

STEEL

Words: Dave Quick
Music: Jon Wakefield

March 2nd 2005 Royal Concert Hall, Nottingham
April 10th 2005 Royal Opera House, Covent Garden

An atom's tale told in music, song & dance

Produced by Jon Wakefield & Dave Quick
Directed by Jon Wakefield & Carrie Bird

Who would like to thank the following organisations for lending their support

Arnold Hill School & Technology College
Flying High Expressive Arts
Sandra Taylor School of Dance
In Accord Chamber Choir
Heathfield Junior School
Ernehale Infants School
Carlton Digby School
Mapperley Plains Primary School
Arnovale Junior School
Ernehale Junior School
Willow Farm Junior School
Stiff-Legged Derrick

Welcome & intro Dave Quick

Nucleus(STSD)

From 'Stardance' a look at the atom. Most of it is unbelievably empty. A tiny bit at the centre is unbelievably solid.

Narrated by Summaya Mughal and Daniel Harvey

Choreography by Tom Gribbey

Sung by Don Price

Danced by:

Holly	Barker	Anna	Jackson	Laura	Rudolph
Kirsty	Basigara	Rosie	Lesurf	Ellena	Self
Caroline	Brierley	Elisa	Maffucci	Sally	Short
Kate	Coombs-Taylor	Vicky	Marsden	Rosie	Swingler
Charlotte	Cox	Sarah	McCalla	Helen	Towers
Annabel	Houldey	Hannah	Paradise		

Grubs & Old Queen (Heathfield & Ernehale)

Two pieces from 'Hive', the story of a beehive. In the first we see the two burning passions of a bee grub. One is eating. The other is getting fat. Fortunately they go together well.

In the second piece we see the old queen about to die. After a lifetime as an egg-laying sausage machine, she's pretty happy about it.

Introduced by James Birkett

Sung by Heathfield Primary School Choir, conducted by Jan McQueen

Nilufar	Ahmadi	Nicole	James	Billie-Jo	O'Keefe
Nadiyah	Ariff	Nadine	James	Nicole	Passarelli
Samantha	Baumfield	Amara	Lemard	Renee	Rubio-Richards
Paige	Berresford	Hillie	Leverton	Hannah	Smith
Grace	Blick	Claire	Machin	Jake	Stephenson
Lauren	Chubb	Jessica	Mackay	Robbie	Vaughan
Kathryn	Cook	Poppy	Marsden	Lauren	Wakelin
Leah	Cook	Dominic	Marsden	Billie	Wheat
Kimara	Curtis	Kalen	Merrin	Kimone	Williams
Amy	Davies	Megan	Morris	Jessica	Wyer
Aaliyah	Deacon	Paige	Murphy		
Tyler	Guy	Hannah	Musovic		

Choreography by Marie Hopkins, Costume & dance by Woodthorpe Infants

Emma	Bartlett	Courtney	Bowns	Bethany	Cooper
George	Bateman	Kelly	Brown	Holly	Cunningham
Alexander	Beard	Alexander	Brown	Harvey	Devenport
Raine	Beckford	Fiona	Calderwood	Emily	Hancock
Rebecca	Blasdale	Alfie	Cook	Zoe	Harrison

Kathryn	Hopkins	Jacob	Rajakaruna	Georgia	Skill
Ben	Hunt	Isaac	Rajakaruna	Conchita	Waddington-Little
Ella	Magiera	Alexander	Reed	Rosie	Watson
Niamh	McKenna	Rohan	Samrai	Chloe	Wigmore
Ivan	Newman	Bethany	Sayers		
Matthew	Pike	Archie	Simmons		

Volcanoes (AHS)

From 'Little Blue' a dance reflecting a very early and highly hostile time in the life of our little blue planet.

Introduced by Ashanti Payne

Choreography, costume and dance by Louise Anderton and Sacha Rowbotham

Gold (Carlton Digby)

From 'Stardance' comes an element with more significance as metaphor than chemistry.

Introduced by Jon Wakefield

Choreography & costume design by Marie Hopkins

Sung by Kate Egner

Danced by

Louise	Anderton	Emily	Gurney	Luke	Pollard
Matthew	Artis	Marie	Hopkins	Kayleigh	Weaver
Matthew	Gosling	Callum	Moore		

2nd law (AHS)

Short for 'The second law of thermodynamics'. Truly fascinating in its importance and complexity, this law basically says things get worse. The first performance of this piece

Introduced by David Quick

Sung by Laura Woodward, accompanied by Jez Fleet

Danced and choreographed by Leanne Parker and Sophie Broughton

Uranium 235(STSD)

The final piece in 'Stardance'. Uranium 235 has an over-stuffed nucleus, which is prone to split, giving off a puff of energy. This wouldn't matter if all the nuclei around it didn't decide to do the same. This is called a 'chain reaction' and is what did for Hiroshima and Chernobyl.

Introduced by Jon Wakefield

Dialogue by Tom Horton & Kate Egner

Choreography by Tom Gribbey

Danced by

Holly	Barker	Anna	Jackson	Laura	Rudolph
Kirsty	Basigara	Rosie	Lesurf	Ellena	Self
Caroline	Brierley	Elisa	Maffucci	Sally	Short
Kate	Coombs-Taylor	Vicky	Marsden	Rosie	Swingler
Charlotte	Cox	Sarah	McCalla	Helen	Towers
Annabel	Houldey	Hannah	Paradise		

-----Interval-----

'Steel'

The story

It all takes place in mountains of Kazakhstan (one of many places to find iron ore) and tells of iron's search for a mate. He nearly makes a bad choice of partner, having a short lived dalliance with smelly old sulphur from which he is saved in the nick of time by the arrival of the beautiful & irresistible oxygen. Sulphur is left heartbroken. As for iron and oxygen, they hitch up and live happily ever after.... until the Soviet Union collapses.

Just as our pair of loving atoms seem to have got their act together, everything suddenly goes horribly wrong. You would think that being buried deep under the hills of Kazakhstan would more or less guarantee that the activities of mankind would have no effect whatsoever on your lifestyle.

Not so. If you and your partner happen to make up iron ore and the world up above just happens to want iron ore, then they're going to come looking for you. With language difficulties it is easy to see how an expression like 'strip miners' could be misunderstood.

The fortunes of our young lovers plummet as the local miners dig them out & take them into captivity and the service of mankind

In Act 2 they come face to face with the dark priest of the blast furnace, Father Tuyère who, with his twisted assistant Slagrat, seeks to produce pure iron...steel. In the pursuit of purity for iron, this fallen priest sets about wresting oxygen from the arms of her man. Failing to separate the lovers with his torments of fire, he conjures up the terrible carbon crows, the monoxide monsters, whose lust for oxygen is powerful enough to break their loving bond and bear her away on the winds of the world. The iron atoms, alone, become steel and are put to work in the service of mankind.

In Act 3 oxygen is released from her unholy bondage by the ladies of the leaf in the green forest and the carbon crow is taken into the tree to become part of its fabric, although not before a bit of well-earned payback. Oxygen searches for her iron atom, and finds him on the battlefield. Joy of discovery sinks to melancholy as the iron atom, broken in spirit, cannot accept her advances. Oxygen has to set him right. They come together in the chapel of rust and sink into happy and eternal obscurity as a tiny flake of rust in the Kazak mud. Bless

Introduction Summaya Mughal

Going East

In which we head towards the hills of Kazakhstan where our heroes are to be found

Choreography by Marie Hopkins

Baritone solo by Tim Plaice/Tony Bell

Iron

Iron appears on the scene and looks for a mate. He tries a few. Sulphur may pong a bit, but she's around

A Little Lovin'

She's willing.

Choreography by Jennifer Manderson

Solo voice: Will Moss

Sulphur Rock

& she's the only game in town

Solo voice: Emma Woods

Oxygen

Until oxygen arrives.
Choreography by Nicola Chambers
Sung by Laura Woodward & Sian Holding

Man of iron

Sulphur out, oxygen in....iron oxide.
Sung by Will Moss and Claire Moss

Might have been

Sulphur is left; abandoned & alone
Choreography by Jennifer Manderson
Solo voice: Laura Woodward

Ironstone Rock

For iron oxide, deep in the Kazak hills, everything looks good

Freedom

Back to the full scale world of mankind to see what is happening up above. The Soviet Union has collapsed, freedom is breaking out. A good thing? Depends on whether you're old communist, peasant or mafia.
Choreography by Marie Hopkins
Solo voice: Don Price

Strip Miners

Dimitri isn't the sharpest tool in the box, throw in some language difficulties and it's easy to see how confusion can arise.
Acted by Kate Egner (Svetlana) and Tom Horton (Dimitri)

Mountain Down

Finally, it's time to go get that rock
Choreography by Sandra Taylor + dancers

Misery Road

Back down to the atomic scale. For iron oxide home has gone and captivity beckons
Solo voice: Don Price

Act 2**The Blast Furnace**

A place of torment ruled by a fallen priest.
Father Tuyère: dancer James Cox, voice Tony Bell
Slagrat: dancer Robert Drew, voice Peter Kempster

Purity

Slagrat's song about just how important purity is, not just for iron, but for all of us.
Choreography by Jennifer Manderson

Torment by Fire

In the fight to separate oxygen from iron, flames make the first attack

Wake up Dead

Father Tuyère summons his most poisonous allies. One of mankind's deadliest enemies. The monoxide crows. They sing of the harm they do to mankind.

Crow Feast

Turned loose on iron oxide they tear oxygen from the arms of iron

Wings of Night

And carry her into exile

Flute: Miriam Bell

Piano: Jez Fleet

Miserere**Rattle them Chains**

Father Tuyère leads the iron atoms in a dance to celebrate their purity and life of service to mankind

Solo voices Tony Bell & Don Price

Act 3**Lady of the Leaf**

the powers of the forest release oxygen and trap carbon

Choreography by Jennifer Manderson & Rachel Elderkin

Solo voice: Amy Southgate with Emma Woods, Claire Harvey & Laura Woodward

The Battlefield

With the help of the forest oxygen searches for her lost lover

Solo voice: Holly Collinson-Shield

Can it be you?

Who could believe that they would find each other again?

Sung by Will Moss & Kate Egner

Take me to the Chapel

A girl can only listen to a bloke moaning for so long. Its make up your mind time

Sung by Emma Woods

Chapel of Rust

Windsor Guildhall was booked, so it has to be the chapel.

Solo voice: Emma Woods with Laura Woodward, Claire Harvey and Amy Southgate

Wedding

Ceremony performed by Jon Wakefield

Finale

Cast of 'Steel'

Choreography by Carrie Bird unless indicated

Soloists

Iron danced by Jonathan Bird

Oxygen danced by Nicola Chambers

Sulphur danced by Jennifer Manderson

Monoxide crow danced by Rachel Bird

Father Tuyère danced by James Cox, sung by Tony Bell

Slagrat danced by Robert Drew, spoken by Peter Kempster

Ladies of the Leaf danced by Jennifer Manderson & Rachel Elderkin

Narrators**Act 1** Diane Blythe & Helen McKinnon**Act 2** Will Moss & Tom Horton**Act 3** Leanne Parker**Group Dancers****Iron (Flying High)**

Catherine Ackrill

Sophie Maynes

Daisy Sowter

Natasha Bird

Evie Parker

Emily Thurston

Katie Brooks

Alice Pilkington

Elizabeth Hunt

Emma Richardson

Oxygen (Flying High)

Ruby Brooke-Wilkinson

Sophie Hatton

Kathryn Moore

Zoe Brandwood

Katherine Hopewell

Faye Oliver

Yasmin Castle

Kathryn Jackson

Olivia Shykles

Kathryn Drew

Alexandra Kerrison

Evie Shykles

Felicity Earnshaw

Emily Massey

Evie Slade

Elizabeth Earnshaw

Lottie Massey

Emma Stanfield

Emily Evans

Ellie Maynes

Nicole Thurston

Crows, corpses & Flames (Flying High)

Rebecca Anderson

Rosaria Cracolici

Jennifer Manderson

Rachel Bird

Rachel elderkin

Alice Mason

Molly Brown

Alice Feetham

Emma Terzza

Joanna Chambers

Lauren Fletcher

Sam Ward

Megan Chilton

Cassie Holden

Kate Watson

Jessica Collinson-Shield

Shona Manderson

Esther Wilson

Going East & Freedom (AHS)

Stephanie Bray

Sarah MacDuff

Aliz Tennant

Sophie Broughton

Alice Mason

Hannah Wilson

Laura Corder

Coran Roberts

Mountain Down (STSD)

Caroline Brierley

Ellena Self

Helen Towers

Annabel Houldey

Laura Rudolph

Musicians**Lead guitar:** Rob McKinnon, (also on backing track in Uranium & Volcanoes)

Drums: Martin Lee & Sophie Mills
Bass guitar: Paul Williams
Rhythm guitar: Don Price
Keyboards: Jez Fleet
Saxophone: Tony Bell
Flute: Miriam Bell

Singers

In Accord

Miriam	Bell	Anna	Gregory	Tim	Plaice
Tony	Bell	Philip	Hardy	Don	Price
Olwen	Bowpitt	Lucy	Matthews	Sandra	Wakefield
Holly	Collinson-Shield	Denise	Mear	Mags	Wigram
Sue	Cooper	Claire	Moss		
Vicky	Ewan	Alyson	Pinskey		

Junior School

Alicia	Brown	Sophie	Hatton	Summaya	Mughal
Annie	Butcher	Connor	Holmes	Laurie	Osborne
Emily	D' Aguiar	Helen	Lewis	Zoe	Tait
Jonathon	Greensmith	David	Lynas		
		Joe	Mitchell		

Arnold Hill

Matilda	Archon	Ashanti	Payne	Kate	Egner
Sarah	Argyle	Alex	Richards	Daniel	Harvey
James	Birkett	Charlotte	Rollins	Claire	Harvey
Jessica	Bryan	Rachel	Simpson	Sian	Holding
Rosie	Burnside	Josh	Smith	Ashley	Holt
Harriet	Cameron	Clare	Walsh	Thomas	Horton
Nicola	Chadburn	Rosie	Whitton	Helen	Mckinnon
Heather	Gretton	Christen	Woods	Sophie	Mills
Nicholas	Heeley	Katie	Wragg	William	Moss
Emily	Harrison	Diane	Blythe	Amy	Southgate
Iain	Harvey	Sophie	Broughton	Emma	Woods
Peter	Kempster	Kirsty	Carr	Laura	Woodward
David	Mear	Carmel	Clarkson		
Sophie	Mitchell	Gio	Cracolizzi		

Carlton Digby

Gary	Brookes	Ian	France	Kayleigh	Weaver
Martin	Brookes	Pam	Loydall		

Costumes

Philippa Riley
 Isabelle Riley

Kayleigh Wells (oxygen & sulphur)

Lighting Damian Painton

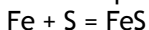
Sound Rob Kettridge

Science notes

Iron atoms can only form in the very biggest and most violent explosions of dying stars, so a whole generation of stars had to live and die before our planet could even begin to form. When the earth did finally coalesce from the stardust clouds of their funeral pyre, most of the iron went to the core. It remains there to this day in truly massive amounts under tremendous heat and pressure where it makes the north and south magnetic poles. A little, however, made its way to the surface. It has been around since the earliest days of the planet. While not as high in the reactivity series as metals like sodium and magnesium it is still pretty reactive. Later in the history of our planet, plant life used photosynthesis to produce oxygen. This is a very reactive gas, highly toxic to lower life forms, which would become a feature of our atmosphere. Over the next two billion years it would react with just about everything, including iron.

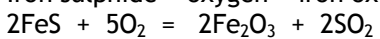
In those early days, however, the atmosphere consisted of gases like nitrogen, methane, ammonia and carbon dioxide, none of which were in a position to react with iron. Sulphur, however, was around and often did react. The symbol for iron in the equation below is 'Fe' because it was known when science was studied in Latin and was called 'ferrum'...similarly lead is Pb because it was called 'plumbum'.

Iron + sulphur = iron sulphide.



Iron sulphide forms heavy square golden crystals, known as 'fools' gold' because it has so often been mistaken for the precious metal. Often found in the sort of places you would look for gold and glittering like gold in the light of a miner's lamp, it was an easy mistake to make. The sulphur smell on your hand when you handle these beautiful crystals should generally put you right. As plants produced more & more oxygen so more and more elements and compounds reacted with it to form oxides. An awful lot of iron sulphide would remain, unchanged, deep in the rocks. Any iron sulphide near to the surface, however, was oxidised by the newly arrived oxygen.

Iron sulphide + oxygen = iron oxide + sulphur dioxide



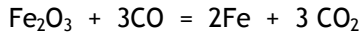
It can be seen that sulphur does not remain alone once iron has abandoned her for oxygen. She takes a leaf out of iron's book and bonds with oxygen herself!

When iron ore is mined and separated from all the waste rock it is essentially iron oxide. In order to get the pure iron, we have to remove the oxygen to which it is bonded. This is not easy as iron and oxygen are bonded together very firmly. The separation takes place in a blast furnace and requires a reducing agent. A reducing agent is a chemical that is hungry for oxygen and a powerful reducing agent will go to any lengths, break any bonds, to get the oxygen it wants. The reducing agent used in the blast furnace is just about the most powerful one going. It is called carbon monoxide. It does us harm whenever it gets the chance. Wherever there is burning it can appear. It crops up all over. A car engine pumps it out, so does a badly serviced central heating boiler. Sometimes when you put a piece of coal on the fire a little pocket of gas breaks open and a pretty blue flame jets out. That pretty blue flame has killed thousands of coal miners. It has no taste, no smell and no colour. If you do happen to breathe some, it will go straight to your blood and bond to the oxygen it finds there. This means your muscles and brain are starved, it also makes your blood turn solid. All you notice is a pleasant drowsiness, your face becomes flushed and you nod off.

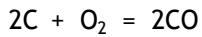
Trouble is, you wake up dead.

In the blast furnace it uses its powerful hunger for oxygen to reduce the iron oxide to iron.

Iron oxide + carbon monoxide = iron + carbon dioxide



The carbon monoxide is provided by burning carbon in a limited air supply. The blast of hot air that starts this process enters low in the blast furnace through special nozzles called tuyères



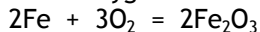
Having gained an oxygen atom it becomes carbon dioxide and is no longer dangerous.

Sooner or later, however, every molecule of carbon dioxide in the air is drawn into the leaves of a plant and forced to undergo photosynthesis. This will result in the oxygen half of carbon dioxide being released back into the air and the carbon half being incorporated into the very being of the plant itself. About a thousand litres of carbon dioxide are locked up in every kilo of plant material. Be it lettuce, tulips or timber. A five kilo bag of potatoes locks up around five thousand litres of this notorious greenhouse gas. We release it whenever we eat them.

When the iron comes out of the blast furnace it is not very pure, mainly due to the presence of carbon. In fact this impure iron, called 'cast iron' is not an awful lot of use until it has been purified a bit more to turn it into the material we call 'steel'. Now here's a bit of a contradiction: Only about 96% of the atoms in 'iron' are iron atoms. The figure for steel is about 99%. There is usually more iron in a piece of steel than there is in a similar piece of iron?!

Iron belongs to a very useful group called the 'transition metals'. It is strong yet malleable (you can bend it), ductile (you can stretch it) and it's cheap. Its only drawback is it will always try to react with oxygen, although it needs to be in contact with both air and water if it is to achieve this. The reaction is actually quite complex and quite electrical, but the equation that summarises it is:

Iron + oxygen = iron oxide



We call this iron oxide 'rust' and devote lots of energy to trying to prevent it.

In fact from an iron atom's point of view things have gone full circle and they are back to where they started.