Do You Want Fries with That?
Learning about Connection Circles:
The Shape of Change

The text of
Lesson 10: Do You Want Fries with That?
Learning about Connection Circles
From the books

The Shape of Change
and
The Shape of Change: Stocks and Flows

By Rob Quaden and Alan Ticotsky
With Debra Lyneis
Illustrated by Nathan Walker
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The Shape of Change

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http://www.clexchange.org

milleras@clexchange.org.

Introduction

Connection circles are thinking tools designed to help students understand complexity. Using connection circles as graphic organizers, students focus their attention on a problem and generate ideas about its causes and possible solutions. As in previous lessons, students identify *what* is changing and describe *how* it is changing. In this lesson, they begin to think about *why* it is changing. They trace cause and effect relationships to uncover feedback loops that underlie the problem. [1]

In this lesson, students use connection circles to examine an article about the health risks associated with rising French fry consumption. Any story about something that changes over time, fiction or nonfiction, can be analyzed with a connection circle. The topics students study are complex and often difficult to understand; seldom is an issue as simple as it appears on the surface. Connection circles help students delve into a problem and manage a number of different ideas at once. [2]

> You may find it helpful to read another example of a connection circle.
>
> Lesson 11: Keystone Species in an Ecosystem, Using Connection Circles to Tell the Story
>
> Available on-line at www.clexchange.org or in ***The Shape of Change*** (2008)

Materials

- Overhead projector or display board
- Several different colored pens or markers for each student
- Connection Circle template for each student (page 17)
- Posted copy of Connection Circle Rules (page 18)
- Copies of "Eyes on the Fries," by Rene Ebersole, in *Current Science*, March 1, 2002, reprinted with permission in ***The Shape of Change*** (2008) beginning on page 135.

How It Works

The purpose of a connection circle is to help students focus on the problem presented by the author and to uncover its causes. Here is a quick overview:

- First, students briefly define the problem: What is the author concerned about? What is the main point or problem? *What* is changing over time?
- Next, *how* is it changing? In a few words, or using a quick behavior over time graph sketch, students describe how the problem is increasing or decreasing over time.
- Finally, students look for elements in the story that contribute to the problem. They use a connection circle to organize their thoughts, find cause and effect relationships, and trace the feedback loops that tie them together to explain *why* the problem occurs.

Procedure

1. Choose a story to read with students. The piece may be a newspaper or magazine article, a book chapter, or a work of fiction. It should address an issue that is increasing or decreasing over time. For this lesson, we will examine the article "Eyes on the Fries" by Rene Ebersole, which is reproduced for your convenience beginning on page 135 of ***The Shape of Change*** (2008).[3]

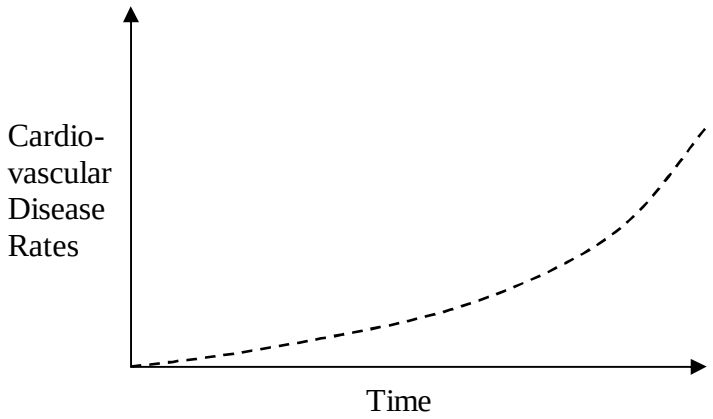
2. Create teams of four students each. Although this structure is not necessary for the steps of the lesson, we have found that collaborative conversations improve student thinking. Ask students to read the article – independently, shared orally in groups, or aloud as a class.

3. **What's the problem?** *What* is changing over time? As a class, briefly identify the main problem the author is presenting. Students may say, "People are worried that cardiovascular disease is rising;" or, "People are getting fatter and fatter eating too many French fries." Help students distinguish the central problem from other details like the recipe for French fries or the characteristics of oils, factors that do not increase or decrease over time.

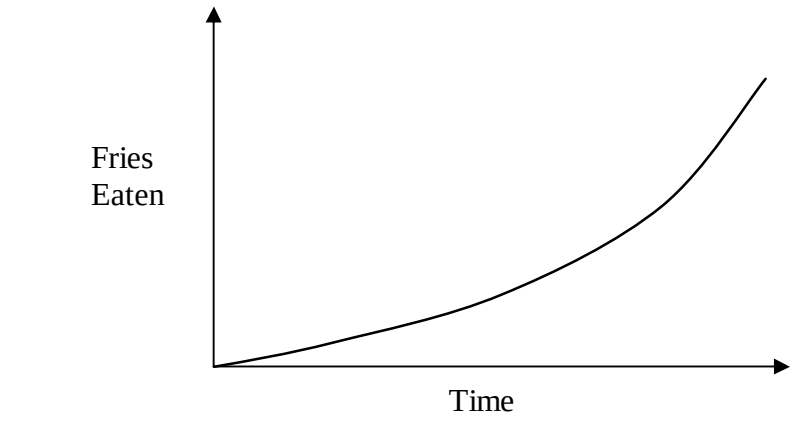
4. After quickly identifying the problem, ask students to think about *how* it is changing. The author says that the number of people with cardiovascular disease is rapidly growing over time. So are the number of obese people, the number of McDonald's restaurants and the consumption of French fries.

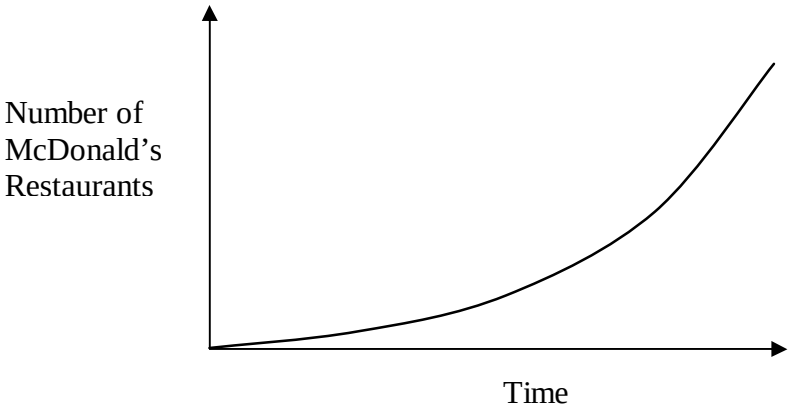
If students are familiar with behavior over time graphs, ask them to sketch *how* the problem is changing – just as they did in the Infection Game and the Tree Game (see these and other lessons in ***The Shape of Change*** for explanations and examples of behavior over time graphs). The idea is to further sharpen their focus on the problem by defining it in terms of *change over time*.

Students might suggest graphs like these:



A behavior over time graph is just a rough sketch of the pattern of behavior.





5. Give each student a copy of the Connection Circle template (page 129) and briefly explain the next step in the following Connection Circle Rules. (For a larger copy of the rules to post in your classroom as a reference see page 18.).

CONNECTION CIRCLE RULES

1. What's the problem: *What* is changing? *How* is it changing?
2. Choose elements of the story that satisfy ***all*** of these criteria:
   - They contribute to the problem.
   - They are nouns or noun phrases.
   - They increase or decrease over time.
3. Write your elements around the circle. Include no more than 5 to 10.
4. Find elements that cause another element to increase or decrease.
   - Draw an arrow *from* the cause *to* the effect.
   - The causal connection must be direct.
5. Look for feedback loops. Tell their story.

6. Look for elements in the story that relate to the problem and its possible causes. They must be variables that increase or decrease over time, expressed as nouns or noun phrases.

Keep a focus on the problem and its causes. For example, the author describes the McDonald's recipe for French fries and the properties of various frying oils. While these details are interesting, they are not things that increase or decrease over time, and, except for the effect of saturated fat on cholesterol levels, they do not directly contribute to the problem of increasing cardiovascular disease.

Precise Language Is Important in Naming Elements

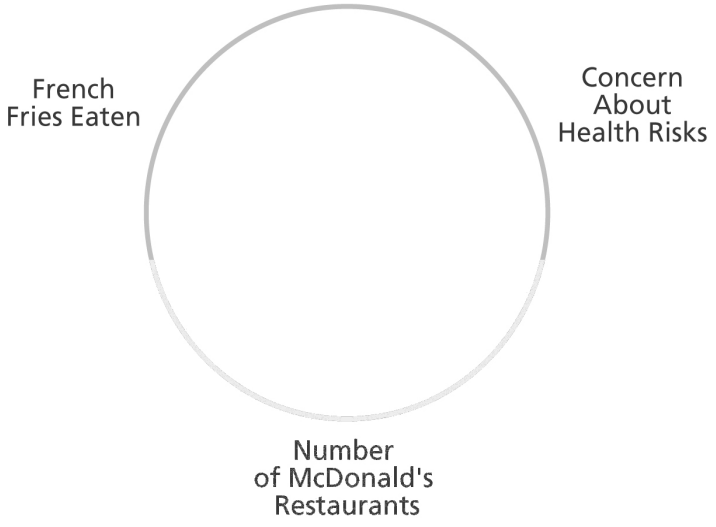
Throughout the lesson, guide the discussion to be sure that students are specific in their language. "French fries" figure prominently in the story, but that label is too vague. A more useful label to show the change in quantity might be "French fries sold" or "French fries eaten." Similarly, "McDonald's" is a major topic of the article, but what quantity about McDonald's might change? Phrases such as "number of McDonald's restaurants" and "McDonald's profits" more accurately describe factors in the story that cause change to occur.

Do not use words like "more" or "less" in the titles.

Elements may be tangible, like "number of restaurants," or intangible, like "concerns about health risks" or "desire to change the law." Often intangible elements are keys to the changes.

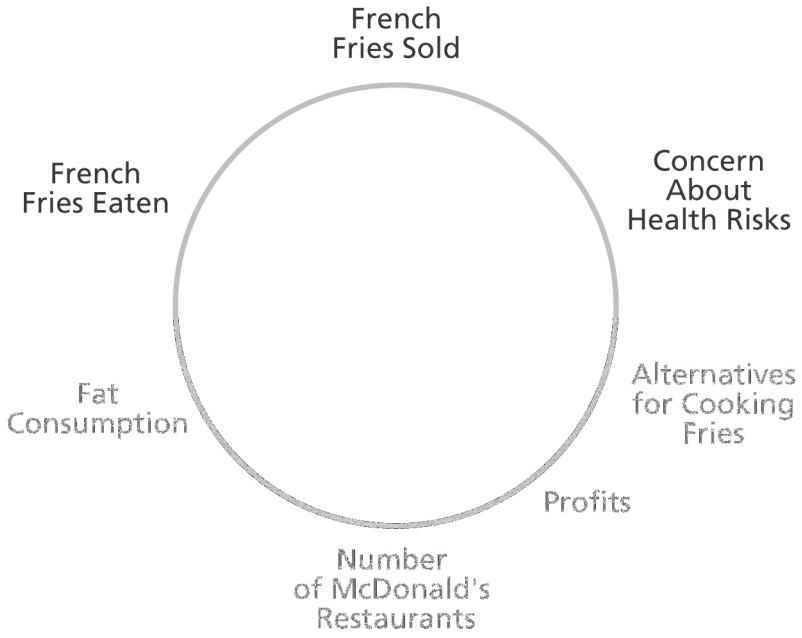
Precise language and clear thinking go hand in hand in using connection circles.

7. As a class, brainstorm two or three elements, and ask students to write them around the outside of their connection circles. Draw a connection circle on the board or overhead to use as a class example. Below is the beginning of one connection circle for "Eyes on the Fries." Student suggestions will vary.



8. Allow students time to continue adding elements to their circles as they talk in teams. Encourage dialogue among student teams, but ask each student to draw an individual connection circle. Connection circles may vary within a team. The words around each circle do not have to be the same nor in the same order, but they should all be things that work together to contribute to the problem.

9. Start a class discussion by asking volunteers from each team to suggest elements for the sample class circle. Students may add or delete elements from their circles as they hear the ideas of others. Although the class may suggest and discuss many different elements, the final circles should have *no more than five to ten elements.* That way, students begin to clarify their language and their thinking about what is happening and why. The circle below shows an example of one way to represent elements from "Eyes on the Fries."

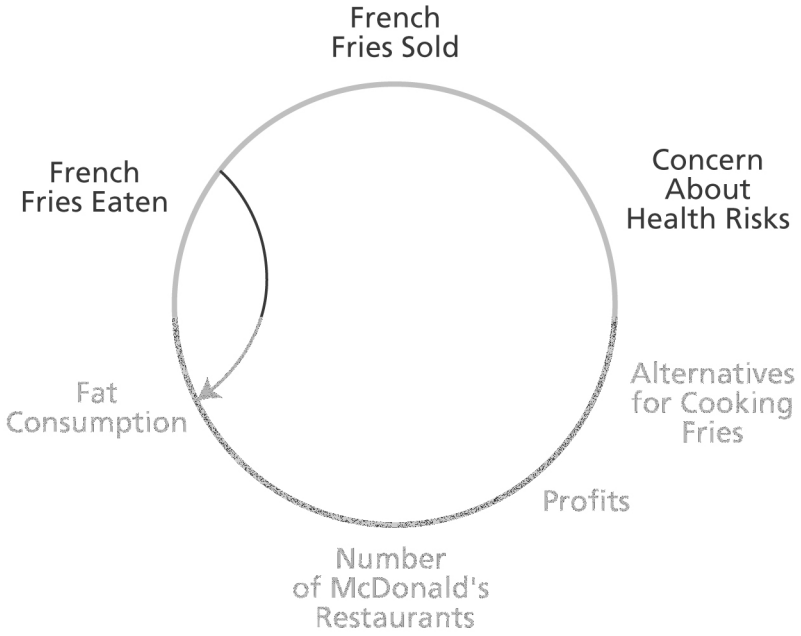


As students refine their mental models,
they are always free to change, add or erase elements around their circles.
The thinking process is important – not just the product.

10. Ask a volunteer to describe a causal connection between two of the elements around the connection circle.

? Does an increase or decrease in one of the elements *cause* an increase or decrease in another element? For example, as the number of French fries eaten increases, it *causes* fat consumption to also increase.

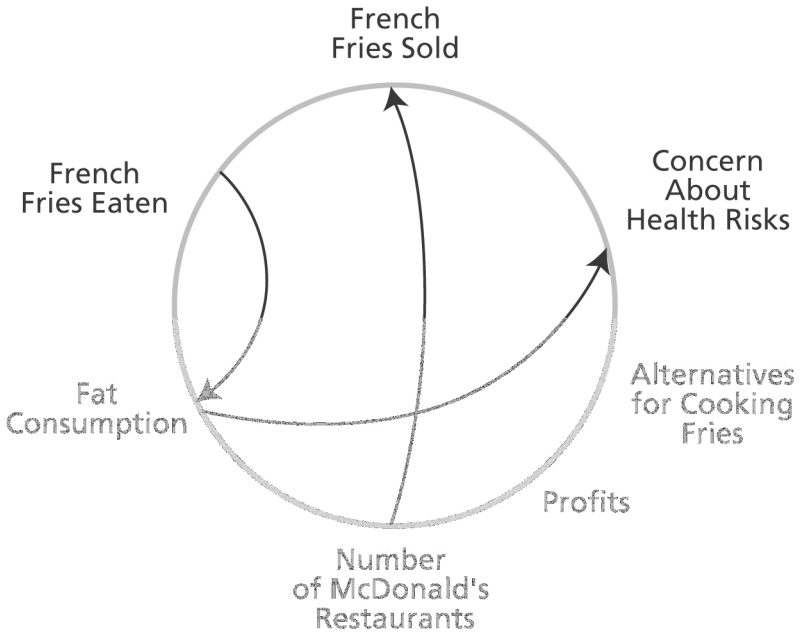
? To represent this statement, draw an arrow *from* "French Fries Eaten" *to* "Fat Consumption." Be sure the arrowhead points *to* "Fat Consumption" as shown – *from* the cause *to* the effect.



Remember these are examples only.
Student work will vary in the elements chosen and their placement around the circle.
Let students generate their own circles to explore and refine
their own mental models.

Here are two other possible connections shown in the next circle below:

- ? An *increase* in "Fat Consumption" can cause an *increase* in "Concern about Health Risks."
- ? An *increase* in the "Number of McDonald's Restaurants" will likely cause an *increase* in "French Fries Sold."



Students like using connection circles to figure things out. It may appear complicated at first, but after one class demonstration, students are usually ready and able to use the tool to tackle problems in a wide range of applications.

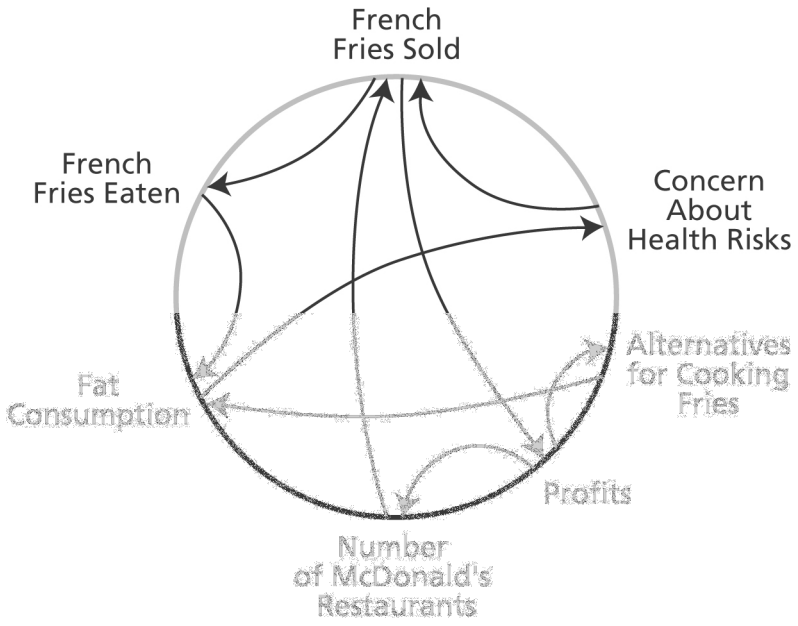
The Connection Circle Is a Thinking Tool

The goal of using this tool isn't to find one specific connection circle that will correctly describe a given topic or article. Rather, the circle is designed to generate ideas and connections, and to clarify our thinking about the underlying causes of complex issues. Connection circles help us brainstorm about what is changing and to trace webs of causal relationships within systems to understand those changes. The connection circle examples in this chapter demonstrate one way to interpret "Eyes on the Fries," but they are not the only way.

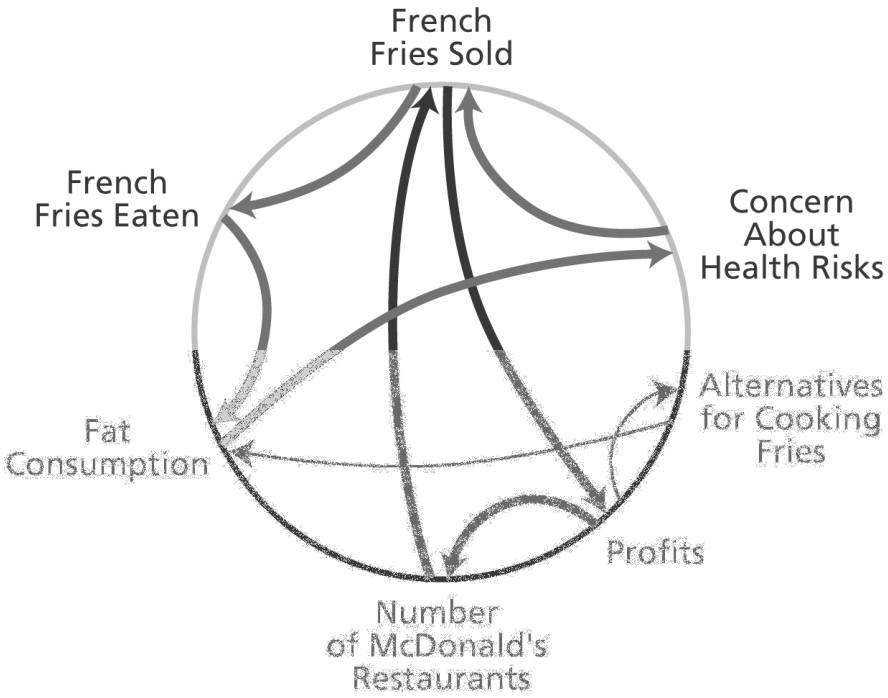
11. Let students work in teams to connect the elements in their connection circles.
    - Emphasize that elements are not limited to one connection, and that some elements may not have any connections. (Students will eventually discover that some of their elements are central to the problem while others are not as important as they expected).
    - Students should be prepared to state explicitly how and why the arrow connections work. For example, in our sample connection circle, an arrow leads from "Fat consumption" to "Concerns about health risks." Here's the reasoning: an *increase* in fat in a person's diet causes an *increase* in susceptibility to higher cholesterol levels, obesity, and other conditions detrimental to well being.

Here is a sample of a complete connection circle with causality arrows drawn. Notice that arrows frequently cross, making the diagram somewhat confusing to follow. Connection circles begin as brainstorming tools and can get messy.

However, *do not stop here*. Keep going to help students make sense out of their confusing "spaghetti plates" of connections.



12. After students have had a few minutes to draw their arrows, ask them to search their circles for paths that make a closed loop. In other words, can they begin at one element of the circle, follow connecting arrows to other elements, and end up back at their starting point, as shown below? Focusing first on the elements with the most connections, students trace each loop in a different color.



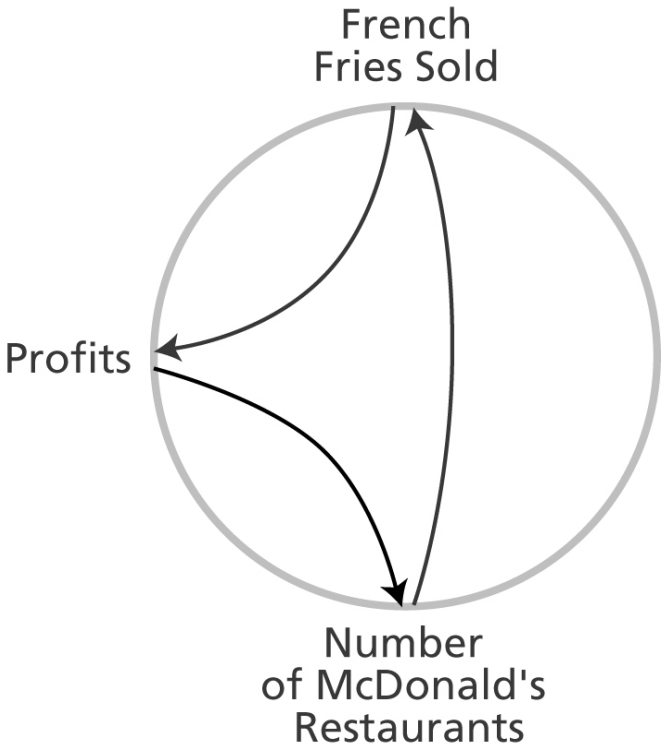
Closed pathways are called feedback loops.
Tracing the causal links around the loop, a change in one element comes back to effect that element again, and around again.

Uncovering the causal loops extracts meaning from the confusing circle diagrams.
*The loops explain the **causes** of the problem.*

Do not skip these steps.

Ask students to draw each closed loop separately and tell the story of that loop. Here is an example from our sample connection circle.

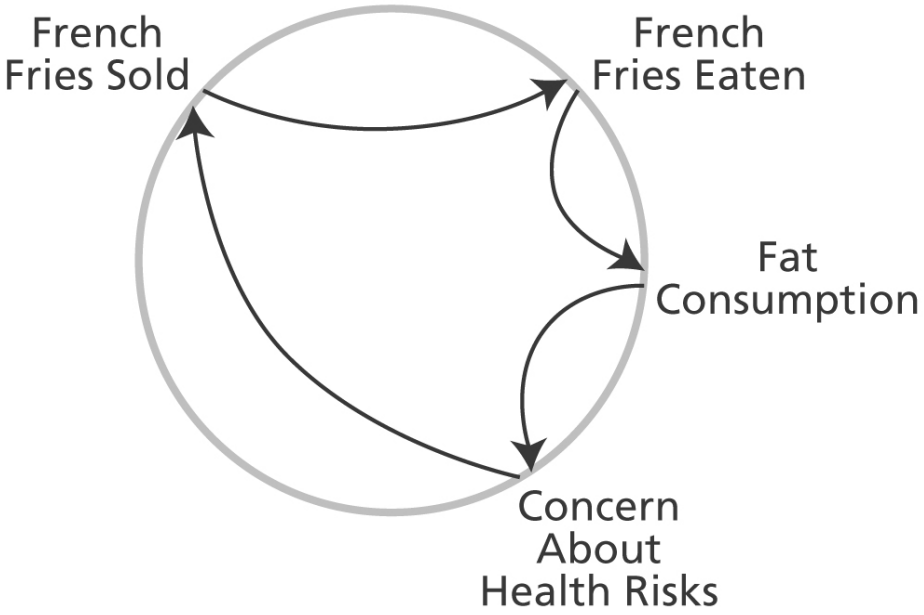
- An *increase* in the number of French fries sold causes an *increase* in profits which can be used to open *more* restaurants. An increase in restaurants causes an *increase* in French fries sold, and the loop begins again, ***reinforcing*** itself each time around.



Students may use circle templates to draw their closed loops at first,
but soon they will be quickly drawing the loops freehand without the underlying circles,
as shown at the end of the lesson.

13. Distribute a blank overhead transparency sheet to each team. Assign one student in each group to draw a feedback loop on the sheet and prepare to share it with the class. Resume the class discussion with a representative of each team describing the feedback loops and sharing the group's thinking.

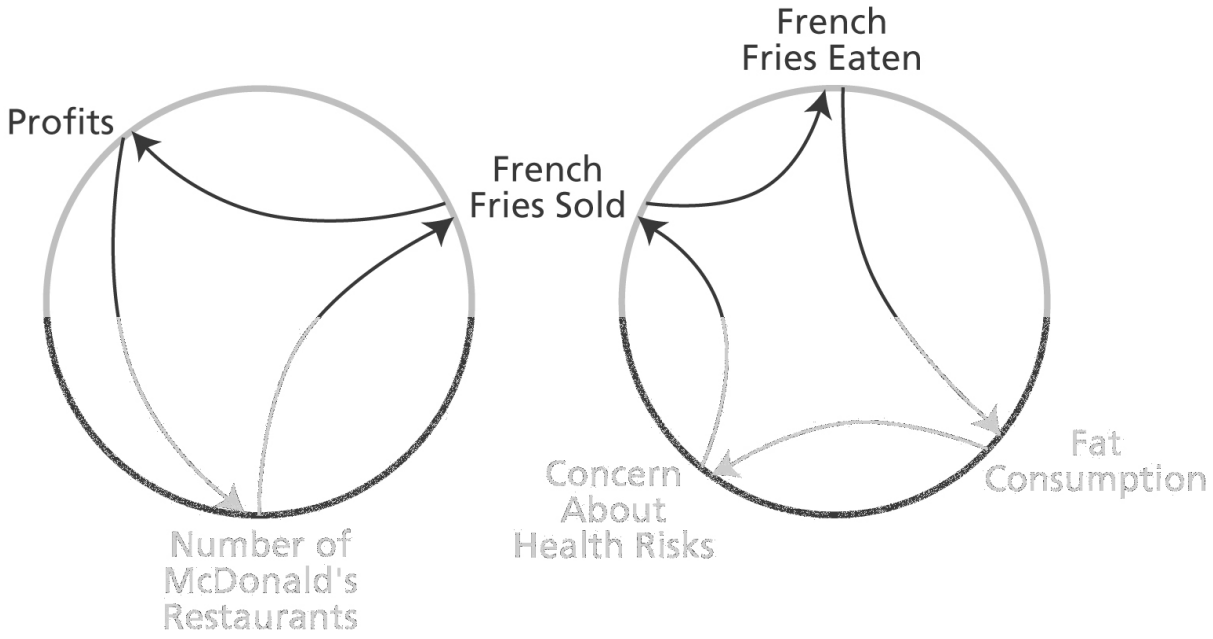
Another feedback loop from our sample connection circle is drawn below.



In this loop, an *increase* in fries sold causes an *increase* in fries eaten. That causes an *increase* in fat consumption which in turn *increases* the level of concern about health. When concerns grow sufficiently, it causes sales of fries to *decrease* as customers try to eat more healthy foods. Continuing around the loop again, fewer fries sold causes fewer eaten and consequently less fat consumed. A drop in fat consumption *decreases* people's health concerns. With fewer health concerns, French fry sales *increase* again, sending the loop around again with changes reversing.

This feedback loop is ***self-balancing***. Tracing around the loop, an initial increase in one element comes back around to cause a decrease in that element, balancing back and forth each time around the loop.

14. When the work of each team is displayed, challenge students to discover loops that share a common element. In our sample connection circle, "French fries sold" appears in at least two feedback loops. As students talk their way around the loops, they will be describing the changing behaviors of the elements in the story. The diagram below shows two intersecting feedback loops drawn together.



As students uncover feedback loops in their connection circles, they are surprised to find that many changes are interdependent and simultaneous. They are beginning to make sense of complexity.

Mental Models

Everybody needs a way to make sense of the world. You could say that we build "mental models" of the way things work. Reading comprehension strategies are often tools to help build mental models of the author's message and the ideas presented. A connection circle works in this way by constructing pathways of causality. We reason out how and why things changed – this increased, causing a second thing to increase, which caused the first thing to decrease, and so on. Lots of elements can be changing at one time or in some sequence that isn't linear, and the connection circle can represent that.

Bringing the Lesson Home

The purpose of a connection circle is to uncover the causal loops that explain *why* the problem occurs. Give students a chance to reflect on what they have learned.

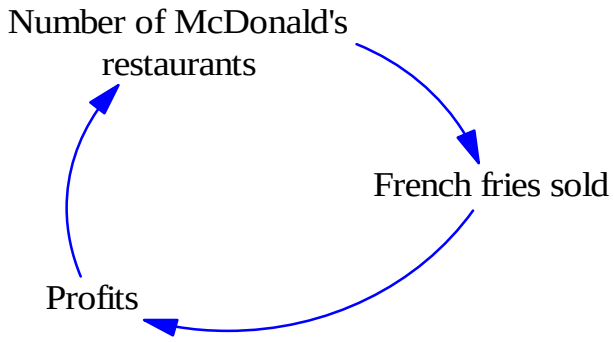
? How has your perception of the problem changed?

Ask students to reflect on how they originally viewed the problem and how their thinking has changed. In the process of developing their connection circles, students are often surprised to discover that a problem does not have simply one cause. Instead, problems and their solutions arise out of interdependent webs of causes and effects. With connection circles and feedback loop diagrams, students can begin to probe and appreciate this complexity in the systems around them.

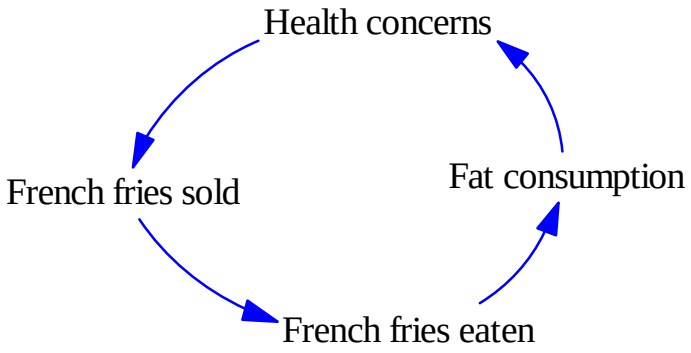
? What does it mean when a pathway of arrows leads back toyour starting element?

When an arrow pathway loops back to the original element, there is feedback in the story. Each closed loop is a feedback loop. When one element in the loop changes, the effect ripples through the whole loop, affecting the original element as well.

For example, as the number of restaurants goes up, the amount of French fries sold also goes up. That causes profits to increase which will tend to increase the number of restaurants being opened, starting the process again. This is a ***reinforcing loop,*** *commonly known as a vicious or virtuous cycle.*



*Another kind of feedback loop is a **balancing loop**. In contrast to a vicious cycle, a balancing loop does not spiral in the same direction, but rather see-saws back and forth. For example, "French fries sold" increases "French fries eaten." That leads to more fat consumption and on to greater health concerns. If health concerns grow strong enough, French fry sales will be driven down. Trace the loop around a second time and notice what happens to the change among the elements.*



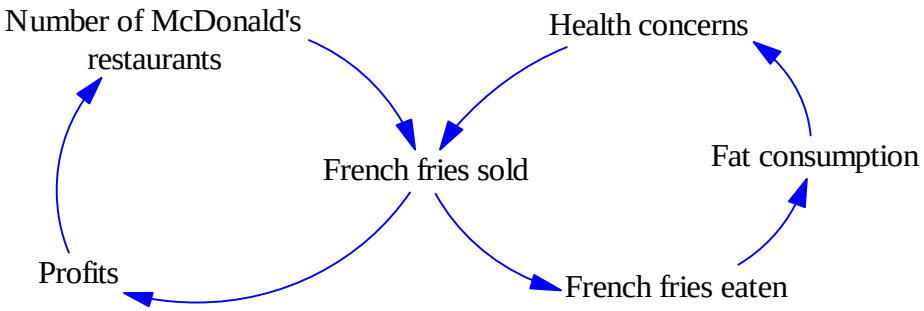
When concern grows strong enough, the number of French fries sold decreases. The number of French fries eaten goes down, fat consumption is reduced, and eventually concerns lessen. With less concern about health, people will buy more French fries again.

*There are two kinds of feedback loops: **reinforcing loops** and **balancing loops**.*

*(For much more on how these feedback loops work see all of the other lessons in **The Shape of Change** and their extensions in our next book, **The Shape of Change, Stocks and Flows**, both available from the Creative Learning Exchange.[4])*

? What happens when elements from the connection circle are in more than one feedback loop?

The loops will interact in ways that make the behavior interesting, and often quite complex. As demonstrated in the previous paragraph, the sale of French fries creates profits but also creates health concerns. Profits increase the number of restaurants, and more restaurants mean more French fries are sold. But, meanwhile, health concerns tend to reduce the number of French fries sold. The loops push in different directions, causing tension and complexity in the story, as shown on the next page.



Although it is not always possible to do, identifying multiple feedback loops usually brings the reward of deeper insights. There are seldom simple answers to real world problems. Connection circles can help us understand change more clearly.

? Can students add other loops to their diagrams?

Yes. As they tell the story of their causal loop diagrams, ask student to think about which loops might be the most important driving forces and also which other loops might be missing. For example, in exploring solutions to the problem, students may want to consider the effects of alternative fats on cardiovascular illness and related health concerns. Use the diagram as a springboard for discussion.

? Can students draw causal loop diagrams like these without using connection circles?

Yes. The purpose of a connection circle is to help students uncover the feedback loops that are causing the problem. With practice, students can learn to focus on the problem, identify contributing factors, trace feedback loops in their connection circles, draw them separately freehand, and use the loops to explain why the problem occurs. Eventually we hope that they can find the feedback loops in a story without using connection circles at all.

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[1] We have revised our earlier explanation of connection circles in this third edition of ***The Shape of Change*** to make the purpose more clear. Readers can find more about this lesson and its next steps in our second book, **The Shape of Change, Stocks and Flows**(2007), also available from the Creative Learning Exchange.

[2] The connection circle was conceived by Julia Hendrix, a fifth grade teacher in Carlisle, Massachusetts when she used the circle in the Connections Game (Lesson 9) as a template for examining causal connections in a story. Alan Ticotsky and Rob Quaden have since adapted and refined the method and application of the tool to help students probe causality and feedback in a range of complex systems.

[3] "Eyes on the Fries," by Rene Ebersole, appeared in the student magazine *Current Science*, March 1, 2002. It is reproduced by permission beginning on page 135 of ***The Shape of Change*** (2008).

[4] Quaden, Ticotsky, and Lyneis, ***The Shape of Change*** (revised 2008) and ***The Shape of Change, Stocks and Flows*** (2007), available from the Creative Learning Exchange at www.clexchange.org.

Name_____

Connection Circle Template

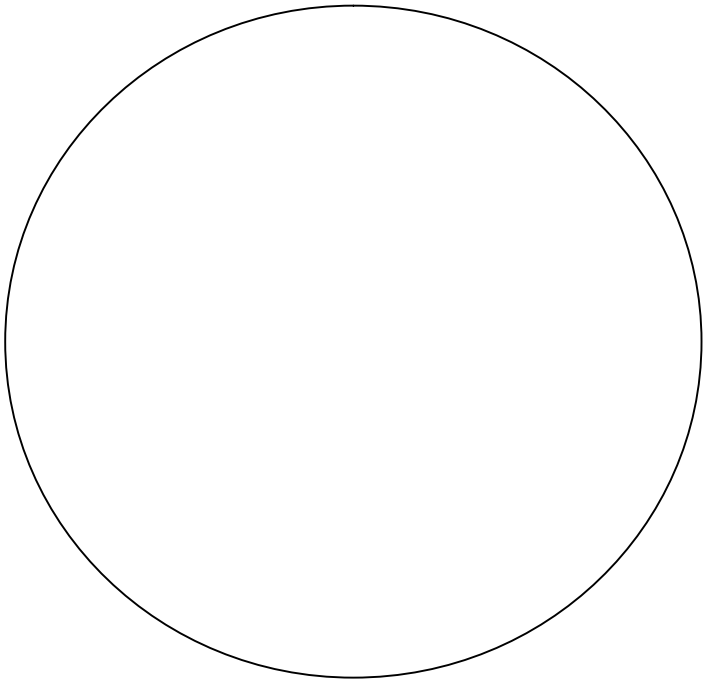
1. What's the problem: *What* is changing? *How* is it changing?

2 Choose elements of the story that satisfy ***all*** of these criteria:
   - They contribute to the problem.
   - They are nouns or noun phrases.
   - They increase or decrease in the story.

3. Write your elements around the circle. Include no more than 5 to 10.

4. Find elements that cause another element to increase or decrease.
   - Draw an arrow *from* the cause *to* the effect.
   - The causal connection must be direct.

5. Look for feedback loops. Tell their story.



Connection Circle Rules

1. What's the problem:
   What is changing? *How* is it changing?

2. Choose elements of the story that satisfy ***all*** of these criteria:

   They contribute to the problem.
   They are nouns or noun phrases.
   They increase or decrease in the story.

3. Write your elements around the circle.
   Include no more than 5 to 10.

4. Find elements that cause another element to increase or decrease.

   Draw an arrow *from* the cause *to* the effect.

   The causal connection must be direct.

5. Look for feedback loops. Tell their story.

*All of the lessons in **The Shape of Change, Stocks and Flows** build directly on classroom activities and lessons presented in **The Shape of Change**, also by Quaden, Ticotsky and Lyneis (2004), available from The Creative Learning Exchange. These lessons also build on one another sequentially.*

The Shape of Change

In Lesson 10 of ***The Shape of Change***, students learned how to use a connection circle to analyze an article about rising obesity rates and increased fast food consumption. After identifying key variables and the causal links among them, they traced the causal loops that drive the system. See Pages 103-116 in ***The Shape of Change*** for the full lesson.

About Connection Circles

A connection circle is a handy graphic organizer that helps students understand the main ideas in their reading. For us, however, the connection circle has a much broader purpose in our endeavor to heighten students' awareness of the causes of change all around them. We'd like to expand our original explanation to make our purpose more clear.

The purpose of a connection circle is to uncover the causal loops that could be causing the problem we have observed. That means that there are two essential elements: a problem behavior pattern and the causal loops driving it.

? **The Behavior: What's the Problem?**
After students have read the article, ask them to identify briefly the problem that the author is presenting. In this case, they might say, "People are getting too fat and cardiovascular disease is rising," or, "People are eating more and more French fries."

Try to identify what is increasing or decreasing over time, and if possible, sketch a very rough behavior over time graph of a variable or two. The graph serves to focus attention on the problem behavior, just as we have done in our previous lessons. It is a very quick rough sketch of the pattern of behavior that we are trying to understand. The graph shows us *what* is changing and *how* it is changing.

Focusing attention on a problem helps students find the most relevant variables to place around the circle. Now they are looking for elements in the story that may be contributing to the problem, rather than just listing "important" big words or things that do not change over time.

A connection circle is for analyzing a problem:
What is the author concerned about?
How is it increasing or decreasing over time?
Why is it changing?

? **The Loops: What's Causing the Problem?**
After students have drawn the connecting links across their circles, be sure they follow through with uncovering the causal loops, as we described in ***The Shape of Change*** (Pages 110-116.)

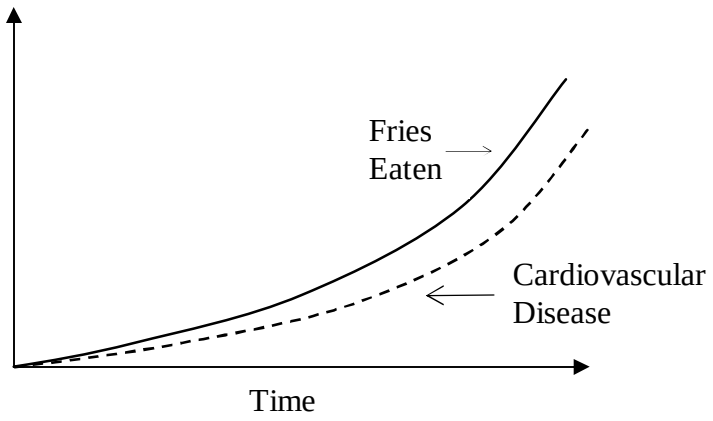
When students unfold the causal loops, they extract meaning from their confusing "spaghetti plates" of connections. They get a deeper understanding of the problem and its causes; they find clues to its solutions. The feedback loops explain *why* something is changing. Don't skip this step.

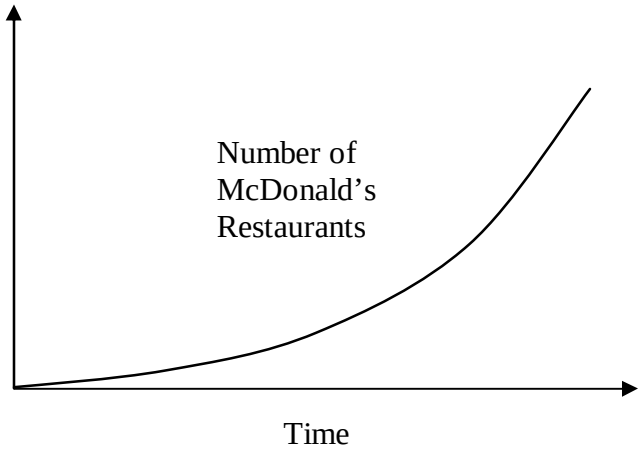
> Feedback loops are the key to understanding *why* things change over time.

The Fries Connection Circle

The Problem Behavior: Students read in "Eyes on the Fries" by Rene Ebersole[1] that Americans are eating more and more French fries and that cardiovascular disease is rising. They have sketched a behavior over time graph of French fry consumption and the incidence of disease.

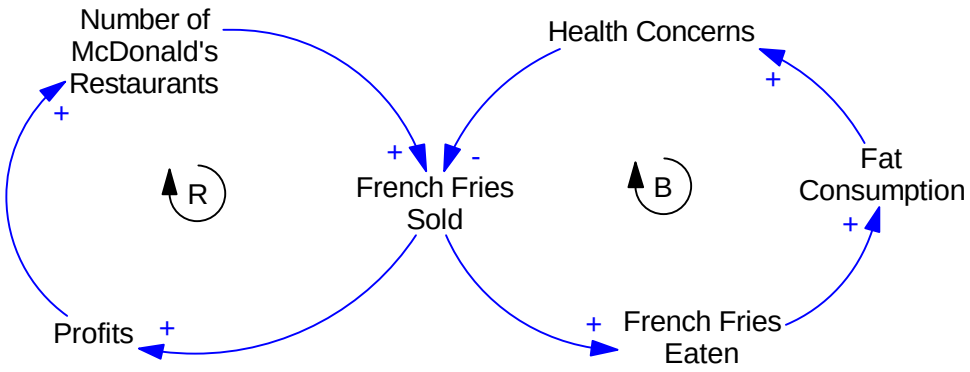
They could also graph the growing number of restaurants, or rising profits, which also define the problem, as shown on the following page.





Looking for Causes: What could be causing this rapidly increasing growth in cardiovascular disease, according to the article's author? Students used their connection circles to identify possible causes and placed them around the circle. Remember that each element must be something that can increase or decrease over time and that might somehow be contributing to the problem. In ***The Shape of Change***, students identified the number of French fries eaten, the growing number of fast food restaurants, and other variables.

The Feedback Loops: After tracing closed loops in their connection circles, students came up with a causal loop diagram something like this one:



This causal loop drawing is a rough sketch of the feedback processes that could be causing the increases in French fry consumption and cardiovascular disease.

The loop on the left is a *reinforcing feedback loop*: An *increase* in the number of French fries sold produces an *increase* in profits that McDonald's then invests in opening *more* restaurants to sell even *more* French fries. This increasing growth is like the exponential growth we saw in Making Friends. It is also like the exponential growth pattern in our behavior over time sketch of Fries Eaten. It is beginning to look like this loop could be one cause of the problem.

The loop on the right is a *balancing loop.* An *increase* in fries sold causes an *increase* in fat consumption; however, after a while, increases in obesity *raise* health concerns and people begin to eat *fewer* French fries. The article by Ebersole and our behavior over time sketch describe the first part of the story – the rise in obesity and cardiovascular disease. Our balancing loop could explain what happens when those health concerns get very high.

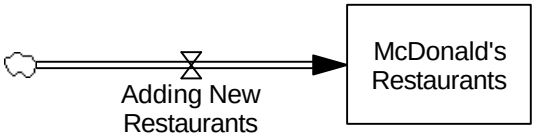
Stocks and Flows

The connection circle has stimulated a good discussion while helping students examine the article more closely for clues about the causes of the problem. Now, drawing a stock/flow map will help them understand more precisely how the system works.

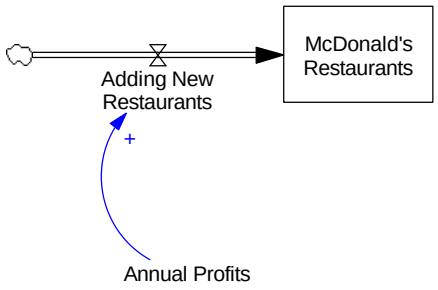
1. Ask students to name the stocks in the system. Think about the problem we identified, the graphs we drew, and the causal loops we proposed as causes of the problem.

   Starting with the reinforcing loop, we identify McDonald's Restaurants as our first stock. If we could take a snapshot of the system, we would see the number of restaurants that had accumulated.

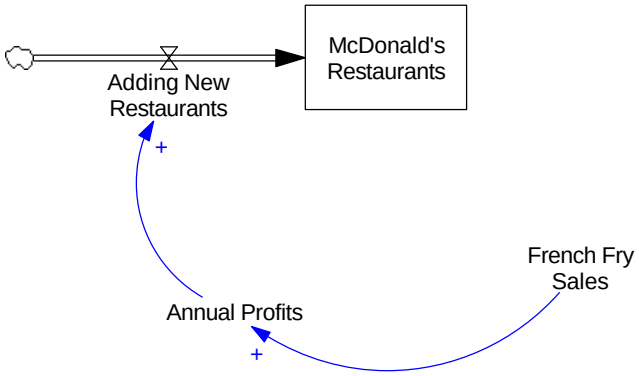
2. What causes the number of restaurants to increase? Since a stock can increase *only* through a flow, add an inflow to increase the number of restaurants.



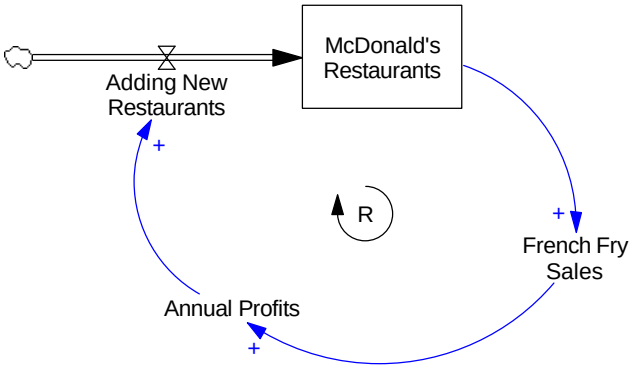
3. Working backwards from the flow, what caused McDonald's to add new restaurants? According to the article, McDonald's added new restaurants when their profits grew. An increase in profits led to an increase in new restaurants (labeled "+").



4. What caused the profits to increase? The author says that profits increased as French fry sales increased.



5. What caused the French fry sales to increase? The more restaurants there were, the more French fries they sold.



This closes our loop. It is a *reinforcing loop* because an initial **increase** in the number of restaurants works around the loop to further **increase** the number of restaurants. We expect that this reinforcing loop would produce the exponential growth we sketched earlier in our behavior over time graph hypothesis.[2]

How to Find the Stocks

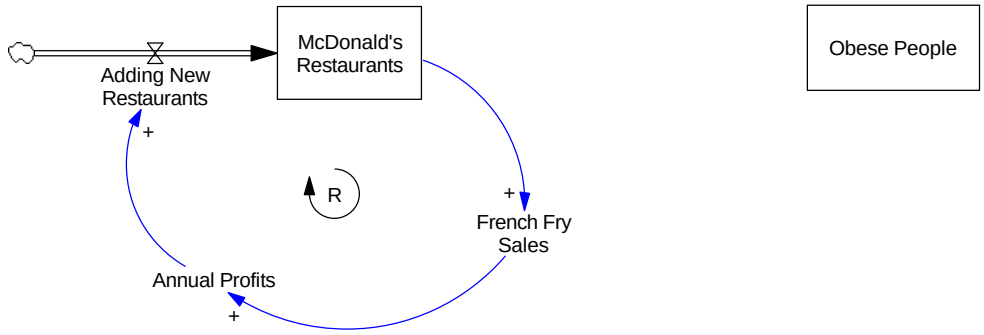
- *Stocks* are accumulations. If you could stop time and take a snapshot of the system, you would see only the stocks. In the fries example, we could count a number of restaurants and a number of overweight people at that moment, but in a snapshot we could not tell whether they were increasing or decreasing. The *flows* are the rates at which the stocks increase or decrease over time.
- Each feedback loop must have at least one stock – to accumulate the increases and decreases that are caused by the feedback processes. Restaurants were increasing. Overweight people were increasing.
- Sometimes we break the flows into parts to make the diagram more understandable and to show the logic of the feedback process. In this case, we show how French Fry Sales lead to Fat Consumption which then causes weight gain.

6. Are there other stocks in the system? The next loop will take a little more thought. A stock/flow map is not simply a direct translation of a causal loop diagram. While a causal loop diagram is a rough sketch of the feedback loops that may be driving a system, a stock/flow map requires us to look more carefully at how the system actually works – how the accumulations increase and decrease over time.

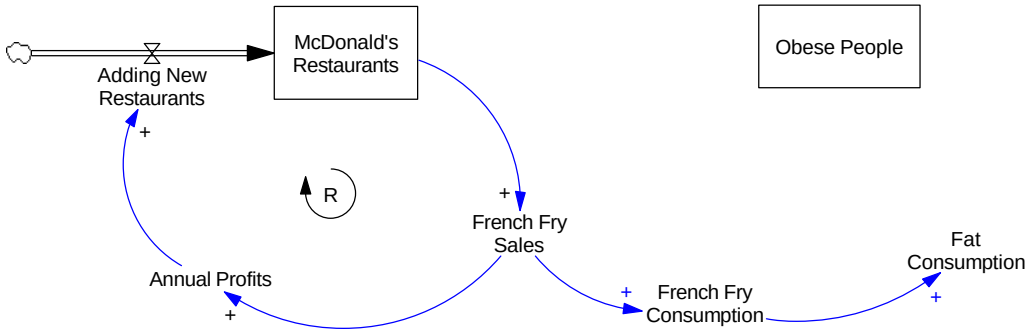
   Try these lines of reasoning:

   - Our first loop was about money: French fry sales generated profits that were used to build restaurants to sell more fries and generate even more profits. What is our second loop about? What else does a rise in French fry sales cause? Our second loop is about people eating more French fries and gaining too much weight. Our causal loop diagram listed "Health Concerns," but the problem is more specific than that – the author was worried about too many people getting fat on fast food. Our stock is the growing number of obese people.

   - If we could stop time and take a snapshot of the system, what accumulations would we see? We'd see the number of obese people at that point in time.

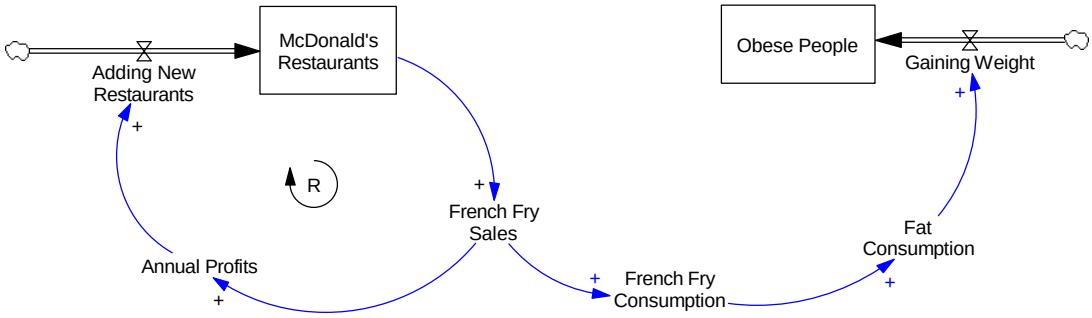


7. How do those people get fat? Follow the causal trail from "French Fry Sales" to tell the story. As French fry sales increase, the number of French fries consumed also increases – people eat the French fries that they buy. Since every French fry is loaded with fat, an increase in French fry consumption means an increase in fat consumption. Add these connections.

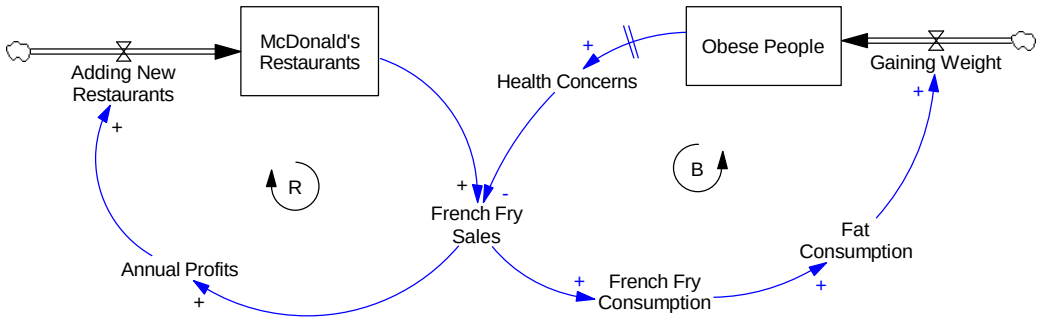


A stock/flow map traces direct causes.
People gain weight because they *eat* more fries,
not because sales are rising.

8. Increased fat consumption leads to weight gain. "Fat Consumption," therefore, influences the flow of people gaining weight. Remember, stocks can change only through flows.



9. In our causal loop hypothesis, we said that rising numbers of obese people raised concerns about cardiovascular disease and other weight-related health problems. Because there are so many obese people now, the author hopes that public concern about the health risks will rise (labeled "+"), and that a rise in health concerns will lead people to consume fewer French fries (labeled "-").



Our balancing loop is now complete. It works to bring fat consumption down to healthier levels when rising obesity numbers raise health concerns.

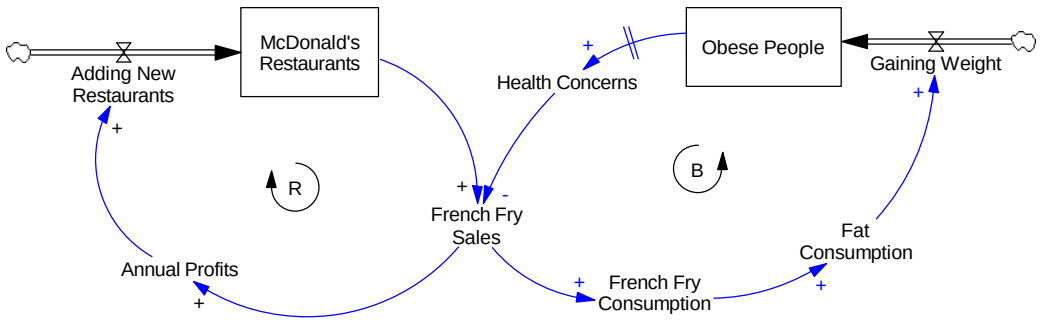
This stock/flow map represents the problem described in "Eyes on the Fries." It explains how rising French fry sales spur both an increase in restaurants and an increase in obesity in the population.[3]

A Delay

Notice the two little lines on the link to "Health Concerns." This is the symbol for a *delay*. Health concerns do not rise immediately with an increase in obesity levels.

It takes a while for people to notice the change, acknowledge it, and raise the alarm about health risks. (You might argue that there is also a delay before people respond to that alarm and eat less.)

? **How does our stock/flow map explain the rising number of obese people? Use the map to tell the story.**



In "Eyes on the Fries," Ebersole links the growing obesity and cardiovascular disease epidemic to the increased consumption of French fries. Our map makes the connection more clear. As people buy more and more French fries, McDonald's earns increased profits that it can use to build even more restaurants. This positive loop causes the number of restaurants, fries sales and profits to escalate. The increase in sales of French fries means people are eating more fries, consuming more fat, and gaining more weight.

? **How does the balancing loop affect the sales of French fries?**

After a while, when the number of obese people gets very high, public health concerns rise about cardiovascular disease and other weight-related health problems. This publicity makes people cut back on eating fries (which also reduces French fry profits and the number of new restaurants).

Unfortunately, however, a balancing loop "balances" back and forth. After people have abstained from fries for a while, the health concerns fade and people once again indulge their insatiable appetite for fries. The cycle begins again.

The goal of the balancing loop is to have healthy people. When too many people are obese, health concerns rise to limit the sales and consumption of fries.

While the reinforcing loop causes growth in French fry sales, the balancing loop tends to temper that growth over time when fatter people eventually decide to eat fewer fries.

? **Does the article suggest any solutions to the problem?**

Yes, Ebersole explains that the fast food industry, in response to health concerns related to saturated fats, will use more healthy unsaturated oils in making fries. In our map, that change would alter the type of fat consumed, but would that solve the problem? If the change lowers cholesterol levels but not obesity levels, would that allay health concerns? Our map helps us raise good questions about a very complex issue.

? **Does our stock/flow map tell the whole story? What else is missing?**

Ask students to think about how this story and map relate to their own real-world experience.

- *What drives our "humongous appetite for French fries?" Is it more than just their easy availability?*
- *Is increased French fry consumption the only cause of our widening waistlines?*
- *What about exercise, or portion sizes, or changing family mealtime habits?*
- *Do public health warnings about the risks of obesity really reduce fat consumption?*
- *Where does the responsibility lie for the problem of obesity?*
- *What can we do about it?*

? **Our stock/flow map presents one mental model of the problem. Can there be other views?**

Certainly! If students come up with different maps, use the opportunity to discuss the similarities and differences. A stock/flow map can help students surface their assumptions and examine the causes of a problem in an objective way. It can also help them be explicit and internally consistent in their reasoning. A stock/flow map is not an "answer;" it represents a thinking and problem-solving process.

Building a stock/flow map can help students think carefully about a problem:

What is changing, how is it changing, why is it changing, and what can we do about it?

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[1] "Eyes on the Fries," by Rene Ebersole, appeared in the student magazine *Current Science*, March 1, 2002. It is reproduced by permission beginning on page 18 in ***The Shape of Change*** (2004). The book is available from The Creative Learning Exchange at www.clexchange.org.

[2] A stock/flow diagram "lays out the plumbing" for the next step – building a system dynamics computer model of the system. Here, we would use equations to specify the relationships between the variables. Then, we would run the simulation to see if this loop actually produces exponential growth before adding more to the model.

[3] If we wanted to keep going, we'd carefully specify the relationships with equations and run the model to see if our balancing loop can eventually curtail the consumption of fries. Then, we would use and expand the model to experiment with policy alternatives that might solve the problem of rising obesity rates.

Connection to Characteristics of Complex Systems Project

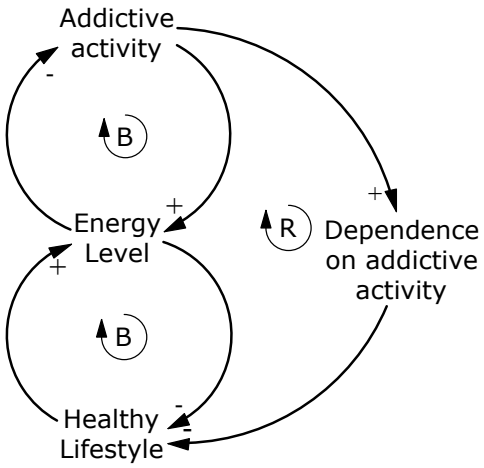
Lesson Title:
Shape of Change, Lesson 10: Do You Want Fries With That? including Stocks and Flows

Overview:
Students use behavior-over-time graphs, connection circles, causal loops, and stock/flow diagrams to examine health risks associated with rising French fry consumption.

Related Characteristic(s) of Complex Systems:
- Cause and effect are not closely related in time or space.
- Conflicts arise between short-term and long-term goals.

Ideas and Examples for Connecting to the Characteristic:
Expand this lesson by asking students to identify where delays exist within the connection circle or stock/flow representation. For example, eating French fries does not immediately lead to health problems. This result would build over a long period of time, given a reliance on fries and other similar foods as a main staple in the diet. Thus, a long delay in time exists between "Fat consumption" and "Health concerns" within the lesson's diagrams.

Challenge students to identify other similar systems that have inherent delays. These may include weight management, smoking, and "recreational" drug use. These delays within a system can also tie into seeing conflicts between short-term goals (immediate gratification) and long-term goals (having a long, healthy life). An issue that illustrates this conflict between short- and long-term goals is addiction (including to fast foods); ~~a~~ shifting the burden archetype illustrates how reliance on the addictive behavior can take away from a long-term fundamental solution of choosing a healthy lifestyle.



Resource(s)

Shape of Change. Rob Quaden and Alan Ticotsky.

Article: "The Extraordinary Science of Addictive Junk Food," The New York Times, Michael Moss, February 20, 2013, http://www.nytimes.com/2013/02/24/magazine/the-extraordinary-science-of-junk-food.html