This resource has been prepared by Jens Altheimer for Regional Arts Victoria in collaboration with Emily Atkins, Education and Families Manager at RAV.

Presented by Regional Arts Victoria

Regional Arts Victoria’s Education and Families Program is supported by:
DEECD
ACTF
RE Ross Trust
Australian Communities Foundation – Silver Gold Fund
Australian Communities Foundation

This resource is supported by:
ACAPTA

ACAPTA
aust. CIRCUS and PHYSICAL THEATRE
ABOUT THIS RESOURCE

This teacher resource has been developed to complement your class’ visit with *Squaring the Wheel*.

We would like to assist you and your students to maximize the theatrical, scientific and educational experience that the show offers and want to provide you with inspirational extra material to bring the performance and its pedagogical content to life in your school.

A short introduction to the show’s main features:

*Squaring the Wheel* is an energetic and humorous performance full of twists and surprises, handling themes like loneliness, thinking outside the box, friendship, creativity and finding one’s place in the world.

It has two outstanding characteristics:

1. A unique mix of circus, contraptions and clowning: after working for years with those three elements separately, Jens Altheimer combines them into a quirky, unusual and engaging show.

The custom built contraptions of great theatrical impact are appealing to both children and adults (who wouldn’t like to see a machine that uses an ironing board, toilet seat, vacuum cleaner, baby toy, mousetrap and other stuff to throw a hat onto someone’s head?).

Circus skills are packed into unexpected contexts and the performance has a physical, contemporary, clown-like performance style, which is very inclusive and delivered with very little text.

2. The educational program that follows the show: A 20 minute interactive introduction to contraptions and the physics behind them.

This is demonstrated with the help of an extra chain-reaction machine, highlighting concepts like gravity, friction, levers, counterweight, pulleys and stored energy. The concepts are explained and demonstrated through active participation. This is great fun, even for kids that normally don’t like technical stuff!

In summary, the show provides an original mixture of an engaging theatre experience and an educational introduction into physical principles.

Arts and science in one place, offering an opportunity for cross curricular learning.

This Education Resource Pack provides you with a number of possible activities in the areas of Performance and Contraptions and offers useful information and links to support your approach.
## CURRICULUM LINKS

<table>
<thead>
<tr>
<th>Domain</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpersonal Development</td>
<td>WORKING IN TEAMS</td>
</tr>
<tr>
<td></td>
<td>Foundation - Students describe basic skills required to work cooperatively in groups.</td>
</tr>
<tr>
<td></td>
<td>Level 1-2 - Students work in teams in assigned roles, stay on task and complete structured activities within set timeframes</td>
</tr>
<tr>
<td></td>
<td>Level 3-4 - Students cooperate with others in teams for agreed purposes, taking roles and following guidelines established within the task</td>
</tr>
<tr>
<td></td>
<td>Level 5-6 - Students work effectively in different teams and take on a variety of roles to complete tasks of varying length and complexity.</td>
</tr>
<tr>
<td>Personal Learning</td>
<td>THE INDIVIDUAL LEARNER</td>
</tr>
<tr>
<td></td>
<td>Foundation - Students begin to take responsibility for managing their time and resources within the context of structured tasks that have clear outcomes and a set timeframe</td>
</tr>
<tr>
<td></td>
<td>MANAGING PERSONAL LEARNING</td>
</tr>
<tr>
<td></td>
<td>Level 3-4 - Students undertake some multi-step, extended tasks independently.</td>
</tr>
<tr>
<td></td>
<td>Level 5-6 - Students develop and implement plans to complete short-term and long-term tasks within timeframes set by the teacher, utilising appropriate resources.</td>
</tr>
</tbody>
</table>
### Domain Dimension

<table>
<thead>
<tr>
<th>Domain</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Arts</td>
<td>CREATING AND MAKING</td>
</tr>
<tr>
<td></td>
<td>Foundation - Students explore and, with guidance, use a variety of arts elements (on their own or in combination), skills, techniques and processes, media, materials, equipment and technologies in a range of arts forms.</td>
</tr>
<tr>
<td></td>
<td>Level 1-2 - Students use skills, techniques, processes, media, materials, equipment and technologies in a range of arts forms. They identify, describe and discuss characteristics of their own and others’ arts works.</td>
</tr>
<tr>
<td></td>
<td>Level 3-4 - Students select and combine a range of arts elements, principles and/or conventions, and use a range of skills, techniques and processes, media, materials, equipment and technologies.</td>
</tr>
<tr>
<td></td>
<td>Level 5-6 - Students independently and collaboratively experiment with and apply a range of skills, techniques and processes using a range of media, materials, equipment and technologies to plan, develop, refine, make and present arts works.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXPLORING AND RESPONDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 3-4 - Students comment on the exploration, development and presentation of their arts works, including the use of specific arts elements, principles and/or conventions, skills, techniques and processes.</td>
</tr>
<tr>
<td>Level 5-6 - Students discuss traditional and contemporary arts works using appropriate arts language to describe the content, structure and expressive qualities of their own and other people’s works from a range of arts disciplines and forms.</td>
</tr>
<tr>
<td>Domain</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td><strong>English</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<p>| Mathematics | <strong>MEASUREMENT AND GEOMETRY</strong>                  |
|            | Foundation - Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language (ACMMG006) |
|            | Level 1 - Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features (ACMMG022) |
|            | Level 2 - Describe the features of three-dimensional objects (ACMMG043) |
|            | Level 3 - Make models of three-dimensional objects and describe key features (ACMMG063) / Identify angles as measures of turn and compare angle sizes in everyday situations (ACMMG064) |
|            | Level 4 - Use scaled instruments to measure and compare lengths, masses, capacities and temperatures (ACMMG084) |
|            | Level 5 - Estimate, measure and compare angles using degrees. Construct angles using a protractor (ACMMG112) |
|            | Level 6 - Convert between common metric units of length, mass and capacity (ACMMG136) |</p>
<table>
<thead>
<tr>
<th>Domain</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>SCIENCE UNDERSTANDING</td>
</tr>
<tr>
<td></td>
<td>Foundation - The way objects move depends on a</td>
</tr>
<tr>
<td></td>
<td>variety of factors, including their size and</td>
</tr>
<tr>
<td></td>
<td>shape (ACSSU005)</td>
</tr>
<tr>
<td></td>
<td>Level 1 - Everyday materials can be physically</td>
</tr>
<tr>
<td></td>
<td>changed in a variety of ways (ACSSU018)</td>
</tr>
<tr>
<td></td>
<td>Level 2 - A push or a pull affects how an</td>
</tr>
<tr>
<td></td>
<td>object moves or changes shape (ACSSU033)</td>
</tr>
<tr>
<td></td>
<td>Level 4 - Forces can be exerted by one object</td>
</tr>
<tr>
<td></td>
<td>on another through direct contact or from a</td>
</tr>
<tr>
<td></td>
<td>distance (ACSSU076)</td>
</tr>
<tr>
<td></td>
<td>SCIENCE AS A HUMAN ENDEAVOUR</td>
</tr>
<tr>
<td></td>
<td>Foundation - Science involves exploring and</td>
</tr>
<tr>
<td></td>
<td>observing the world using the senses (ACSHE013)</td>
</tr>
<tr>
<td></td>
<td>Level 1-2 - Science involves asking questions</td>
</tr>
<tr>
<td></td>
<td>about, and describing changes in, objects and</td>
</tr>
<tr>
<td></td>
<td>events (ACSHE021)</td>
</tr>
<tr>
<td></td>
<td>Level 3-4 - Science knowledge helps people to</td>
</tr>
<tr>
<td></td>
<td>understand the effect of their actions (ACSHE051)</td>
</tr>
<tr>
<td></td>
<td>Level 5-6 - Scientific understandings,</td>
</tr>
<tr>
<td></td>
<td>discoveries and inventions are used to solve</td>
</tr>
<tr>
<td></td>
<td>problems that directly affect peoples' lives</td>
</tr>
<tr>
<td></td>
<td>(ACSHE083)</td>
</tr>
<tr>
<td></td>
<td>SCIENCE ENQUIRY SKILLS</td>
</tr>
<tr>
<td></td>
<td>Foundation - Explore and make observations by</td>
</tr>
<tr>
<td></td>
<td>using the senses (ACSIS011)</td>
</tr>
<tr>
<td></td>
<td>Level 1-2 - Through discussion, compare</td>
</tr>
<tr>
<td></td>
<td>observations with predictions (ACSIS212)</td>
</tr>
<tr>
<td></td>
<td>Level 5-6- Suggest improvements to the methods</td>
</tr>
<tr>
<td></td>
<td>used to investigate a question or solve a</td>
</tr>
<tr>
<td></td>
<td>problem (ACSIS091)</td>
</tr>
<tr>
<td>Domain</td>
<td>Dimension</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>Design, Creativity and Techno-logy</td>
<td>INVESTIGATING AND DESIGNING</td>
</tr>
<tr>
<td></td>
<td>Level 3-4 - Students think ahead about the order of their work and list basic steps to make the product or system they have designed.</td>
</tr>
<tr>
<td></td>
<td>Level 5-6 - Students contribute to the development of design briefs that include some limitations and specifications. Individually and in teams</td>
</tr>
<tr>
<td></td>
<td>PRODUCING</td>
</tr>
<tr>
<td></td>
<td>Level 3-4 - Students use their list of steps and are able to choose appropriate tools, equipment and techniques to alter and combine materials/ingredients and assemble systems components.</td>
</tr>
<tr>
<td></td>
<td>Level 5-6 - Students use their production plan and select and work safely with a variety of materials/ingredients and systems components to produce functional products and/or systems.</td>
</tr>
<tr>
<td></td>
<td>ANALYSING AND EVALUATING</td>
</tr>
<tr>
<td></td>
<td>Level 3-4 - Students identify what has led to improvements and describe what they consider to be the strengths and drawbacks of their design, product or simple system.</td>
</tr>
<tr>
<td></td>
<td>Level 5-6 - Students reflect on their designs as they develop them and use evaluation criteria, identified from design briefs, to justify their design choices.</td>
</tr>
</tbody>
</table>
Jens Altheimer

*Squaring the Wheel* is devised and performed by Jens Altheimer. He is a performer, teacher and director of circus and theatre, whose curiosity about contraptions and their possible theatrical applications began quite some time ago! By default, contraptions are very theatrical in their open display of over-engineered and complex, yet somehow raw and clunky mechanisms. They also have a huge comical (and somehow philosophical) potential, provided by the paradox of making life not easier (what machines are supposed to do), but more complicated.

After working for years as a circus performer, presenting his tricks with some theatrical context, Jens now creates theatre with some circus mixed in between. His stylistic theatre approach is a very physical, contemporary clown-based performing style.

Born in Germany and trained at the Lecoq International School of Theatre in Paris, he has spent the last 25 years performing and teaching throughout different countries in Europe, including the collaboration in two productions by Philippe Genty.

He relocated from Europe to Melbourne in 2009, where he now divides his time between touring his show, directing divers art projects for children and building contraptions.

**Squaring the Wheel**

“A comical visual feast which simply has to be seen to be believed.” Artshub

When an eccentric misfit meets a strange world of contraptions, everything turns into a challenging and surprising discovery.

*Squaring the Wheel* brings together circus skills, puppetry, magic, wacky mechanisms, unexpected music and audience participation. It is all inserted into a theatrical stage extravaganza with a comical and physical language. Indulge in watching a life perspective of how to complicate simple things!

Kooky antics, absurd gadgets, tomfoolery and high energy are balanced with themes of loneliness, thinking outside the box, friendship and achieving, in a story of finding one’s place.

Winner of the 2013 Adelaide Fringe Festival Award:
Best Children's Production
1. Discussing the experience

- Did you enjoy the performance? What did you like the most?
- What five words would you use to describe Squaring the Wheel?
- Was there any part of the production you didn’t like? Explain your thoughts.
- Were you more curious about contraptions following the performance?
- If you could ask one question about the show, what would it be?
- What do you think the main themes of Squaring the Wheel were?
- Can you describe Squaring the Wheel in one sentence?
- Would you recommend Squaring the Wheel to your family and friends? Why or why not?

2. It is not a real play, is it? : Genre

*Squaring the Wheel* uses a number of different approaches to tell the story and to entertain. It invites the audience to experience its storyline more through physical actions and less through text. This way of devising theatre is called “Physical Theatre”. Physical Theatre has many different styles.

- Using the Internet, research Physical Theatre and find 5 facts to share with the class.
- Without many words or other actors on stage, how did the character communicate his emotions? Explain using 3 examples.
- Would you say the performance is slow or fast paced? How would it be different to watch if it were faster or slower?
3. Transformation and change as a concept

One of the important themes in Squaring the Wheel is being alone. The main character appears hungry, lonely and without a place to go. Despite these setbacks, he doesn’t give up and uses his imagination to overcome this precarious situation, transforming the world around him.

- What do you think the main character had learned by the end of the play?
- Have you ever invented characters and situations by yourself? What sort of things did you pretend to be doing or seeing?
- What do you think the expression ‘thinking outside the box’ means? How does the main character do this?
- The main character re-invents a number of everyday objects. Name 3 examples of how he does this. (examples on Page 33)

“Discovery consists of seeing what everybody has seen and thinking what nobody has thought.”
Albert Szent- Gyorgyi, Nobel Prize winner, discovered Vitamin C

- What do you think this quote means?
- What does the title Squaring the Wheel suggest about what happens in the performance?
Contraptions are also called Heath Robinson or Rube Goldberg machines:

Heath Robinson (1872-1944) was an English Illustrator who produced a body of work featuring ridiculous machines and devices, often requiring multiple operators to control a plethora of pulleys and leavers. The machines, made out of every imaginable piece of junk, were designed to perform odd and often surreal tasks, such as cat-burglar training and spaghetti stretching. Most of his machines were seen to be patched together from loose odds and ends, which has led to his name being commonly associated with instances of ‘quick-fixes’ or cobbled together repairs.

Rube Goldberg (1883-1970) was Robinson’s American equivalent, also known for his humorous illustrations depicting equally ridiculous machines. Unlike Robinson, Goldberg was also an engineer and inventor and this was reflected in his illustrations which portrayed much more practical designs, albeit for equally silly outputs. Today his name is linked to comically involved, complicated inventions, laboriously contrived to perform a simple operation and is used in referring to elaborate but ineffective repair work, inventions, etc. A “Rube Goldberg job” looks impressive but is unreliable.

The two grew up during the dawning of the technological age when the automobile, the telephone, and electricity were revolutionizing everyday life. Their drawings poke fun at those who embraced this new world of technology too enthusiastically, preferring some overly complex mechanical monstrosity to the simpler human way of doing things. Science and technology, they reminded their readers, didn’t always have all the answers. Maybe the rising popularity of contraptions in nowadays is for the same reason.
Theatre exercise 1
Re-Inventing the… Everything!

In the rehearsal process of *Squaring the Wheel*, a lot of time was spent improvising with objects to reinvent their use. This exercise promotes ‘thinking outside of the box’:

1. The class is divided up into teams of ~ 6 people. One team plays at a time.
2. An object is placed on the center of the stage, the team stands or sits off stage.
3. During a 2 minute period on stage, the players must invent played actions with the object that redefine its use, without forgetting its basic shape and size. For example: a plate is the given object. It could be a steering wheel, a holy shrine or a hat… but wouldn’t really pass as a cricket bat!
4. Each student should show their idea in detail so that others are completely aware of what they are doing without any verbal explanation. Each successfully guessed action gets a point.

NB: The exercise gets more interesting the more complex the object. For example, objects that have some articulation (i.e. a pair of pliers transforms into the Eiffel Tower, a crocodile mouth, tightwire walker on a finger…) or can transform (i.e. roll of toilet paper) are very fruitful.

Variation A: Two teams play at the same time, points for both teams with the team that has guessed the most within the time limit winning.
Variation B: Each action must have a minimum of two players (so they have to interact). You may choose to have students talk about the idea beforehand or improvise completely.

Theatre exercise 2
The Movie Machine

This is a great exercise to develop quick transformation and adaption skills.

1. A enters the stage and starts miming a short scene (possibly given in advance).
2. B (any person from the group) shouts stop (or the facilitator stops and nominates). A freezes.
3. B observes A’s position quickly and complements A’s freeze frame with one of his own. Once the new freeze frame is established, he starts a new mime beginning with the new freeze frame.
4. They start playing the scene, until C (or the facilitator) shouts stop. A & B freeze, A leaves the stage, C studies B’s position and complements B’s freeze frame with one of his own, followed by a new mime and so on until all students have been on stage.

Variation A:
Instead of starting a scene, the players name / describe their still images and then change.
Variation B:
Instead of leaving, the involved actors stay onstage and create larger and larger scenes. Once everybody is on stage, they start exiting in the opposite order, coming back to the scenes they played in the build up.
Clowning in a contemporary style is one of the main characteristics of *Squaring the Wheel*. In recent years, traditional red nose clowning has made way for many different styles and approaches. In *Squaring the Wheel*, the character of the clown is not defined by a look or costume, but through the off-balance way he tries to secure his place and survival in the complicated world around him. Playfulness, curiosity and a constant risk of failure replace solid knowledge and superiority. Eccentric improvisation is used as a lifeline to overcome missing means. To get what he wants, he isn’t necessarily always completely honest or fair. Although our main character is a friendly one, he has his faults.

- Identify 3 moments in *Squaring the Wheel* where the main character’s logic is different to what we expect
- How would you describe the clown? Write 2 sentences describing his personality.
- What clown-like characters do you know from film or theatre?
- Clowning always has a with a close connection with the audience. How does the performer in *Squaring the Wheel* make us like him?

Developing one's personal and unique clown is a long and individual process, requiring a committed search and often guided and supported by a trusted teacher. These exercises give a first taste of playing outside the realistic world and help to break down inhibitions. Many of them build upon skills built in Theatrical Exercise 1 and 2.

**Clowning Exercise 1**

*Weird Bus Stop*

1. Start with two chairs on stage, next to each other.
2. Person A sits down, waiting for the bus. B sits next to him, inventing an action that annoys A to the point that he leaves the chair.
3. C comes in and invents an action to annoy B, B leaves. And so on.
4. Last one to come in is A who then stays on his own and finally catches the bus.

*Coaching:* Encourage physically over-the-top actions. Explain that physical contact is possible, but can’t be rough or aggressive. If a scene gets stuck because one player doesn’t want to leave, call them out. Emphasise the importance of staying in character and playing it as ‘straight’ as possible (ie: no giggling!)
Clowning Exercise 2  
*Pass that Thing*

1. Everybody stands in a circle.
2. Person A mimes an object, manipulates it for a moment and passes it on to B.
3. As he receives it, B instantly transforms the imaginary object into a completely different object, miming a short sequence with it. B then passes it to C and so on.

For example, A might make his hands round like a ball and then mime bouncing it up and down. When he passes it to B, B might flick the imaginary shape downwards into a golf club and take a shot before passing it on.

*Coaching:* Encourage children to create big contrasts (a light feather transforms into a block of concrete, a piece of cake into a wild tiger). Ask students to make their object and their relationship with it as outrageous as possible, but at the same time detailed so that it is clear what they are doing.

Clowning Exercise 3  
*Instant Monsters*

1. Everybody walks through the room in a neutral manner.
2. On the teacher’s clap, everybody jumps and transforms, without pre-planning, their body instantly into a strong physical character, as different as possible from their regular state. This should include big gestures, strong distortion of body positions (i.e., elbows out wide and knees pointing inwards). The jump is supposed to promote a spontaneous, less planned ‘landing’ in a new body position.

3. When the teacher shouts ‘move’, all these ‘new beings’ start moving and explore their new bodies and the world around them. This is Character 1. Ask students: How does Character 1 breathe? How does Character 1 react to the world around them? Does Character 1 have a fast or slow rhythm? Is it an even one or is it all over the place? Can they move all parts of their body? How do they walk? What voice do they have? How much space do they take up? How do they sit down? What happens when they are in a hurry?

Students should first work on their own, then encourage brief encounters with the others.

4. On the second clap, everybody instantly transforms into ‘neutral’ again, walking.
5. Then, on a third clap, everybody instantly jumps into a new character and freezes, as different from Character 1 as possible. This is Character 2. Repeat the same process again.
6. On the fourth clap, students transform immediately into Character 1.
7. On the fifth clap they change back to Character 2.
8. On the sixth clap ask half of the class turn into Character 1, the others stay in Character 2. Encourage encounters, activities, brief conversations.
5. Beyond the performance: Stage craft

Stage craft describes the more technical components that are important to put on a show. The set, props, lighting, music, sounds and costumes require a lot of decisions, which a director and his team makes during the rehearsal process. For Squaring the Wheel, a lot of time was spent in the workshop to develop the different contraptions and make them work. What looks on stage as the spontaneous assembling of random material, had a laborious and exacting building process, involving a lot of trial and error.

- Describe 3 things you noticed about the set and the props. What did you think of them?
- Did you notice the music? What sort of mood did it have?
- What sound effects do you remember?

6. So what do you think? Reviewing Squaring the Wheel

Imagine you are invited to write a review of the show for your local newspaper.

In your review, make sure you include
- The title of the performance.
- The name of the company presenting the performance
- The name of the venue where the performance was held and the date of the performance.
- What happened in the performance (without giving away the ending!)
- What sort of performance it is (ie: circus, serious drama, dance)
- What you thought of Jens’ performance
- What you thought of the set, props, lighting and music (stage craft)
- Who you think would enjoy this performance
1. A Few Important Mechanical Terms

To understand contraptions, we have to go back to their building components. A big part of contraptions is based on so called ‘simple machines’. The word “machine” suggests an engine, and many interlocking components, however, a ‘simple machine’ has no independent power source and few or no moving parts.

Listed here are six of the most common and most useful simple machines. All of them provide mechanical advantage (see box).

The trick is to combine a few simple machines to produce more interesting effects. Although other components are involved, simple machines provide the main part of a successful contraption.

Find out what each of the following devices is and why they might help us do something:

- Ramp
- Lever
- Pulley
- Screw
- Wedge
- Wheel and axle

Getting the advantage

Mechanical Advantage (MA) is the factor by which a machine multiplies the force applied to it. In other words, how much faster and more easily a machine will run. For example, it is easier to push a heavy ball up a ramp plane than to lift it up yourself. This means that there is a Mechanical Advantage (MA).
2. Why is it moving: the principal forces behind contraptions

To make contraptions work, a few fundamental principles are involved. Gravity, which was first defined by Sir Isaac Newton (see box), moves the rolling balls in Squaring the Wheel, but also makes the toilet seat and the weight drop down.

With no engine involved, contraptions only work if, in the beginning, they are placed in a position, from where, once triggered or released, they automatically move to another position. For example, you might lift an object to a higher place (once released, gravity does the rest) or set up releasable energy in devices like stretched springs (mousetrap) and blown-up balloons, (once released, they reset back to their original state).

Working with changing counterweights (weighted nappies for the babies on the wheels) or overcoming friction (making the bottle stuck to the tube till the air pressure in the bottle overcomes the friction and makes it pop out) are other ways to put movement into a non-engine system.

Sir Isaac Newton (1643-1727) is one of the most influential scientists of all time. He came up with numerous theories and contributed ideas to many different fields including physics, mathematics and philosophy.

Newton’s law of universal gravitation describes the gravitational attraction between bodies with mass, the earth and moon for example, but also the earth and an apple and even between a book and a pen. As a general rule we can say, that the stronger gravity is, the heavier the object is. Gravity is the force that pulls objects towards the earth. It is the force behind the idea that “what goes up, must come down”.

Gravity is the most important type of force used for building contraptions.
3. One moves the other: chain-reaction machines

**chain reaction**

chain reaction, self-sustaining reaction that, once started, continues without further outside influence. Or we could also say: a series of events so related to each other that each one initiates the next, triggered by the same initial event.

A line of dominoes falling after the first one has been pushed is an example of a mechanical chain reaction.

One way to describe chain-reaction machine is through cause and effect: everything that happens is CAUSED BY another action.

In building chain-reaction machines, this is all planned and calculated, but in real life, sometimes chain reactions get completely out of control (like in Japan 2010: an earthquake triggered a tsunami, that destroyed part of a nuclear power station, which then triggered the uncontrolled fusion of nuclear material….)

To move from one part to the next, chain reaction machines use triggers. Watch the video “The Page Turner”, contraption by Joseph Herscher
http://www.youtube.com/watch?v=GOMIBdM6N7Q

Identify and describe the triggers and explain how you think they worked.
(Hint: there are 19 steps altogether - answer on Page 33).

Another good example is the film clip for OK Go’s song *This Too Shall Pass*:
http://www.youtube.com/watch?v=qybUFnY7Y8w

How many triggers can you identify as a class?
4. Got an idea? Solve the Victorian Mystery!

Look at the picture of this intriguing Victorian contraption which was patented in 1902 in Birmingham, UK.

- What do you think this machine’s purpose is? (answer on Page 33)
- Write a paragraph describing your ideas.
5. Design your own chain-reaction machine

“Imagination is more important than knowledge.”
Albert Einstein, scientist who came up with the theory of Relativity

This is another of Rube Goldberg’s fantastic drawings. Gravity is the main force needed to make this machine work!

- What do you think the intended purpose of THIS machine might be?
- Can you find the parts that use gravity?
You can start your contraption building more simply:

- Using the following elements, how could you design a simple and functioning chain-reaction machine with a minimum of 7 steps?

Make a description and a drawing of a possible sequence. For example, the ball rolls from inclined plane against a hanging ball pendulum that swings...

You may make elements larger or smaller, place objects on higher places (tables etc.), use extra poles, strings, attachments. The only rule is that your machine must include one of each of the above elements!

With this first purely mechanical drawing done, design a whimsical (you don’t have to build it!) chain-reaction machine, just like Mr. Goldberg did! Find a (silly) task, that your machine accomplishes with its last step (ie: pouring tea, straightening a tie, patting the dog...)
5. Build a chain-reaction machine as a class

“I have not failed. I’ve just found 10 000 ways that won’t work.”
Thomas Edison, his Inventions include the phonograph, motion picture camera and light bulb

Whole class activity: everybody brings to school 5-10 objects, which could be used in a chain-reaction machine. In 4 hours minimum, ideally divided up into two days, the whole class, subdivided into groups of 4, creates their own chain-reaction machine. Each group only devises two or three steps, but has to think of how they can connect their section of the machine to the sections that come before and after their own. Keep it simple!

With all the steps built, the second phase consists in adjustment: by repeated presetting and running of the parts of the machine, construction mistakes are identified and can be adjusted and improved. At the end of the activity, the whole chain-reaction machine runs from the beginning to the end, with as few human interventions as possible.

The teacher should pay special attention to the successful connections between the different groups. Reinforce the necessity of keeping everything simple and easy to preset (ie: it shouldn’t take 10 minutes to get one section of the machine ready for another go!). The success of the whole project doesn’t depend on originality, but the reliability of each component.

Proposed tools/materials to be provided: wood saw, cutter, hammer, nails, string, wire, hinges, screw driver, scissors, gaffer tape, brown tape, electrician tape, clamps, awl, contact glue, silicone, various lengths and thickness of timber, thick cardboard, carpenters square, ruler, bubble level. Plastic and other containers, balls, marbles, anything that can make a ball track. Tables and chairs can provide very useful higher levels.

Documentation is also a part of the scientific process. As you build your contraption, film your process and share it proudly with everybody on our Facebook page, as well as showing it off to Regional Arts Victoria’s Education and Families team (contacts in the back of this resource).
6. Construct a mousetrap car

Mouse trap cars are big classics in contraption building. They are based on the idea that a mouse-trap can propel a four wheeled vehicle. The construction of mousetrap cars is an excellent activity, to experiment a different kind of quirky contraption building. It can be done by simply following the instructions in this resource or, if you’re feeling more adventurous, by designing and building your own model. The activity could culminate in a big racing day: a competition between all models to see which vehicle rolls the longest distance. There may even be extra prizes for the best looking car!

Record the longest ride and publish your results on our Facebook page. We want to know who develops the hottest Australian mousetrap racer!

Detailed instructions can be found on the following pages.

Or you can investigate online different building proposals and make up your own design!
You need:

- 4 barbed drip irrigation tricklers, green & black with a screw thread (“Veri-Flow”, Pope is one possible brand)
- 1 poly irrigation riser, 300mm, rigid (also made by Pope), plastic tube, open on one side, connector on the other
- 1 mousetrap, wood, small
- 4 cup hooks, (15-20 mm, 2.2 mm gauge)
- 2 big balloons (~25 cm)
- 1 piece of clear plastic tube (clear vinyl fitting, 5 mm x 7 cm) (made by Pope), make sure it fits tightly over the black tube
- 2 cable ties (smallest size)
- 45 cm of thin non stretchy string (builders string is rather good)
- 4 CDs
- 2 thick self-adhesive felt dots

Tools:

- Pair of pliers with cutting part and/or metal saw
- Superglue
- Contact glue
- Pair of scissors

1. Cut off the thin end of the plastic tube one 7 cm (back axle) and one 5.5 cm piece (front axle) (you can either use a good pair of cutting pliers or a metal saw). Try to cut as straight as possible: this later will be critical to make your car runs straight!

2. Drip a few drops of superglue around the center of the back axle and tighten a cable tie around it. Cut off the cable tie tail as close to the base as possible.

BE VERY CAREFUL THAT THE GLUE DOESN’T TOUCH YOUR FINGERS! DON’T FORGET THAT IT IS LIQUID AND WILL RUN DOWN THE TUBE! WHEN YOU USE SUPERGLUE, ALWAYS MAKE SURE YOU GIVE IT ENOUGH TIME TO DRY BEFORE USING THE PART FOR THE NEXT STEP.
3. Using pliers, cut off part of the metal wires of the mousetrap as shown in the picture on the right. Depending on the mousetrap, you will have to bend some of the wires, so everything stays in place. The spring pressure must remain in the longer wire.

4. Screw the 4 cup hooks into the small sides of the mousetrap, openings facing up. Make sure they go in straight.

5. Cut the transparent plastic tube in three pieces:
   - one piece fitting in between the 2 cup hooks & the remaining piece cut in half. Slide the big part onto the center of the short axle and the others onto the outsides of the long axle, with hook-hook distance between them. Cut off any excess. Fix them with contact glue.

6. Separate the two parts of the tricklers and screw the black bits into the outside of the two axles.
7. Fit the 4 CDs onto them and screw on the green part of the tricklers from the other side. Tighten them as hard as you can.
8. Open the cup hooks a tiny bit with a pair of pliers, just enough to allow the axles to be pushed in. Don’t push them in yet.

9. Make a knot at one end of the string and use the second cable tie to attach it to the thin end of the remaining piece of black tube. Cut off the tail. Put some superglue (SEE WARNING ABOVE!) around the cable tie.
10. Slide the tube with its threaded side over the wire.

11. Now fit the two axles through the cup hooks of the mousetrap, the one with the attached cable tie goes to the opposite side of the newly attached black tube. Make sure the front wheels run inside of the back wheels.

12. Carefully bend back the cup hooks with a pair of pliers, so the axles aren’t too loose (but still move!) and are straight.

13. Tie a secure loop (one that doesn’t close when pushed), 2-3 cm long to the loose side of your string. When straight, the loop should be just short of the back axle. Cut off the loose tail.

14. Cut out the middle section of the two balloons and push them over the rim of the back axle CDs (where the cable tie is): should look like a rim-cover. It is not a decorative element: the balloons are important to provide some friction between the wheels and the ground.

15. Stick the two self-adhesive felt dots on the corner of the mousetrap to make sure that the tube doesn’t touch the axle.

Congratulations: Everything is done! Except the last bit: get it going...
Pull the long plastic tube backwards (against the resistance of the mousetrap spring, so you take pressure off the string), attach the loop to the axle cable tie and roll the wheels backwards, thus rolling up the string on the axle.

This sounds easy, but is actually rather tricky and takes a bit to learn. Ask somebody to give you a hand. Roll up the string till it is completely stretched, while the plastic tube is tilted all the way back.

And now the big moment: Keeping everything in position, place the mousetrap car on an even hard surface, hold the car down and let the plastic tube go! This also might take a few attempts to get right.

If the car runs to one side, correct the axle position.

Once everybody has their car in perfect running order, start the big competition: which is the vehicle that covers the longest distance? Record it on video and publish the results on our facebook page.

Investigate different construction proposals and make up your own mousetrap-car design!
"Just as one can compose colors, or forms, so one can compose motions."

Alexander Calder, American artist famous for his hanging mobiles

In the Arts, chain-reactions make up part of the big field of kinetic art. Generally, a kinetic art object can be described as artwork that moves or can be moved, quite often with a capacity to intrigue and fascinate the viewer.

http://www.theartstory.org/movement-kinetic-art.htm

The Way of Things

The predecessor of many newly assembled chain reaction machines is *The Way of Things*, a 1987 art film by the Swiss artist duo Peter Fischli and David Weiss. It documents a long causal chain assembled of everyday objects, resembling a Rube Goldberg machine.

The art installation was in a warehouse, about 100 feet long, and incorporated materials such as tires, trash bags, ladders, soap, oil drums, old shoes, water, and gasoline. Fire and pyrotechnics were used as chemical triggers. The film is nearly 29 minutes, 45 seconds long. Some of that time is waiting for something to burn, dissolve, or slowly slide down a ramp, creating moments of slow contemplation.

More information to *The Way of Things*:
http://www.medienkunstnetz.de/works/the-way-of-things/
Rube Goldberg and Heath Robinson

But Fischli and Weiss weren’t the first to transform chain-reaction machines into an art form. The British Heath Robinson and the American Rube Goldberg (see above), both cartoonists and visual artists, created works of great ingenuity that showed complex inventions that were created to solve real everyday problems. The genius of their work was that their held-together-with-string contraptions looked comically plausible. This genre of harmless mad-inventorism has endured, for example as the eccentric Wallace and Gromit characters. Today, quite often the name Rube Goldberg Machine stands as a synonym for chain-reaction contraptions.
Recent popularity
Today there are several artists specializing in chain reaction machines.

Click this link to see five of the most outstanding examples of installations (including the OK GO *This too Shall Pass* music video shown earlier in the resource)
http://richannel.org/blog/2012/january/top-five-chain-reaction-machines

Rube Goldberg Machine Contests
With Rube Goldberg machines having gained icon status across America, each year the Rube Goldberg Machine Contest is held in the USA, with national contests at both high school and college levels. Big university teams entertain themselves for 4-5 months to create the most convoluted, intricate and creative machine possible.

A website with videos and all information about the Rube Goldberg Contest can be found at:
www.rubegoldberg.com

Chain Reactions from Japan
Chain reactions enjoy a special popularity in Japan and are built in a distinct style.

They started to be aired on the educational children television program *Pythagora Switch* and were soon transferred to prime-time TV.

Watch the video and enjoy a very excited commentator!
http://www.youtube.com/watch?v=1kvdq8cRNBM&feature=youtu.be
Chain-reactions and contraptions in movies
Below are a few links to movies, where chain-reactions have an appearance. The ‘filmcynics blog’ provides some extra information.

http://www.thefilmcynics.com/blog/?p=2203

- Wallace and Gromit / Cracking Contraptions - The Snoozatron
  http://www.youtube.com/watch?v=ozzjOQFOKt0&feature=relmfu

- Robots
  http://www.youtube.com/watch?v=PY5xNe8PrUg

- The Goonies - The Walsh’s front gate
  http://www.youtube.com/watch?v=kr_z37TgQO4

- Back to the future

- Pee Wee’s Big Adventure / The breakfast machine
  http://www.youtube.com/watch?v=KVdqwD_bcPs

- Malcolm / Australian 1986 cult movie full of contraptions
  http://www.youtube.com/watch?v=XlaA_TPMXqY

- Happy Gilmore / One shot golf scene
  http://www.youtube.com/watch?v=N7SCvfyQzUQ
Games

Contraptions also have appearances in games, both computer and traditional.

In the computer game *The Incredible Machine* Part I-III, it is the task of the player to construct a combination of different components of a chain reaction that trigger a certain task. Caution: very addictive.

Another computer contraption game is *Fantastic Contraption*. http://fantasticcontraption.com/

*The Mouse Trap Game* and of course *Dominos* are traditional games, incorporating the idea of contraptions.
Page 11 - Examples of reinvented objects:
- Broom: becomes a set of 'devil sticks' (a circus skill toy)
- Hat to head machine: made from vacuum cleaner, toilet seat, baby toy
- Toy car / record player
- Broom poles: become music instruments
- Fry pan: becomes a face

Page 19 - Triggers in Jospehs Herschers machine:
Joseph Herscher drinks his coffee (1), which pulls a string, which yanks a pencil (2), which tips paintings one by one as the balls roll down. The third ball rolls into a shelving unit (3) and swings a ladle, which pours glycerin from a jug into a cup, which combines with potassium and combusts. A fuse catches fire and burns, which releases the pool balls (4) one by one. The fourth ball lands in a hanging green shot glass (5), which turns on the gas. Meanwhile, The fuse (still burning) ignites the gas, which boils the liquid and sends steam into a sponge (6), which becomes heavy and tips, sliding a fly swatter (7) up, which releases a ball, which rolls along the top of the books, knocking the other balls and eventually knocking a Velcro-covered ball. The weight of the Velcro ball tips a book (8) out of the bookcase, which opens it and allows a small marble to roll out of the book and knock a vase (9) off the table. Headphones (10) are pulled by the vase, which releases an orange glass (11), which rolls along the slanted table, sticks to the tape (12) and yanks a pencil in the computer (13). The screen shuts and the computer falls off the table, which pulls a cable, switching on a hair dryer (14), which annoys the hamster (15). He runs, which causes the cage to tip. The pool ball (16) rolls along the top of the cage and drops, which knocks a baking pan (17) off the table, which pulls the hair dryer with it and causes tape (18) to roll across the table, sticking to, and turning, the front page of the newspaper (19).

Page 20 - Solve the Victorian mystery!

The Victorians were mad keen on their morning cup of tea and would go to ingenious lengths to make it without having to get out of bed. Ingeniously, an alarm clock triggers a switch resulting in a match striking against moving sandpaper, and in turn lighting the spirit stove beneath the kettle. Once the water boils, the steam pressure lifts a hinged flap and the kettle tilts, filling a teapot beneath. Finally, a plate swings over the stove, extinguishing its flames. Brilliant! (Maurice Colins/Eccentric contraptions, Rosa Morgan/ The Victorian Time)
WEBSITES:
Squaring the Wheel
http://www.squaringthewheel.blogspot.com
http://www.facebook.com/pages/Squaring-the-Wheel/357865674307586

Primary Drama Games
http://www.primaryresources.co.uk/pshe/pdfs/dramawarmups.pdf

Physical Theatre Activities
http://drama-education.com/lessons/physical-theatre.htm

Top 10 Isaac Newton Inventions
http://science.howstuffworks.com/innovation/famous-inventors/5-isaac-newton-inventions.htm

Simple Machines for Kids
http://scienceforkids.kidipede.com/physics/machines/

Joseph Herscher - The Page Turning Machine
http://www.youtube.com/watch?v=GOMIBdM6N7Q

OK Go - This Too Shall Pass
http://www.youtube.com/watch?v=qybUFnY7Y8w

Kinetic Art
http://www.theartstory.org/movement-kinetic-art.htm

Peter Fischli and David Weiss - The Way of Things
http://www.medienkunstnetz.de/works/the-way-of-things

Rube Goldberg Contest
www.rubegoldberg.com

Top 5 Chain-Reaction Machines
http://richannel.org/blog/2012/january/top-five-chain-reaction-machines

Japanese Chain-Reaction Machine
http://www.youtube.com/watch?v=1kvdq8cRNBM&feature=youtu.be

Rube Goldberg Machines in the Movies
http://www.thefilmcynics.com/blog/?p=2203

Wallace and Gromit / Cracking Contraptions - The Snoozatron
http://www.youtube.com/watch?v=ozzjOQFOKt0&feature=relmfu

Robots
http://www.youtube.com/watch?v=PY5xNe8PrUg

Malcolm / Australian 1986 cult movie full of contraptions
http://www.youtube.com/watch?v=XlaA_TPMXqY

Happy Gilmore - One shot golf scene
http://www.youtube.com/watch?v=N7SCfYqzUQ

Contact Jens Altheimer at jensaltheimer@gmail.com with further questions or, even better, examples of your work!