify some components in the systems relevant to your assigned UNSDG
- Look at the targets for your assigned UNSDG. List 2-3 products, processes, or innovations that chemistry has contributed or could contribute to help reach targets for this UNSDG.
- Pick one of your answers to question 2 and describe how it connects to the system. Who would chemists need to work with to implement the product, process, or innovation?

https://sustainabledevelopment.un.org/

Unit 3: Spatial and temporal scales and system boundaries

Learning Objectives:
Identify what size and time scale is appropriate for a given problem or system
Identify how size scales apply to different fields in science





Molecules
Chemistry
What chemical reactions are involved in the formation of pollutants?

Fuel injector / cylinder
Physics / engineering
What geometry is best for the fuel nozzle to optimize fuel efficiency?

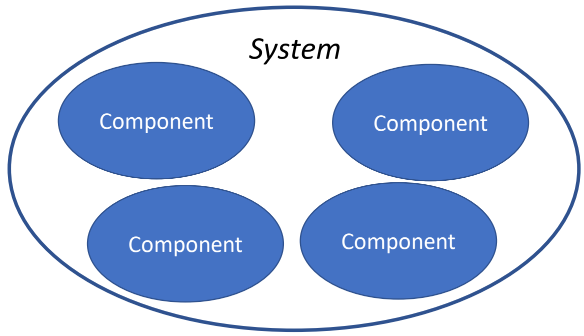
Engine
Physics / engineering
What temperature minimizes formation of harmful compounds?

Example Lecture Slide: Why boundaries are important

Learning Objectives:
Define system boundaries and explain how to set your system boundaries

When mapping out or diagramming a system, it is often tempting to include every imaginable component – you are modeling a complex topic after all!

However, it's important to define boundaries:
- Can focus on the problem in question
- Helps utilize proper expertise
- Reduces errors
- Saves time / effort
- Helps compartmentalize complex problems

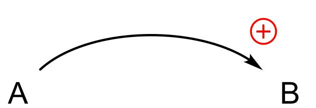


Unit 4: Feedback Loops

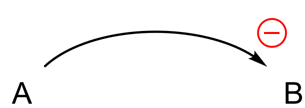
Learning Objectives:

Identify a feedback loop as being reinforcing or balancing

Analyze a causal loop diagram, including assigning link polarities



(+) polarity: a change in A causes a change in B in the same direction



(-) polarity: a change in A causes a change in B in the opposite direction

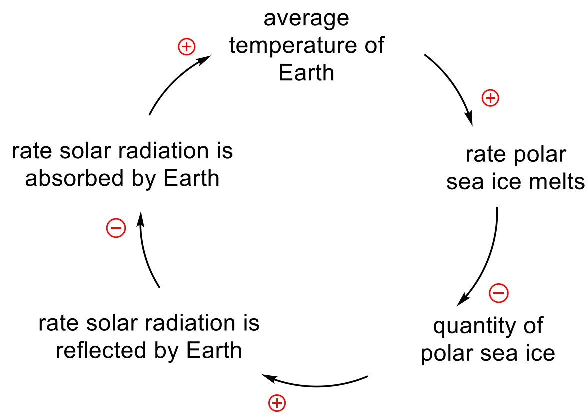
Polarity of linkers in causal loop digrams

Unit 4: Feedback Loops

Learning Objectives:

Identify a feedback loop as being reinforcing or balancing

Analyze a causal loop diagram, including assigning link polarities



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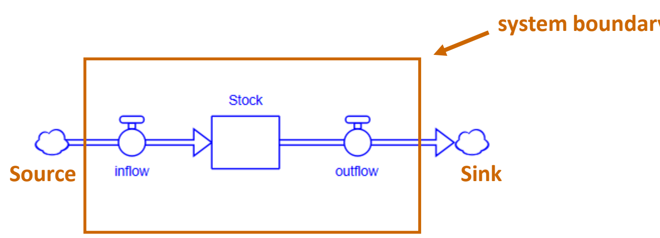
Unit 5: Stock-flow diagrams and systems dynamics models

Learning Objectives:

Identify stocks and flows in stock-flow diagrams, and identify appropriate units for them



Stock
the amount of mass, material, energy, or information that has accumulated over time

Flow
the rate that matter or energy moves; has units of amount per unit time

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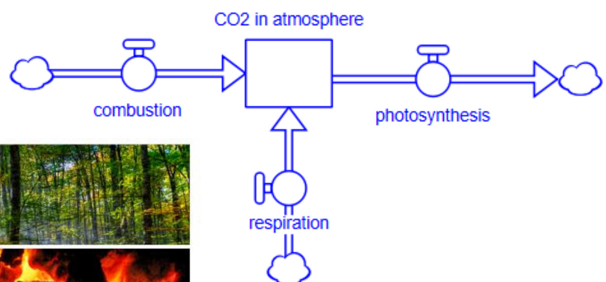
Unit 5: Stock-flow diagrams and systems dynamics models

Learning Objectives:

Identify stocks and flows in stock-flow diagrams, and identify appropriate units for them

https://deq.nc.gov/about/divisions/air-quality



https://earthobservatory.nasa.gov/features/CarbonCycle

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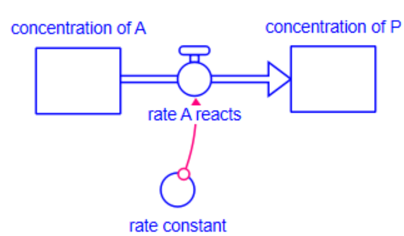
Unit 5: Stock-flow diagrams and systems dynamics models

Learning Objectives:

Explain what a systems dynamics model is, what its output is, and how it could be useful

Explain how the progress of a chemical reaction can be modeled using a systems dynamics model



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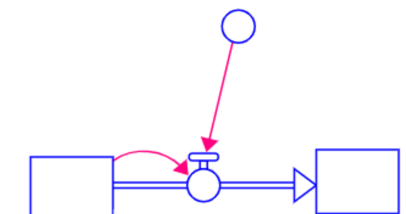

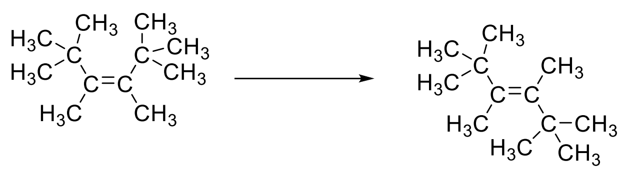

Z alkene   E alkene

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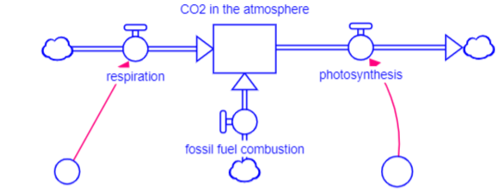
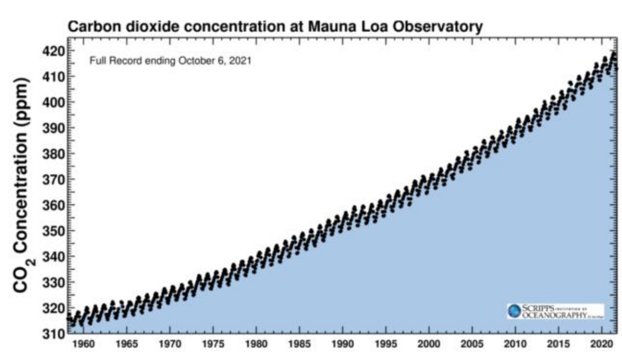
Unit 5: Stock-flow diagrams and systems dynamics models





https://keelingcurve.ucsd.edu/

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Unit 6: Applying Systems Thinking to Grocery Bags: Identifying Environmental Impacts and Potential Leverage Points

Learning Objectives:

Apply concepts from these introductory units to analyze the life cycle of three different types of grocery bags.

Identify potential chemical products or processes and changes in individual or societal behavior that could reduce environmental impacts of grocery bags.

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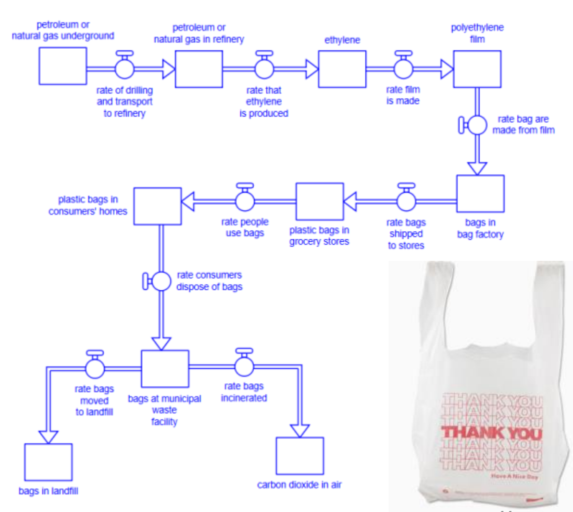
Unit 6: Applying Systems Thinking to Grocery Bags

Energy is used in gathering raw materials, carrying out industrial processes, and transporting goods between locations. Likewise, waste / pollution / greenhouse gases which can affect air and water quality are produced throughout the life cycle.

- Describe how energy is used in three specific steps in the diagram.
- Identify waste / pollution / greenhouse gases produced by three specific steps in the diagram.

Recycling and reusing are not depicted in the diagram. Add stocks and/or flows (i.e., boxes and/or arrows) to show what happens to a bag if it is reused or recycled.



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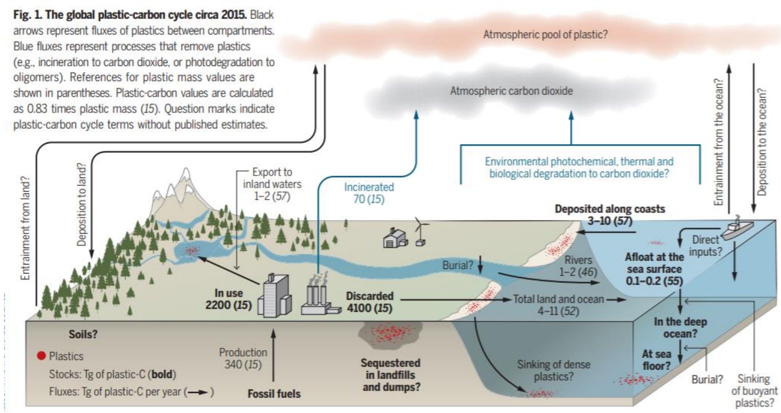
https://www.lowes.com/

Unit 6: Applying Systems Thinking to Grocery Bags



Stubbins et al Science 2021, 373, 51.

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Approach to Assessment

Formative assessments: mix of activities using multiple modalities: individual, small group, in class, at home, guided inquiry, self-reflection

Summative assessments: mostly exam questions – MC and free response. Working on “rubric” for answers

Challenges:

- Want to assess learning objectives centered on systems thinking, but do not want to lose sight of chemistry
- Difficult to build assessments when it is unclear when during the semester the module will be used

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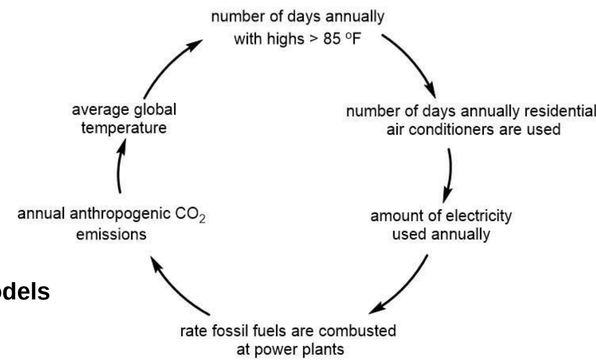
Assessment Question Examples

Unit 1: terminology; what is a systems thinking approach
Say that you have a vegetable garden, and the productivity of it is much lower this year than it was last year. Describe a reductionist approach to figuring out why productivity decreased? Describe a systems thinking approach to figuring out why productivity decreased?

Unit 4: feedback loops and causal loop diagrams
Indicate the polarities (plus or minus) for each of the linkers. Explain your reasoning for each. Indicate if this loop is balancing or reinforcing.



Unit 5: stock flow diagrams and systems dynamics models
Label each of the following as a stock or a flow.
a. Concentration of CO_2 in the atmosphere
b. Amount of methane in the Marcellus Shale
c. Annual increase in atmospheric CO_2 concentration
d. Temperature of a reaction flask

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Piloting of the Module

Connecting chemistry content to global challenges engaged students

Time pressures when adding additional content

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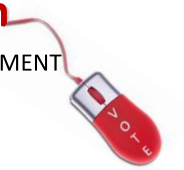
Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



Which do you think is the GREATEST potential benefit of a systems thinking approach in foundational chemistry classes?

- Make students aware of chemistry's role and potential role in solving grand societal challenges
- Increase motivation to learn chemistry content
- Better able to see connections between chemistry and other disciplines
- Increased focus on critical thinking and problem solving
- Other (Let us know more in the questions window!)

** If your answer differs greatly from the choices above tell us in the chat!*

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Stony Brook University
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Suggested Resources

Journal of Chemical Education Special Issue, December 2019
Reimagining Chemistry Education: Systems Thinking, and Green and Sustainable Chemistry

ACS Webinars
https://www.acs.org/content/acs/en/acs-webinars/technology-innovation/systems-thinking.html
https://www.acs.org/content/acs/en/acs-webinars/popular-chemistry/rethink.html

ACS CPT Supplement on Green Chemistry in the Curriculum
https://www.acs.org/content/dam/acsorg/about/governance/committees/training/acsapproved/degreeprogram/green-chemistry-in-the-curriculum-supplement.pdf

Orgill, M.; York, S.; MacKellar, J. Introduction to Systems Thinking for the Chemistry Education Community. *J. Chem. Educ.* **2019**, *96*, 2720−2729. (DOI: 10.1021/acs.jchemed.9b00169), available open access.

Meadows, D. (2008) *Thinking in Systems: A Primer* (ISBN 13: 978-1603580557)

Stubbins, A,; Law, K. L.; Muñoz, S.E.; Bianchi, T.S.; Zhu, L. Plastics in the Earth System. *Science* **2021**, *373*, 51. (DOI: 10.1126/science.abb0354)

Samon, S.; Levy, S. T. Interactions Between Reasoning About Complex Systems and Conceptual Understanding in Learning Chemistry. *J. Res. Sci. Teach.* **2020**, *57*, 58. (DOI: 10.1002/tea.21585)

Jackson, A.; Hurst, G.A. Faculty Perspectives Regarding the Integration of Systems Thinking into Chemistry Education. *Chem. Educ. Res. Pract.* **2021**, *22*, 855. (DOI: 10.1039/d1rp00078k)

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26th ANNUAL
GREEN CHEMISTRY & ENGINEERING CONFERENCE
Thinking in Systems: Designing for Sustainable Use
June 6-8, 2022 / Reston, VA, USA

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In order to highlight the importance of this approach to chemistry and engineering and to facilitate critical discussions on these topics, the theme of each GC&E Conference focuses on one of the stages of the chemical life cycle; put simply: **Design, Make, Use, and Closing the Loop.**

Key Dates

- **January 3, 2022**: Call for Abstracts opens
- **February 14, 2022**: Call for Abstracts closes
- **February 15, 2022**: Early Registration & Housing Open
- **April 30, 2022**: Early Registration Closes
- **May 1, 2022**: General Registration Opens
- **May 14, 2022**: Housing Deadline
- **June 6-8, 2022**: Conference

Join us June 6-8, 2022

The 26th Annual Green Chemistry & Engineering Conference will be held in Reston, Virginia, June 6-8, 2022. For virtual participants, we will be offering a selection of online sessions both prior to and during the conference.

Early registration opens on February 15, 2022.

Early Bird Registration		Regular Registration		Virtual Registration	
Feb. 15 – April 30		May 1 – June 8		Feb. 15 – June 8	
Full	$575	Full	$675	Regular	$50
One Day	$295	One Day	$375	Student*	$25
Student*	$200	Student*	$250		

*Student registration includes all full-time students.

Full Registration provides full access to all in-person technical sessions, receptions, meals, and networking events (except ticketed events), plus all virtual content.

One-Day Registration provides full access to one day of the in-person conference plus all virtual content.

Virtual Registration provides access to a selection of content that will be provided via live stream in advance of and/or during the conference.

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Associate Professor, Department of Chemistry, Stony Brook University

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DAVID CONSTABLE
Science Director, Green Chemistry Institute, American Chemical Society

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Date: Wednesday, November 17, 2021 @ 2-3:30pm ET
Speakers: Stephanie Vivod, NASA John H Glenn Research Center and Christopher Wohl, NASA Langley Research Center
Moderator: Sadeq Malakooti, NASA John H Glenn Research Center

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What You Will Learn:

- How copoly (carbonate urethane) materials can create reusable materials applications
- Surface engineering of existing and novel polymers that will mitigate lunar dust adhesion
- The exciting future of polymer aerogels for space exploration

Co-produced with: ACS Division of Polymer Chemistry

Date: Thursday, November 18, 2021 @ 2-3:15pm ET
Speaker: Elizabeth Tomasino, Oregon State University
Moderator: Brian Guthrie, Cargill

Register for Free!

What You Will Learn:

- What are the compounds associated in smoke and smoke taint in wine
- How smoke taint compounds end up in wine
- How individuals perceive the aroma and flavor of smoke

Co-produced with: ACS Division of Agricultural & Food Chemistry

Date: Thursday, December 2, 2021 @ 2-3pm ET
Speakers: Javier García Martínez, IUPAC and Rive Technology / Laura-Isobel McCall, University of Oklahoma / Diego Solis-Ibarra, Universidad Nacional Autónoma de México / Corinna Schindler, University of Michigan
Moderators: Jessica Marshall and Mitch Jacoby, Chemical & Engineering News

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- What were the hottest trends in chemistry research during 2021, according to the experts
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