

Ahead of the Curve: The SpaceChem Postmortem

Zach Barth

Creative Director, Zachtronics Industries

Zach Barth

Zachtronics Industries

SpaceChem

(specifically, design and production)

Right

Wrong

... and then audience questions!

Let's talk about SpaceChem



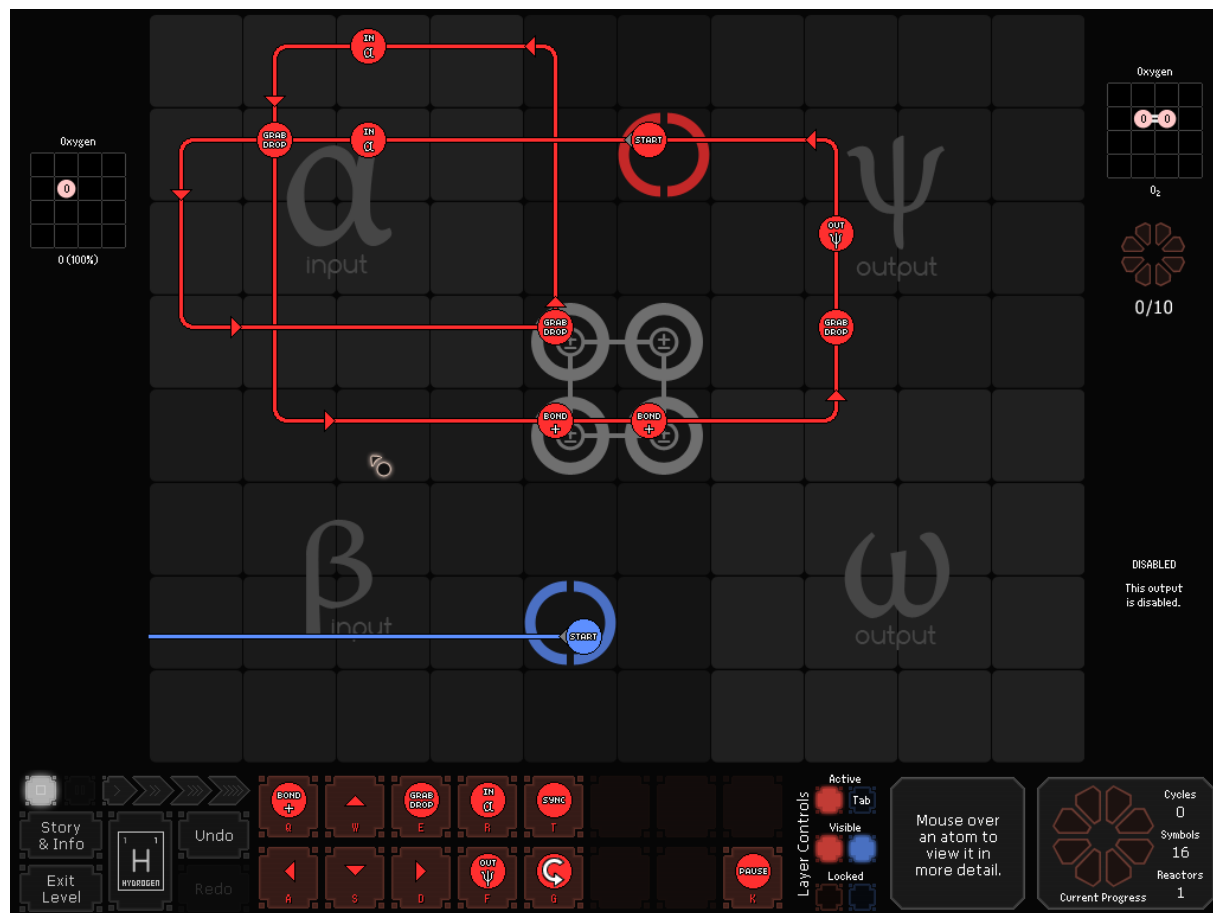
**Raise your hand if
you have HEARD of
SpaceChem**



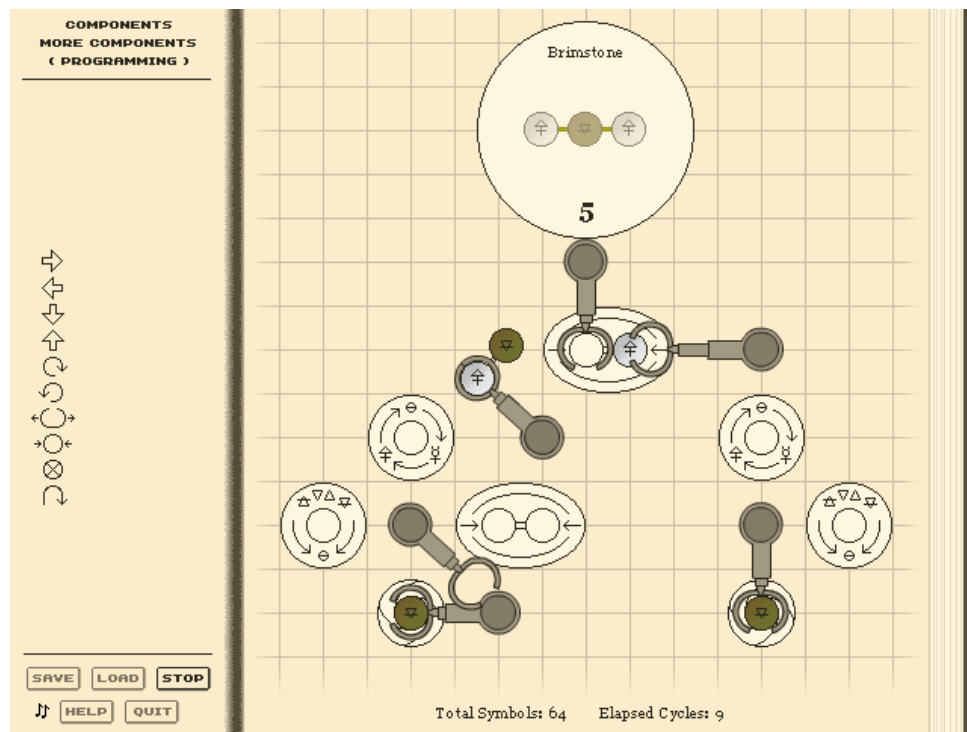
**Raise your hand if
you have PLAYED
SpaceChem**



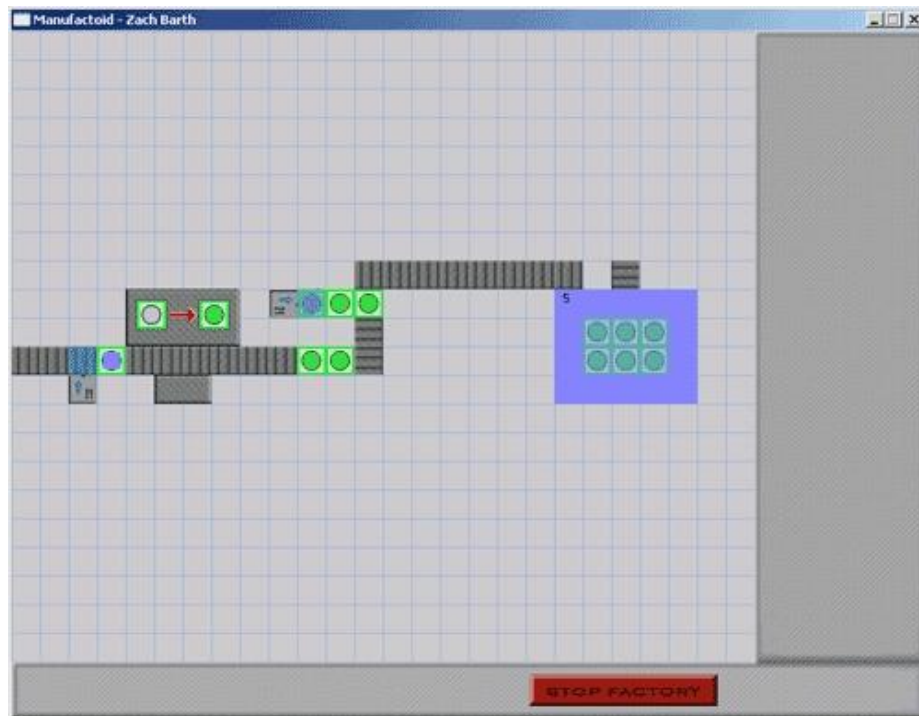
**Raise your hand if
you LOVE/HATE
SpaceChem**



What inspired SpaceChem?



The Codex of Alchemical Engineering



Manufactoid



How It's Made



Gas Works Park (Seattle, WA)

**What genre of game
is SpaceChem?**

Design-based Puzzle Game

What is a design-based puzzle game?

You just made that term up.

Answer #1

A DEFINITION

A design-based puzzle game is a puzzle game where solutions take the form of a design.

design (n.): a specification of an object, intended to accomplish goals, in a particular environment, using a set of primitive components, satisfying a set of requirements, subject to constraints;

**design (n.): plans for a thing, that does stuff, in a
place, using parts, with constraints;**

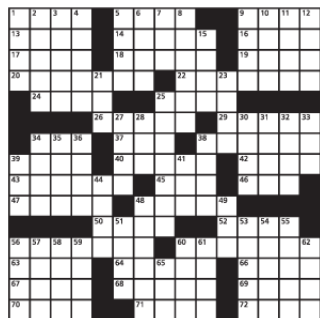
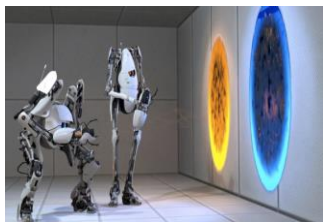
Answer #2

YOU KNOW IT WHEN YOU SEE IT

TRADITIONAL PUZZLE

SINGLE SOLUTION

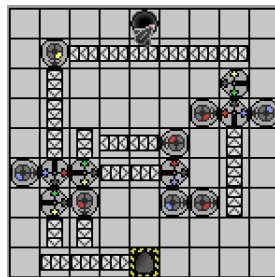
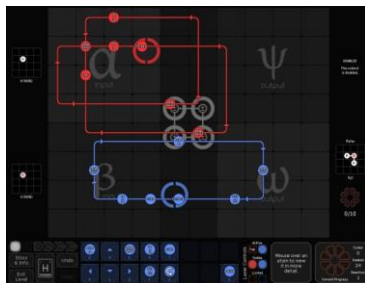
NO REPLAY VALUE



DESIGN-BASED PUZZLE

MANY SOLUTIONS

SOME REPLAY VALUE



NOT A PUZZLE

NOT SOLVABLE

LOTS OF REPLAY VALUE

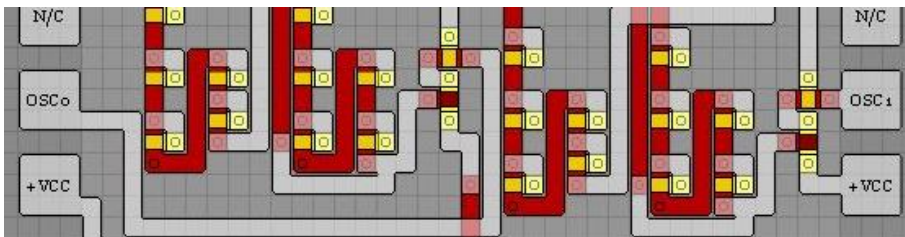
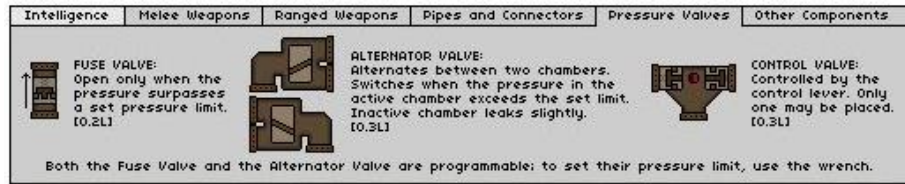


Four Aspects

OF SOME DESIGN-BASED PUZZLE GAMES

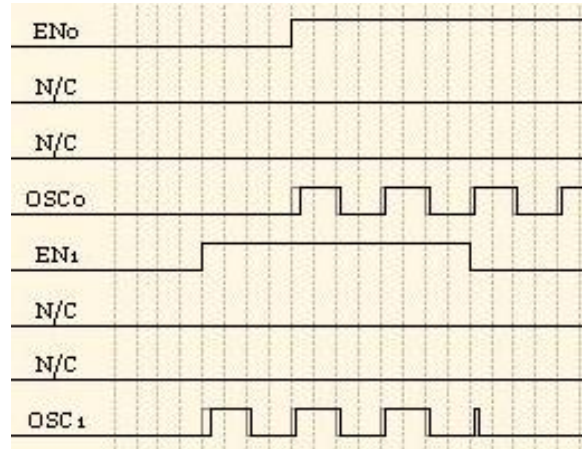
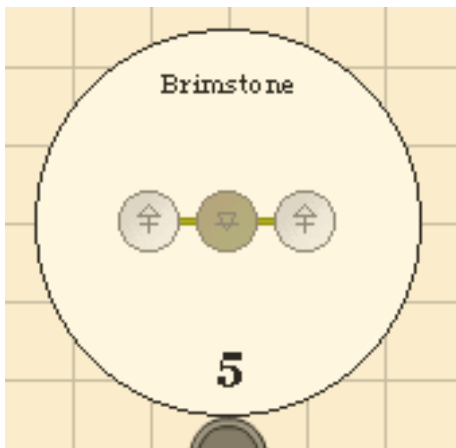
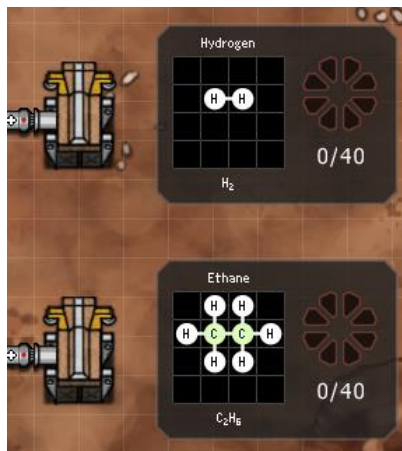
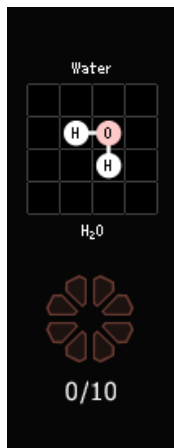
Emergent Tools

“... using a set of primitive components ...”



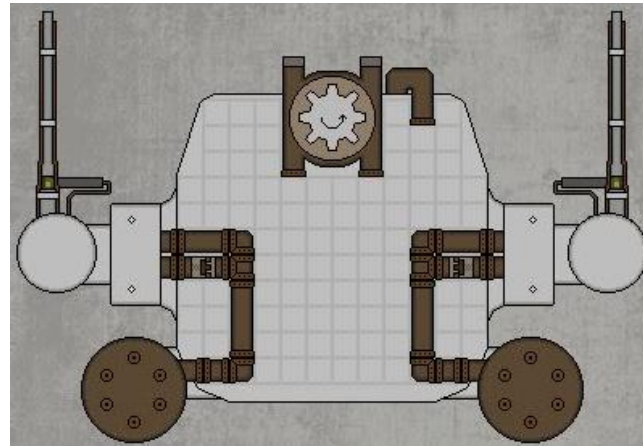
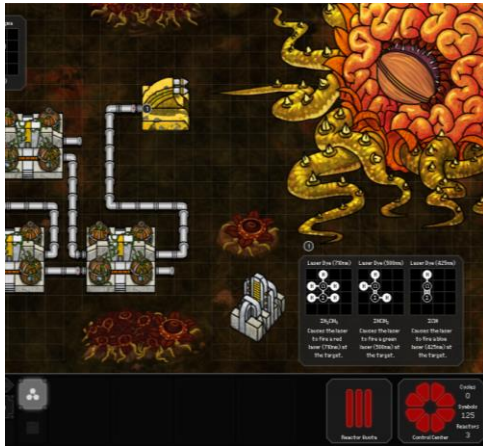
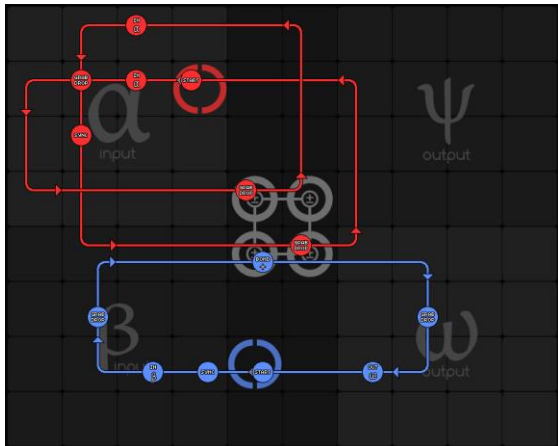
Precise Goals

“... intended to accomplish goals ...”



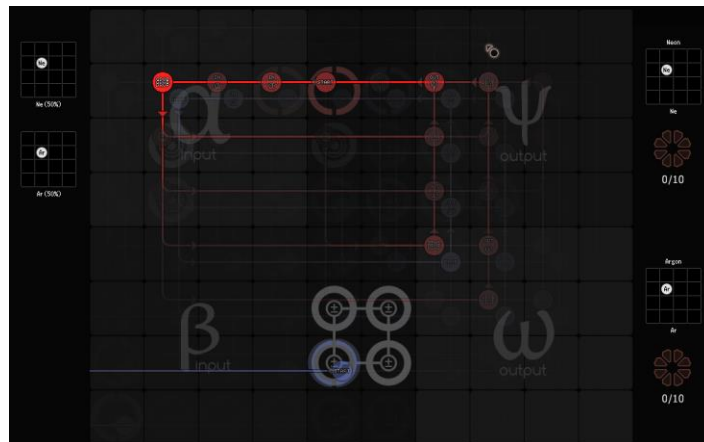
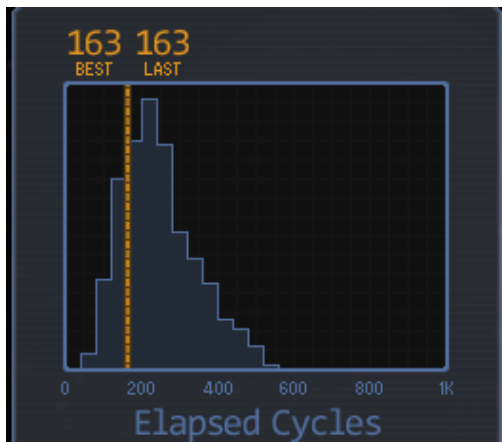
Canvas + Constraints

“... in a particular environment, subject to constraints ...”



Many Solutions

“... a specification of an object ...”



Emergent Tools
Precise Goals
Canvas + Constraints
Many Solutions

“Ingredients”?

Lofty Goal

So what?

Add that together...

Crack for Engineers!

Ownership →
“Favorite Game”

BONUS:

Making puzzles is easy!





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The Free Encyclopedia

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Acetone

From Wikipedia, the free encyclopedia

Not to be confused with [Acetoin](#).

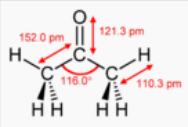
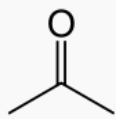
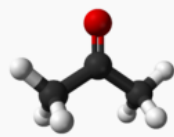
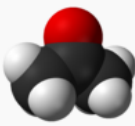
Acetone (systematically named **propanone**) is the [organic compound](#) with the formula (CH₃)₂CO. It is a colorless, mobile, flammable liquid, and is the simplest ketone.

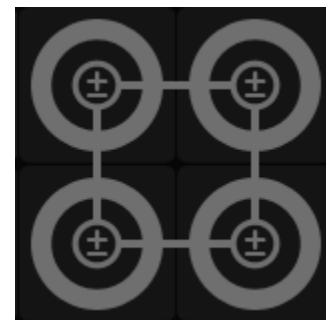
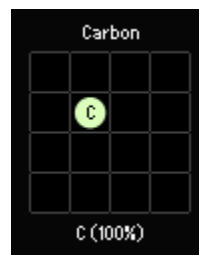
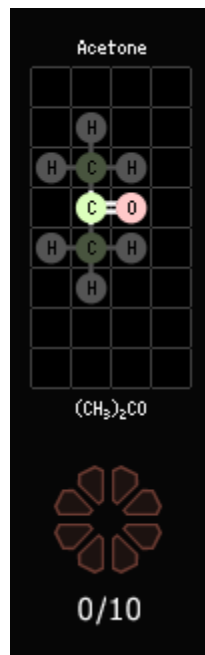
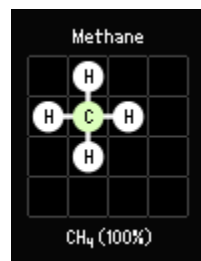
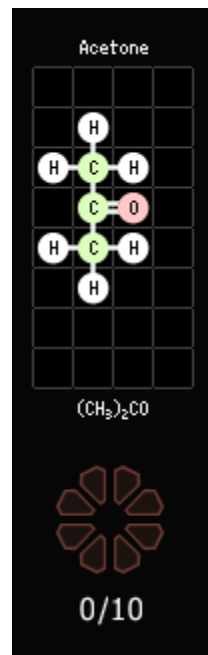
Acetone is [miscible](#) with [water](#) and serves as an important [solvent](#) in its own right, typically as the solvent of choice for cleaning purposes in the laboratory. About 6.7 million tonnes were produced worldwide in 2010, mainly for use as a solvent and production of [methyl methacrylate](#) and [bisphenol A](#).^{[8][9]} It is a common building block in [organic chemistry](#). Familiar household uses of acetone are as the active ingredient in [nail polish remover](#) and as paint thinner.

Acetone is produced and disposed of in the human body through normal metabolic processes. It is normally present in blood and urine. People with [diabetes](#) produce it in larger amounts. Reproductive toxicity tests show that it has low potential to cause reproductive problems. Due to the higher energy requirements in pregnant women, nursing mothers and children, they have higher levels of acetone. [Ketogenic diets](#) that increase acetone in the body are used to reduce epileptic attacks in infants and children who suffer from recalcitrant [refractory epilepsy](#).

Contents ^[hide]

- 1 [Biosynthesis](#)
- 2 [Production](#)
 - 2.1 [Current method](#)
 - 2.2 [Older methods](#)

Acetone ^[1]	
	
	
IUPAC name	^[hide]
2-Propanone	
Systematic name	^[hide]
Propan-2-one ^[2]	
Other names	^[hide]
Dimethyl ketone ^[3]	
β-Ketopropane ^[3]	
Propanone ^[4]	
2-Propanone ^[3]	
Dimethyl formaldehyde ^[5]	
Pyroacetic spirit (archaic) ^[6]	



The interface displays a chemistry puzzle game. The main workspace is a grid where a reaction path is shown. The path starts with Methane (CH_4) at 100% on the left, moves right to a red 'START' node, then down through a series of nodes (including a large α input node and a β input node) to a blue 'START' node at the bottom. From there, the path continues up through a series of nodes (including a large ψ output node) to Acetone ($(\text{CH}_3)_2\text{CO}$) on the right. The path is highlighted with a red line from the top and a blue line from the bottom.

On the left side, there are two chemical structures: Methane (CH_4) and Carbon (C), both at 100%.

On the right side, there is a chemical structure for Acetone ($(\text{CH}_3)_2\text{CO}$) and a progress indicator showing 0/10.

The bottom interface includes a toolbar with various controls:

- Story & Info, Exit Level, and a Hydrogen atom icon.
- Undo and Redo buttons.
- A series of buttons for actions: BOND (+), W, GRAB DRAG (E), IN (C), SYNC (T), FUSE (U), FLIP FLOP (I), PAUSE (K), OUT (V), and a circular arrow button.
- Layer Controls: Active, Visible, Locked, and a button to view an atom in more detail.
- A progress indicator showing Cycles (0), Symbols (0), and Reactors (1).

SpaceChem

Community Features

Jan 3, 2009 4:29pm



Jayless

70 posts

[Flag Post](#)

Wow! I'm impressed. That's another 7 symbols off, and there weren't that many to begin with.
"I don't think it's compatible with my new approach, though."
I tried, it's not :)

Jan 4, 2009 4:16am



Jayless

70 posts

[Flag Post](#)

I saw in the highscores that both Maltro and SAL9000 achieved Level 5 (Oil of Vitriol) in 9 symbols, so I tinkered a bit:
t,9,8;b,4,10;c,3,6;m,1,10,90,2,cluod;m,6,7,90,2,rroc;
It uses only 2 arms, and even though the delivery arm has to carry the product a staggering 2.5 laps to get the desired result, it still works ;)

Jan 5, 2009 1:20am



Jayless

70 posts

[Flag Post](#)

MrRubix, turns out that you CAN do level 7 (Haematite) with only 4 manipulators! It's still 24 symbols though:
p,10,11;b,4,11;m,7,11,90,1,cullldol;m,1,11,90,1,cuuloddl;m,13,11,90,1,cror;m,7,7,0,3,lod;

Players like to COMPETE, OPTIMIZE, and SHARE SOLUTIONS

Histograms



“Egalitarian leaderboard”
Encourages optimization
Everyone is a winner!
... but not for every game

SolutionNet Leaderboards

spacechem.net/leaderboards/no-stomach-for-lunch/cycles

SOLUTION NET

SolutionNet Leaderboards

"No Stomach for Lunch", by least cycles

Switch to least symbols leaderboard

View official solution statistics for this level

- SolutionNet Leaderboards
- Solution Statistics
- FAQ

Not logged in

- Log in
- Register an account

#	User	Cycles	Symbols	Reactors	Uploaded
1	cearn <small>I used the double-rotate in 'Electrophilic Addition' last week and decided to try it here as well. Gave me the extra cycle :)</small>	148	29	1	April 28, 03:09
2	Andy	149	26	1	May 29, 17:09
3	johannes	149	27	1	June 03, 03:23
4	Ze1	149	27	1	June 03, 22:57
5	Saighdiur	172	32	1	November 11, 22:18
6	GuavaMoment	175	28	1	October 17, 20:27
7	jjs132	188	25	1	August 12, 19:04
8	Scaevolus	188	35	1	October 16, 17:32
9	dancek	188	35	1	January 27, 15:32
10	kwanm	188	35	1	August 23, 05:33
11	Haiaiai	188	36	1	October 05, 13:22
12	theelep1	189	31	1	June 19, 11:04
13	eFse7en	192	43	1	August 23, 16:40
14	JYPark1101	196	27	1	March 29, 21:05
15	MiniDoux <small>view on YouTube</small>	198	28	1	December 23, 03:40
16	GiaoTime	200	29	1	August 23, 10:10
17	Bashy_McFetus	207	31	1	October 15, 21:46
18	etotheipi	207	34	1	May 30, 13:25
19	nicuveo	207	35	1	May 29, 17:10
20	sboparen	207	40	1	January 03, 01:59

Videos

index.htm
file:///D:/SpaceChem/Bonus/Early%20Sharing%20Mockup/index.htm

Nitrogen

N_2 (70%)

Oxygen

O_2 (20%)

Carbon Dioxide

CO_2 (10%)

WASTE SILO

Nitric Oxide

NO / 50

Nitrogen Dioxide

NO_2 / 50

Nitrous Oxide

N_2O / 50

★ LEVEL ★

MASTERED

Click on a reactor to view the inside of that reactor.

SAVED: 06/22/2010 04:54 PM

✓ Nitric Oxide

NO

== REQUIRED TO PASS ==

✓ PRODUCE 2 OF 3 PRODUCTS

✓ Nitrogen Dioxide

NO_2

== REQUIRED TO MASTER ==

✓ PRODUCE 3 OF 3 PRODUCTS

✓ Nitrous Oxide

N_2O

== REQUIRED TO MASTER ==

✓ NO WASTE GENERATED

TOTAL CYCLES: 11064

TOTAL SYMBOLS: 161

TOTAL REACTORS: 5

YOU

YOU

YOU

index.htm
file:///D:/SpaceChem/Bonus/Early%20Sharing%20Mockup/index.htm

Metro Guide

0 / 50

Register

★ LEVEL ★
MASTERED

Click here to return to the pipeline view.

SpaceChem
a game by Zachtronics Industries
Enterprises

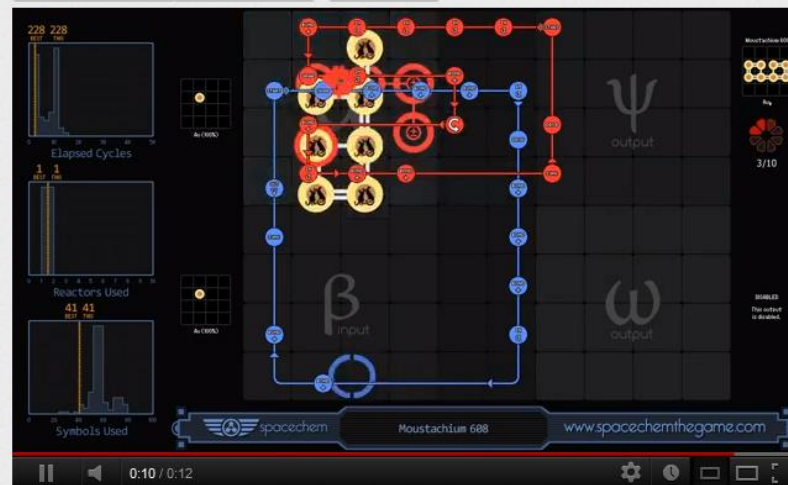
BUY NOW!
ONLY \$10!

SpaceChem - Moustachium 608 (228/1/41)

Alexander Zeillinger

+ Subscribe

92 videos ▾



Like



Add to

Share



4,933

Uploaded by [Alexander Zeillinger](#) on Apr 30, 2011

Original design by krogersish, this one just places the blue out 1 cycle earlier.

32 likes, 2 dislikes

Recorded solution for "Moustachium 608" from SpaceChem, a design-based puzzle game from Zachtronics Industries.

Download the demo at <http://www.spacechemthegame.com> today!

Category:[Gaming](#)**License:**


Standard YouTube License

NOTE:

**Cross-platform recording of in-game videos
is difficult. Talk to me later if you want to
know how we did it.**


Custom Puzzles

Edit Input α



Water
 H_2O
100%

Edit Input β



Carbon Dioxide
 CO_2
100%

Research Editor

Assignment Name
PAX Challenge 2












Author Name
Zach







Save and Play

Save and Exit

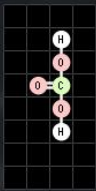
Cancel

Reactor Components


Bonder	Sensor	Tunnel
		
0 2 4 8	0 1	0 2
   	 	 

Fusion Laser	Fission Laser
	
0 1	0 1
 	 

Edit Output ψ



Carbonic Acid
 H_2CO_3

 Large Output

Press Tab to view LEADERBOARDS.

The Journal of Reaction Engineering

RESEARCH
NET

**Volume 1
Issue 9**
"Actual
Science"

Friedel-Crafts
Jseah

Wöhler Synthesis
Kanddak

Diels-Alder
Jseah

**Volume 1
Issue 8**
Nuclear
Science

Chlorination
Dischorran

Sulfuric Acid
Nemorlicus

Bad Times
Kanddak

**Volume 1
Issue 7**
Fantastic
Organics III

Industrial Methanol
Patrick

Glyoxylic Acid
Kdapro

Bioplastic
Sniped50

Back Create or Import an Assignment Newer Older

PROS:

- No “trash” puzzles.
- No puzzles that break the spirit of the game.
- Themed “issues” make puzzles feel more cohesive.
- Getting “published” is exciting!

CONS:

- Kind of a pain in the ass.

Cautionary Tale #1:

APPEAL

Everyone Loves

~~SCIENCE!~~

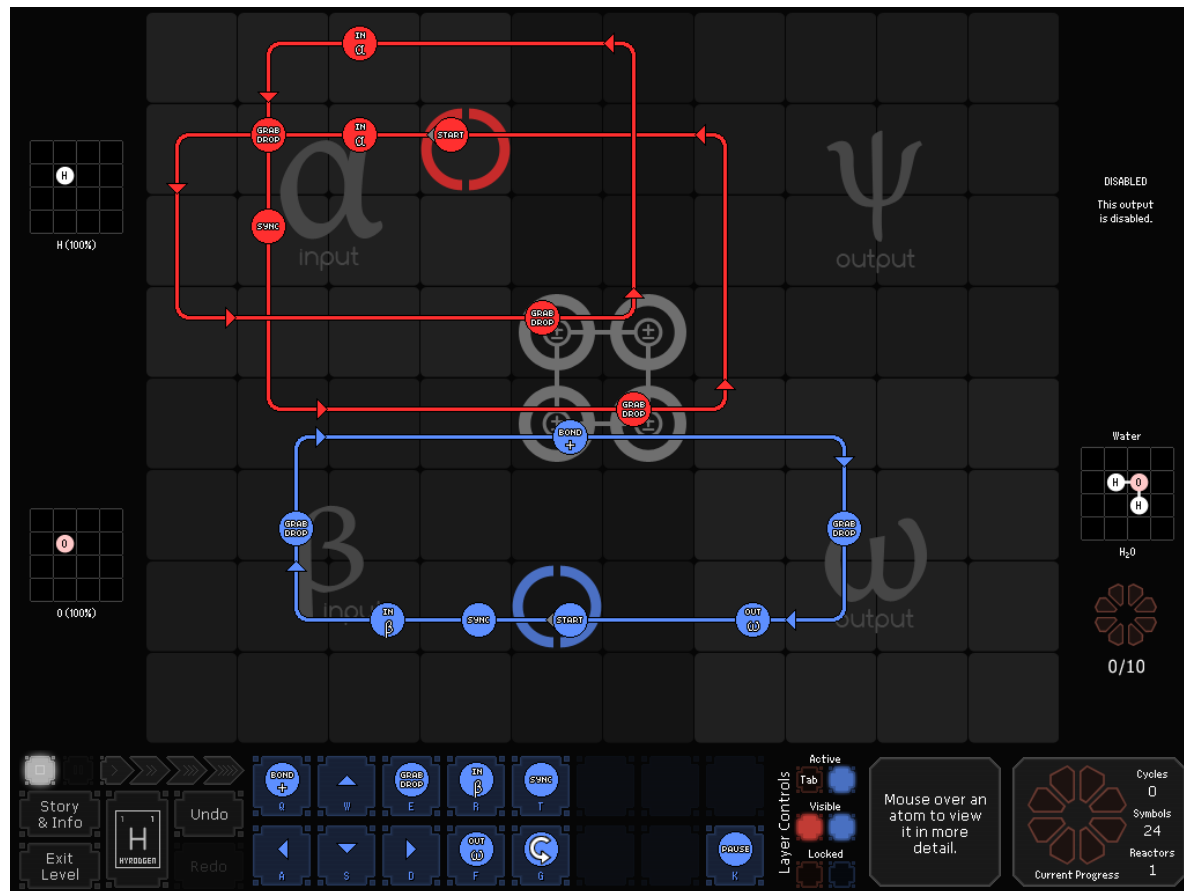
PORTAL

“... but I’m not good at chemistry...”

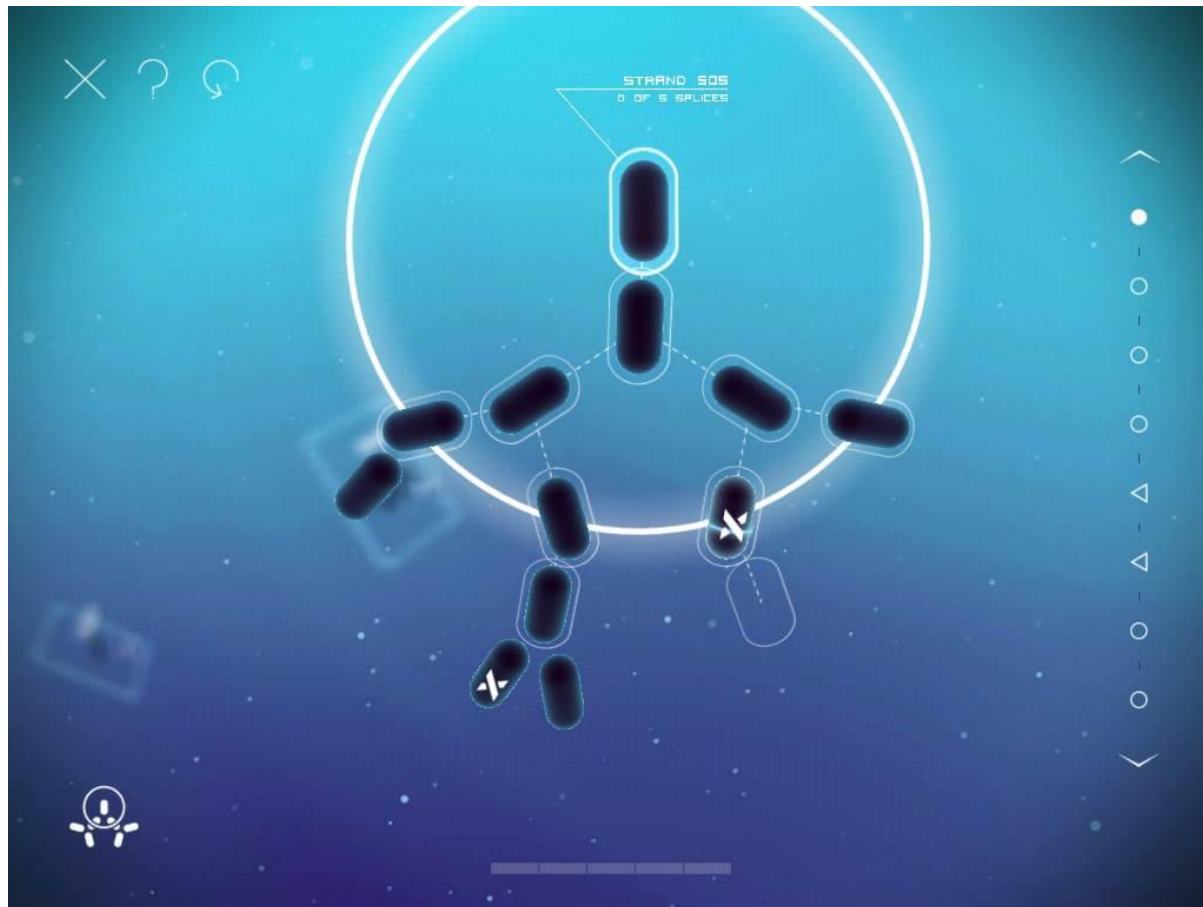
What was the problem?

**Is science *that*
unattractive?**

**No! But SpaceChem
kind of is...**





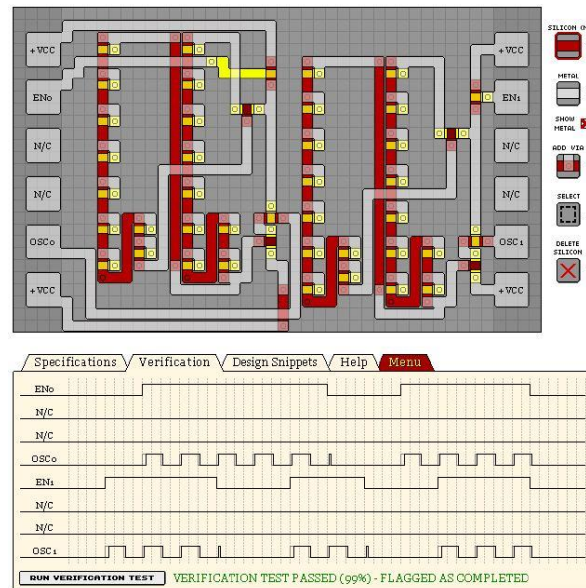
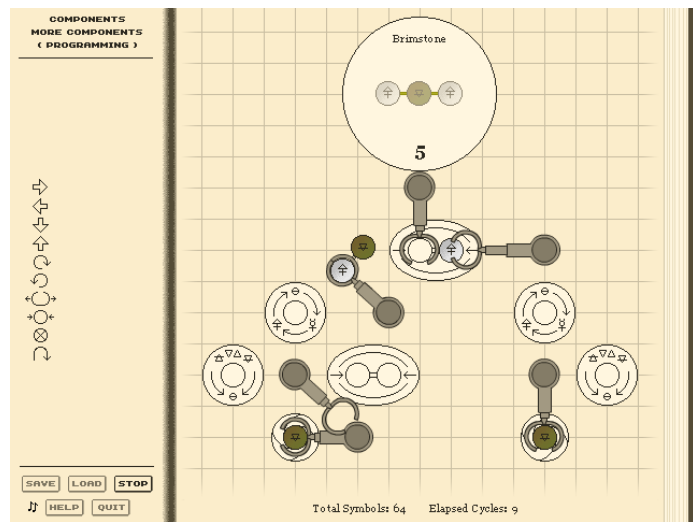


Fortunately...

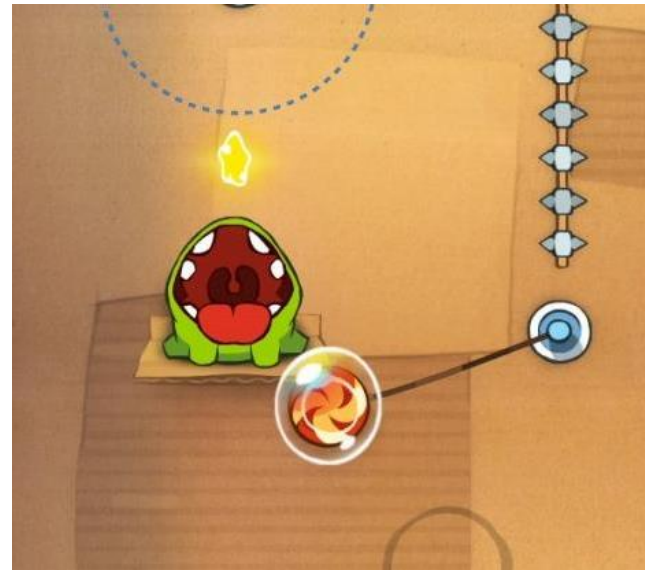
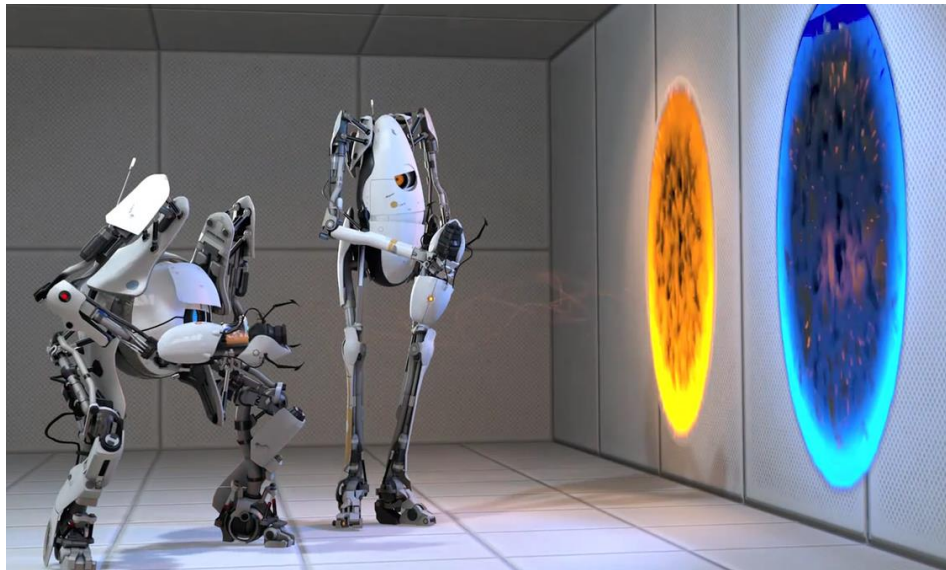
**SpaceChem is
ADDICTIVE!**

**Thanks, questionable
friends!**

Cautionary Tale #2: DIFFICULTY



"Games for Engineers" Audience



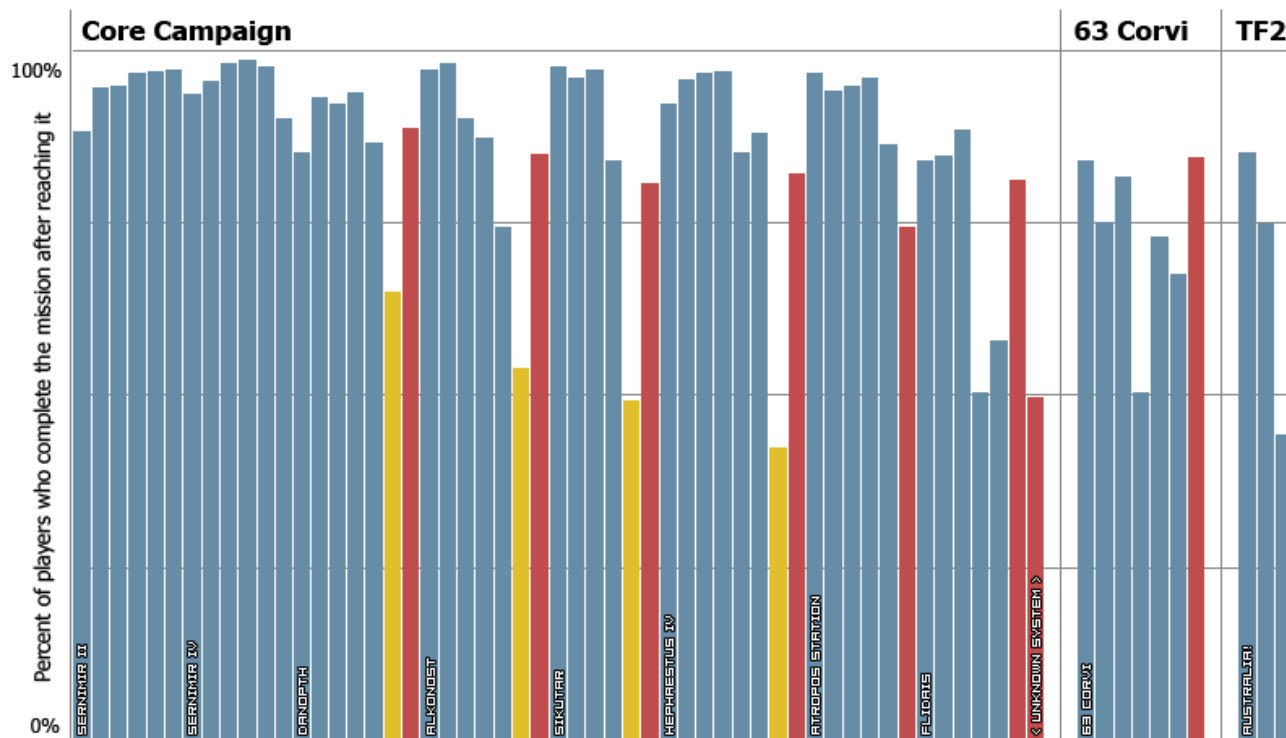
“Games for Normal People” Audience

- **50+ puzzles for “completion”**
- **20-60 minutes/puzzle**
- **7 vague “defense” puzzles**

SpaceChem: Mission Completion (Independent Rates)

Most of the time, not being able to complete a mission in SpaceChem means that a player will not be able to reach (let alone complete) a mission that follows it. A better indicator of difficulty is the percentage of players that complete a mission after reaching it.

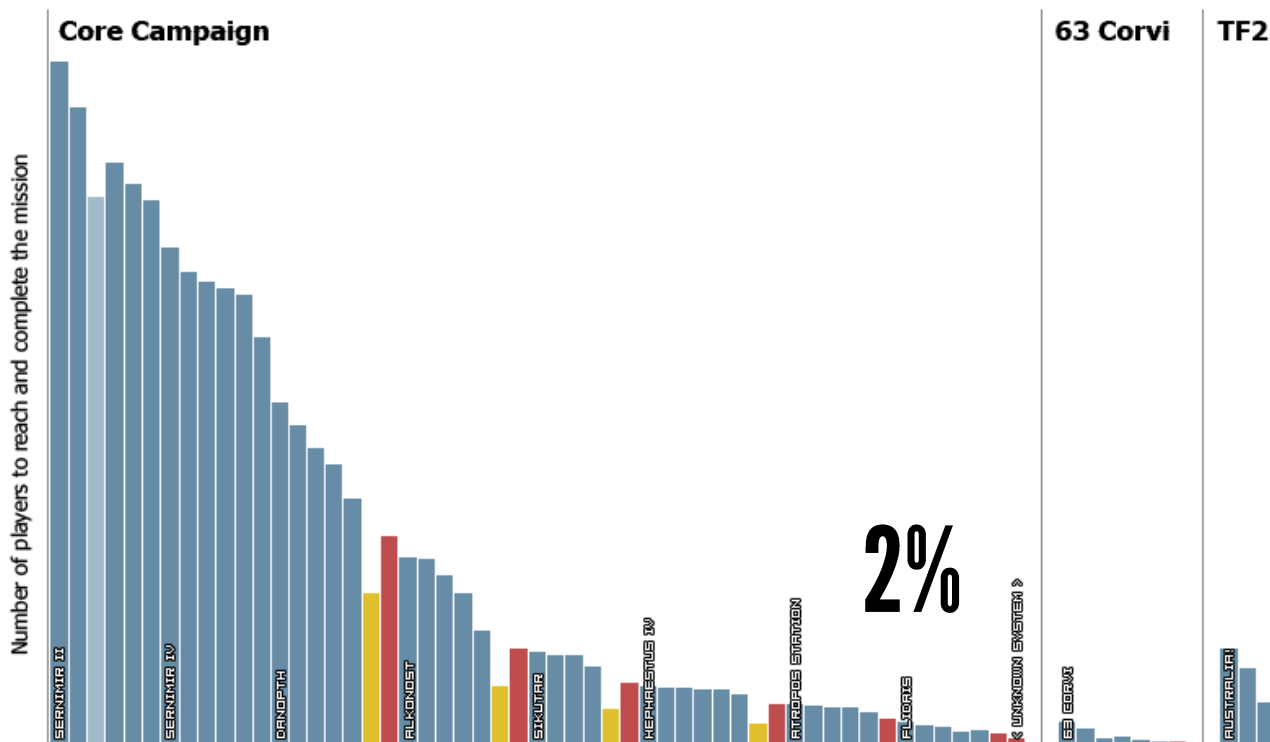
■ Required
■ Optional
■ Defense



SpaceChem: Mission Completion (Cumulative Quantity)

The metrics system in SpaceChem captures information on when and how players beat missions. The following graph shows the absolute number of players to beat each individual mission in the game. The light blue bar on the left represents a mission that was added post-launch ("Crossover").

- Required
- Optional
- Defense



**Chief Executive Officer**

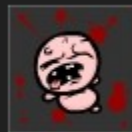
Beat the game!

2.5%

**The End**

Beat the light world

5.8%

**The Real End**

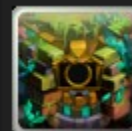
Beat the dark world

1.6%

**Executive Producer of Goo Product**

All Levels Complete

15.5%

**The End**

Complete the story

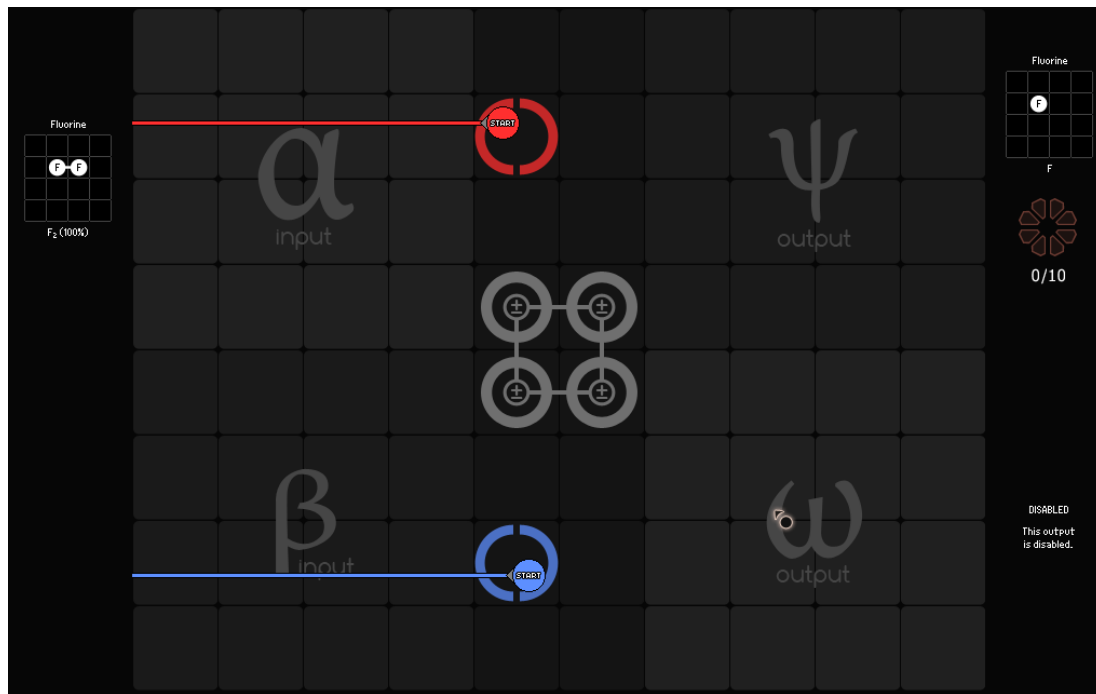
15.8%

OPEN QUESTION:
Is this acceptable?

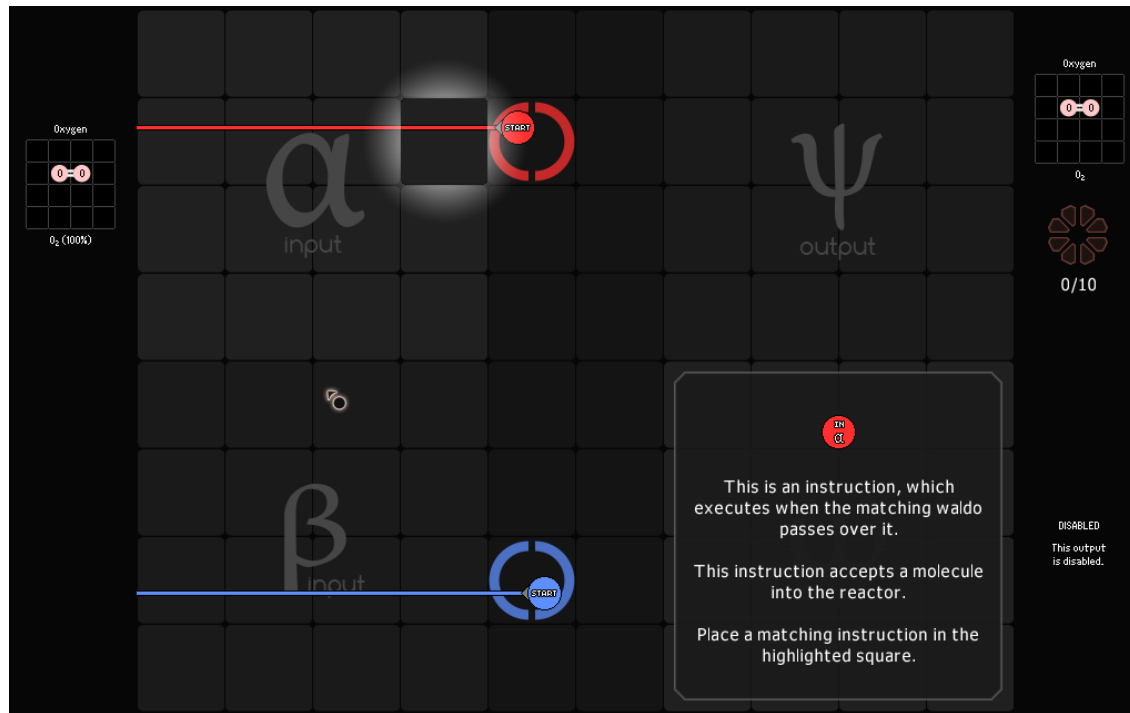
Cautionary Tale #3:

TUTORIALS

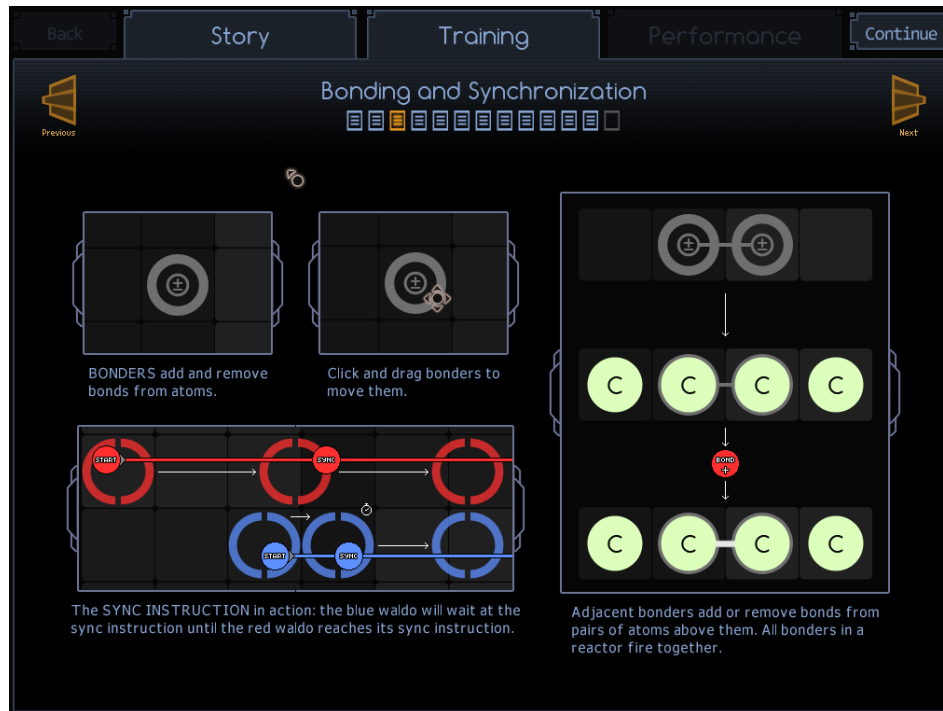
The SpaceChem Tutorial Experience



12 puzzles for the “basics”



2 “step-by-step” puzzles



13 in-game info screens

How effective was it?

**Immediate
Comprehension**

**Complete
Confusion**

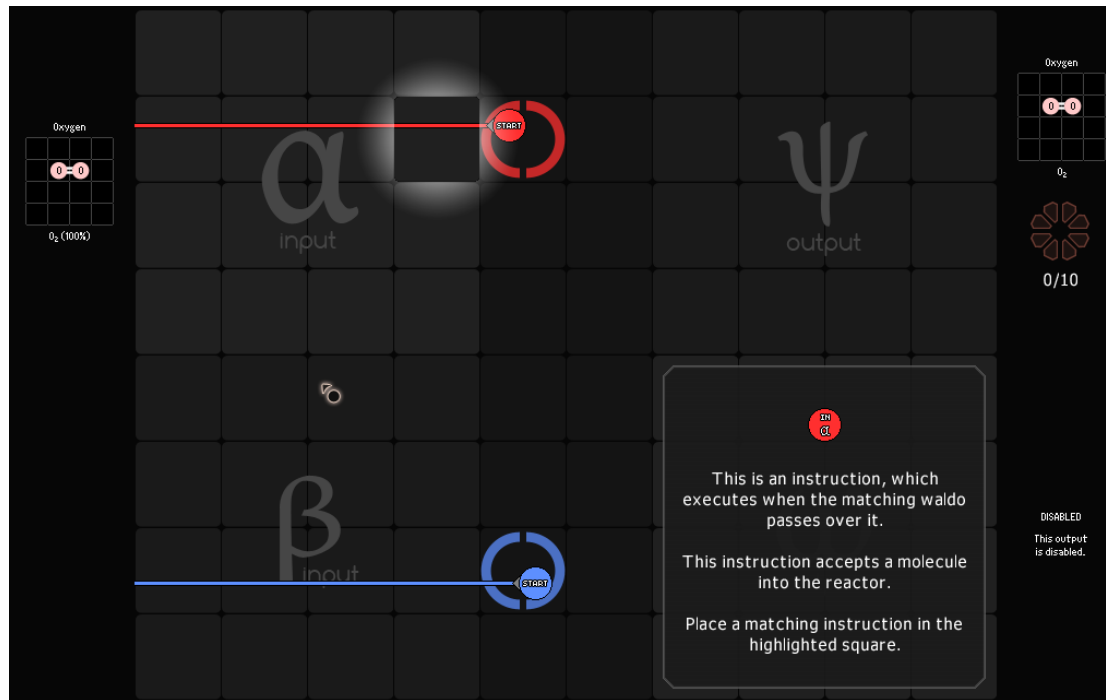


How did this happen?

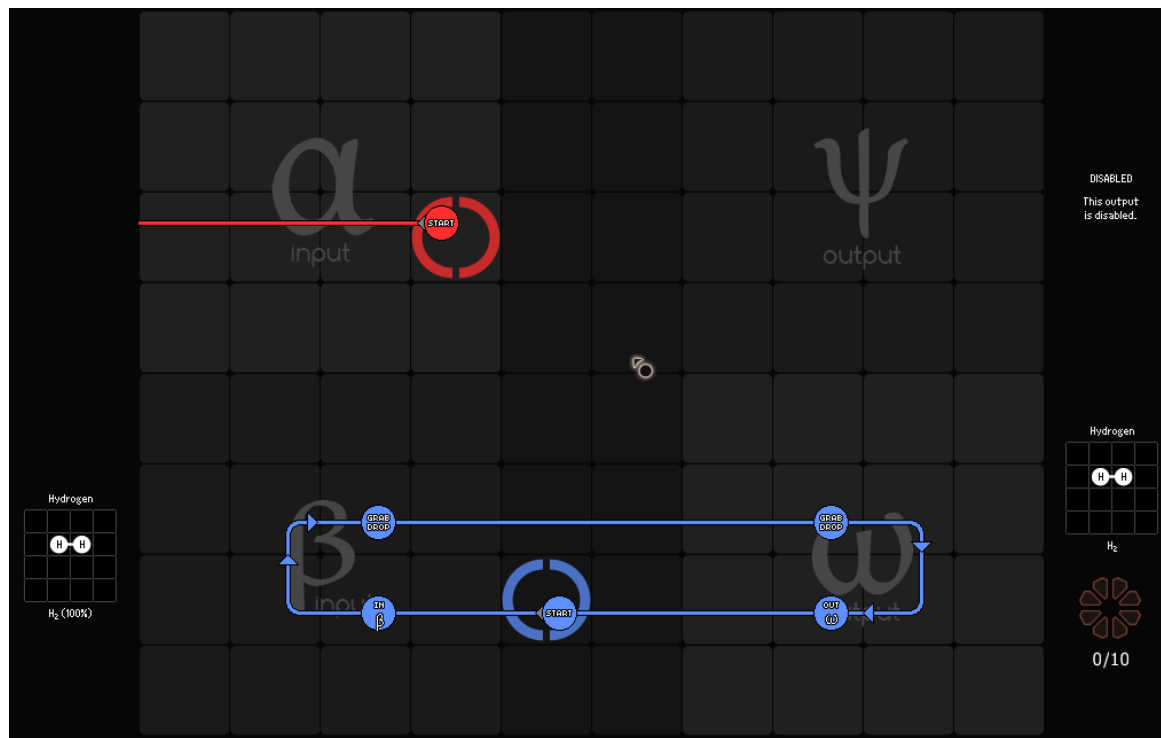
SHORT ANSWER:

**We didn't focus on optimizing the
“new player experience”.**

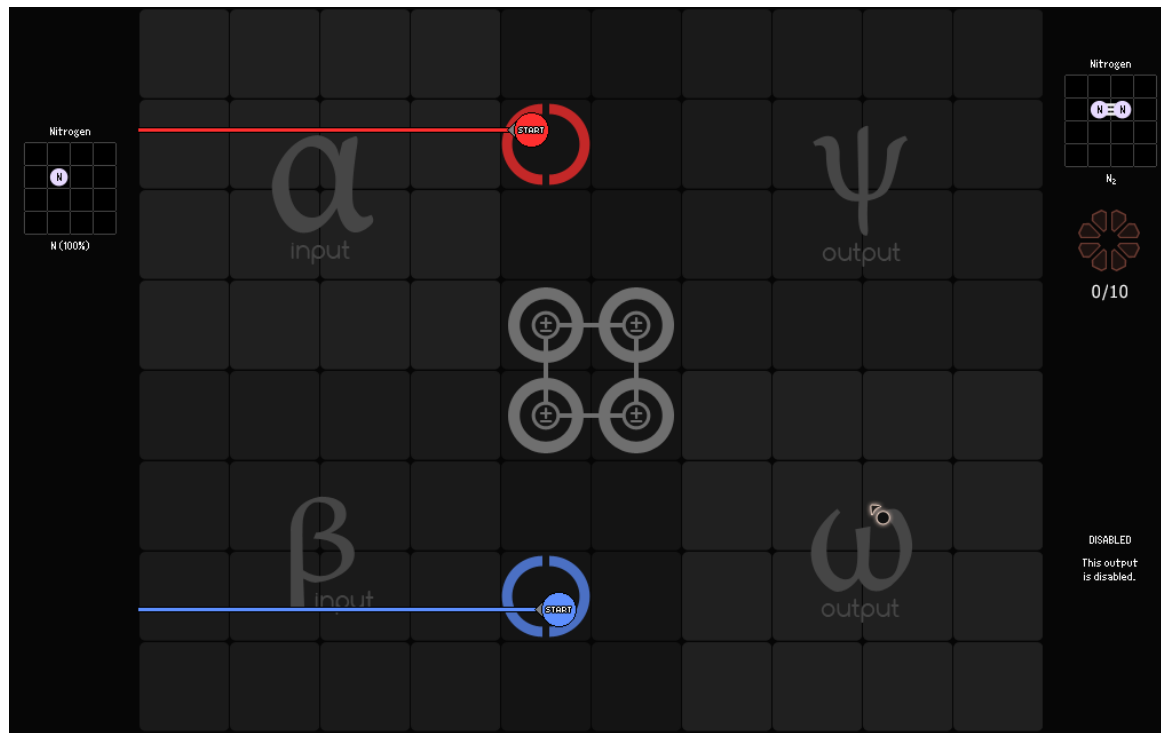
LONG ANSWER:



Failed to show the game's objective



Overly complicated “boilerplate”



Too many variables

Back Story Training Performance Continue

Reactors and Reactions

Reactors are programmed with REACTIONS to transform one set of chemical substances into another.

Reactors may move atoms, rotate molecules, and modify bonds.

In RESEARCH ASSIGNMENTS, a reactor is programmed to perform a single reaction.

These are WALDOS. They grab, move, rotate, and drop atoms. Atoms bonded together into molecules move together.

Waldos move constantly and can be redirected with ARROW INSTRUCTIONS.

Waldos execute ARROW and REACTOR INSTRUCTIONS of the matching color when passing over them.

Too much text

How do we fix this?

THEORY:

Players only learn through trial and error while playing the game.

TECHNIQUE:

**Make your tutorial a set of “experiments”
that can be solved through trial and error
with a high chance of success.**

More simply,
PLAYTEST!

And now,

RAPIDFIRE POST- LAUNCH SECRETS!

Steam

Great Platform, or Greatest Platform?

Steam

Greatest! Over 90% of sales

Mac + Linux

Is it worth it?

Mac + Linux

Yes! 10% + Humble Bundle

iOS

Is it worth it?

iOS

Maybe – even SpaceChem did okay!

iOS

Although it was mostly PC customers...

Android

That's a thing too, right?

Android

Roughly 1/5 the sales of iOS...

Android

but the Android Humble Bundle is great!

Funding

How did you afford to make the game?

Funding

Nights + Weekends + Profit Sharing

Revenue

How much did you make?

Revenue

About \$700k (and still going!)

Support

How do you handle support?

Support Personally!

Don't make me feel stupid!

[Turn on highlighting](#)[Forward all](#)[Collapse all](#)[Print all](#)

store@zachtronicsindustries.com x

zach@zachtronicsindustries.com x

 **Space Chem Fan** spacechemfan@.com

5/10/11 ☆



to store ▾

I bought your awesomely awesome game at 1am yesterday after trying out the demo and loving it. Then only a few hours later the price was chopped in half! Your game is awesomely awesome, but now I feel like a boob. As payment for this insult I will accept either one free copy of Space Chem to give to my friend's nerdy son, because I know he'll love it, or a 5 verse limerick telling me how awesome I am for buying your awesomely awesome game for full price on the same day it was selling for half price.

P.S.

Thanks for the awesomely awesome game.

The Future

What are you working on now?



Thank you!

Now, if I've talked fast enough...

Q&A