

# The Joy of Engineering

A Celebration of Autistic Talent in STEM

by

Barnabear

(he/him/bear)

# Introduction

- This is a family friendly talk about the Joy of Engineering
  - Celebrate autistic people in STEM, past, present and future.
  - Engineering and STEM used almost interchangeably
- I am an autistic engineer
  - I very much enjoy my work.
  - Passionate about autistic employment in STEM.
  - I hope to share some of that passion today.
- All people referred to in this talk either are or probably were autistic
  - Except Albert Einstein's teacher (maybe)
- I hope to take questions at the end ...

# Porgy and the Importance of Play





# Chris Packham CBE

- Naturalist
- Nature Photographer
- Television Presenter
- Author

“We don’t need a cure, there is nothing wrong with us – we are different. And that difference has enormous biological and social importance. **Many of us have skills to invent solutions, produce art and science to benefit all and to receive these gifts all we need in return is understanding, tolerance and acceptance. For all autistic people it mustn’t any longer be about what we can’t do, it’s got to be about what we can do.**”





# Celebrate!

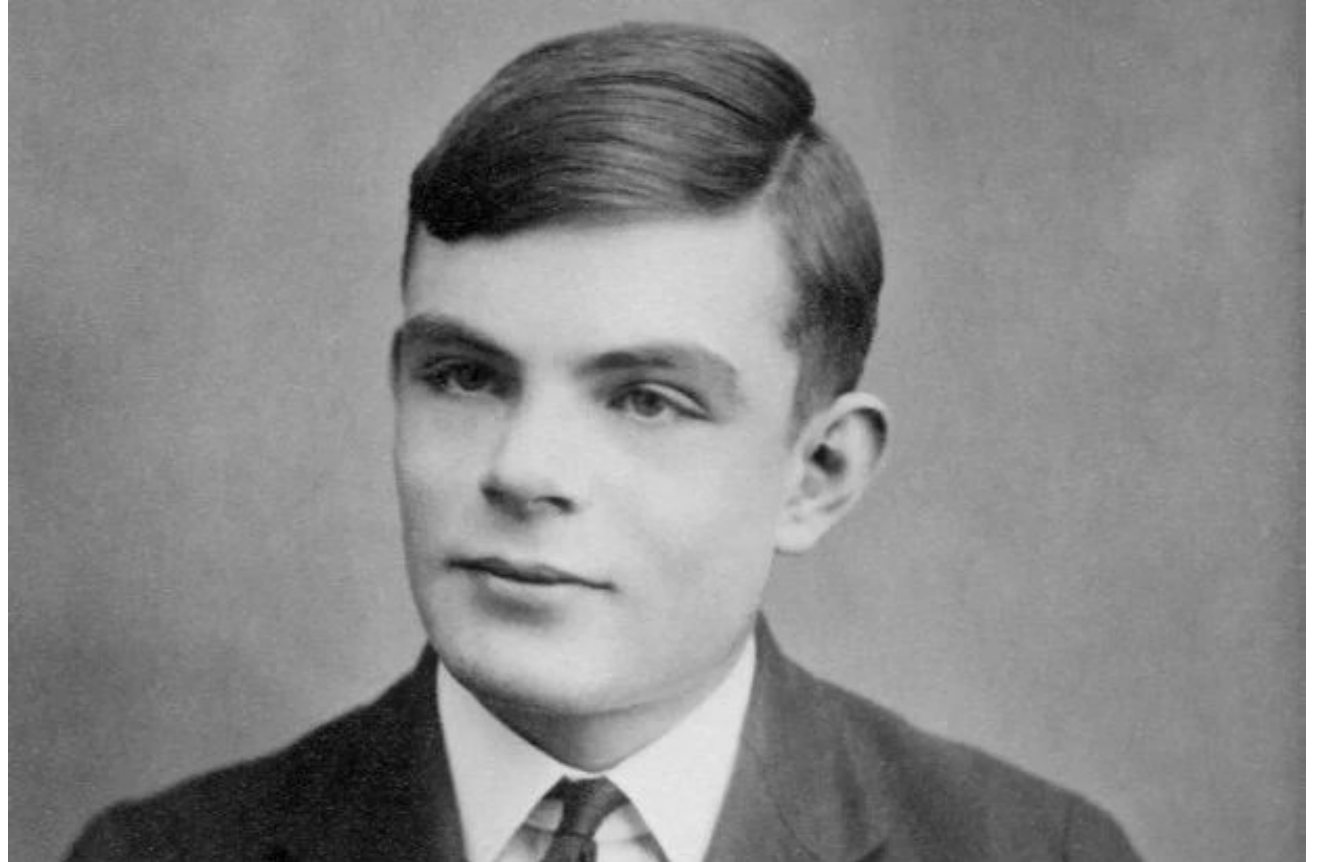
Many autistic people are good at STEM.

They have a passion for their field.

There is deep joy in this.

# **Alan Turing OBE** **FRS**

- Mathematician
- Codebreaker
- “Father of Modern Computing”
- Shortened W.W. 2
- Saved many lives







  
To commemorate all  
British and Allied personnel  
whose work with Signals Intelligence  
and Communications Security  
has supported HMG  
in war and peace since 1914

To commemorate  
the  
His Royal Highness  
Royal Communications Corps





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# Porgy

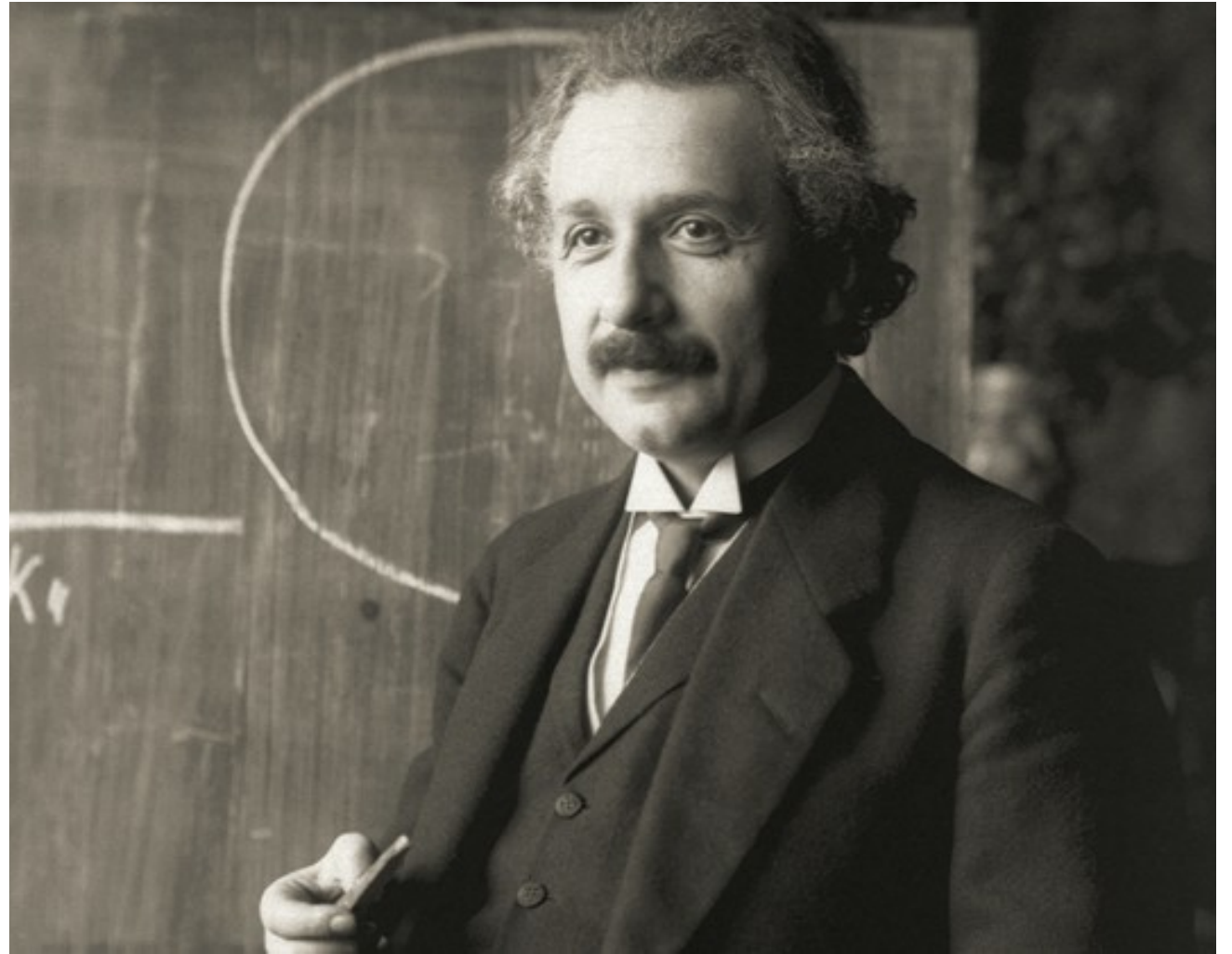
- Bear to Alan Turing
- Bletchley Park
- Displayed in glass case





# **Albert Einstein**

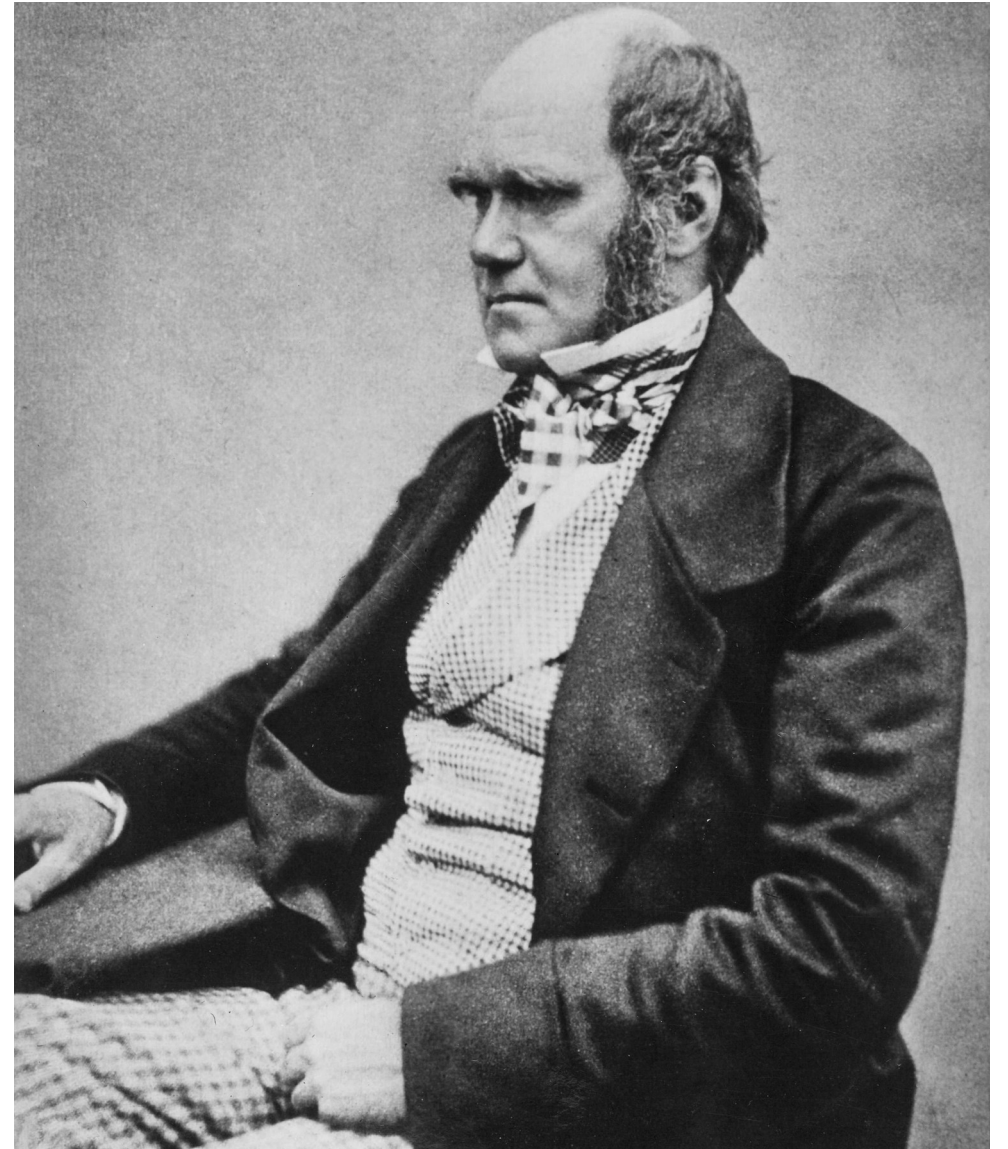
- Theoretical Physicist
- Theories of Relativity
- Quantum Mechanics
- Nobel Prize Winner
- Campaigner for Peace
- Household Term for Genius





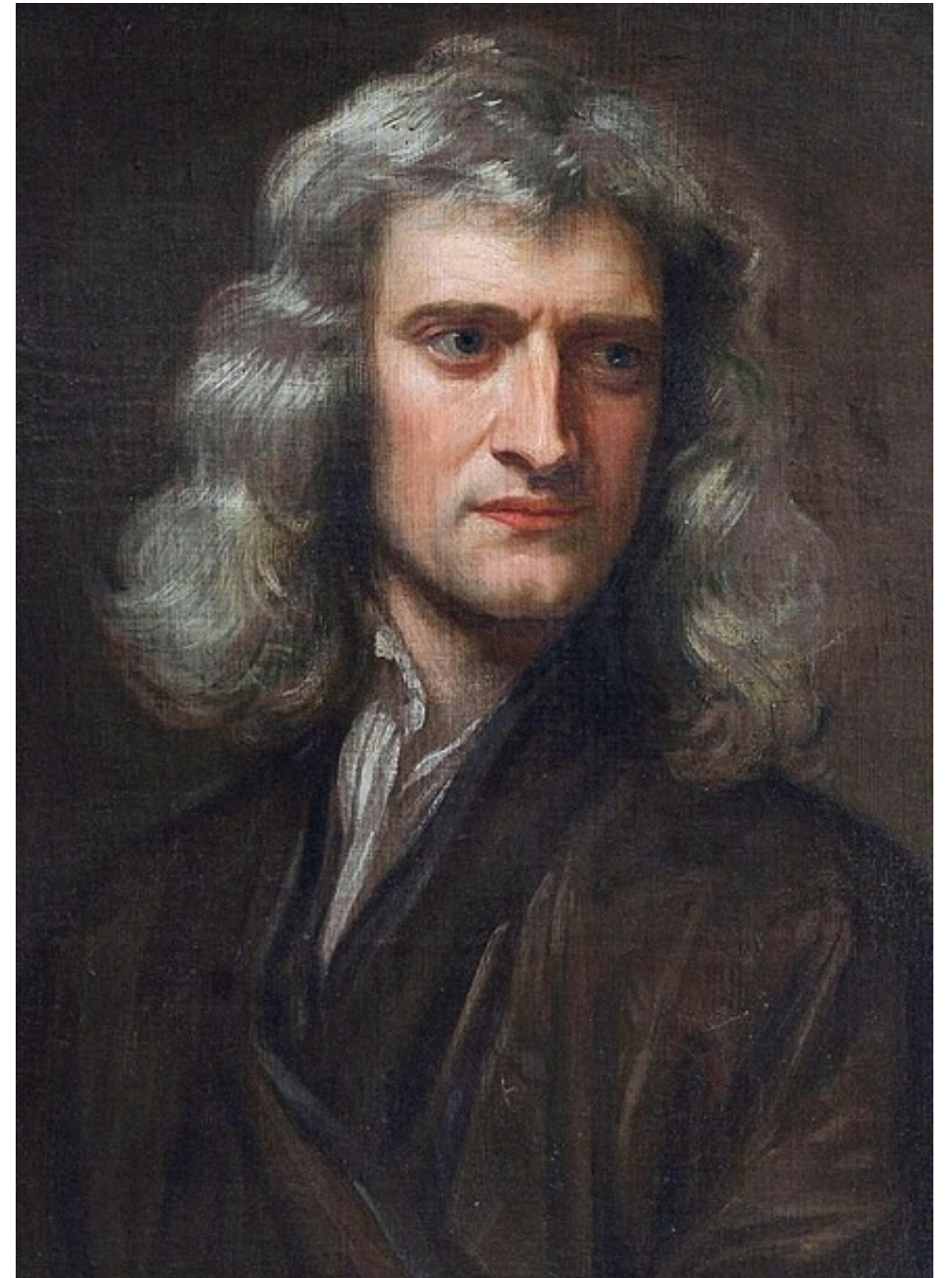
# Charles Darwin FRS FRGS FLS FZS JP

- Naturalist
- Geologist
- Biologist
- *On the Origin of Species by Means of Natural Selection*
- Theory of Evolution



## **Sir Isaac Newton FRS**

- Mathematician (calculus)
- Physicist (gravity, laws of motion)
- Astronomer (optics)
- Alchemist
- SI Unit of Force



# **Marie Curie**

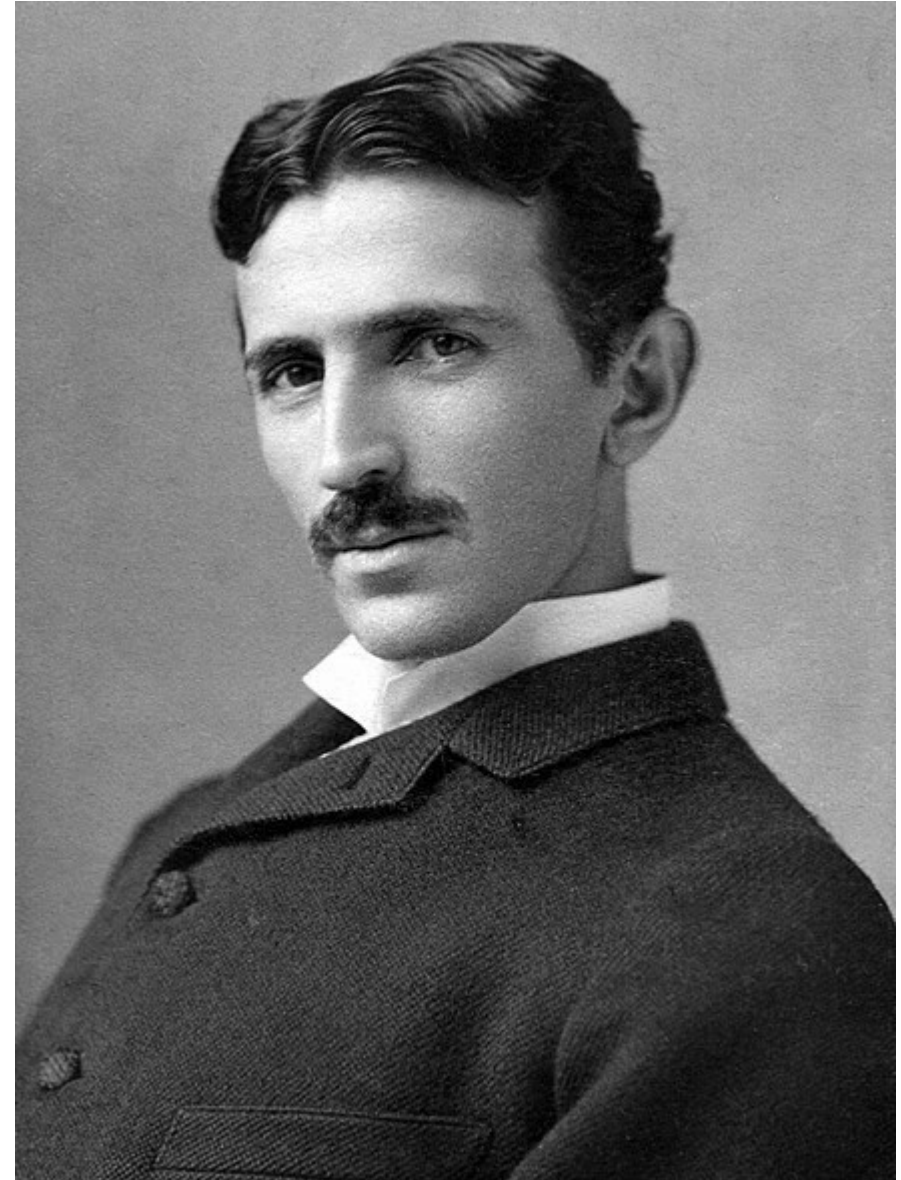
- Physicist & Chemist
- Coined term “Radioactivity”
- 2 Nobel Prizes (Physics, Chemistry)
- Discovered Polonium & Radium
- Medical X-Rays
- Radiotherapy
- Chemical element Curium (Cm)





# **Nikola Tesla**

- Inventor
- Electrical engineer
- Mechanical engineer
- AC electrical supply systems
- Tesla coil (high voltage)
- 300+ patents
- SI unit of magnetic flux density



# Temple Grandin

- Animal Behaviourist
- Academic
- Author



# Our Cast of Autistic Talent

- Alan Turing
- Albert Einstein
- Charles Darwin
- Isaac Newton
- Marie Curie
- Nikola Tesla
- Temple Grandin



# Curiosity

- Albert Einstein: *“I have no special talents. I am only passionately curious.”*
- Marie Curie: *“Be less curious about people and more curious about ideas.”*
- Marie Curie: *“If I see anything vital around me, it is precisely that spirit of adventure, which seems indestructible and is akin to curiosity.”*
- Isaac Newton: *“I know not how I seem to others, but to myself I am but a small child wandering upon the vast shores of knowledge, every now and then finding a small bright pebble to content myself with while the vast ocean of undiscovered truth lay before me.”*
- Alan Turing: *“Codes are a puzzle. A game, just like any other game.”*

# Pattern Thinking

- Charles Darwin - *“My mind seems to have become a kind of machine for grinding general laws out of large collections of facts.”*
- Nikola Tesla - *“There is no subject more captivating, more worthy of study, than nature. To understand this great mechanism, to discover the forces which are active, and the laws which govern them, is the highest aim of the intellect of man.”*
- Temple Grandin - *“You take a bunch of data about something you don't know about, and you (find patterns to) sort them into categories.”*
- Marie Curie - *“I am among those who think that science has great beauty.”*

# Perseverance

- Isaac Newton: *"My powers are ordinary. Only my application brings me success."*
- Albert Einstein: *"It is not that I'm so smart. But I stay with the questions much longer."*
- Temple Grandin: *"My advice is: You always have to keep persevering."*
- Marie Curie: *"We must have perseverance and above all confidence in ourselves. We must believe that we are gifted for something and that this thing must be attained."*
- Marie Curie: *"One never notices what has been done; one can only see what remains to be done."*
- Alan Turing: *"We can only see a short distance ahead, but we can see plenty there that needs to be done."*



# Independent Thought

- Charles Darwin: *“I am not apt to follow blindly the lead of other men”*
- Nikola Tesla: *“Be alone, that is the secret of invention; be alone, that is when ideas are born.”*
- Albert Einstein’s Teacher (NT?): *“You are a smart boy, Einstein, very smart but you have one great fault. You do not allow yourself to be told anything.”*

# Dissent

- Isaac Newton: *"I can calculate the motion of heavenly bodies, but not the madness of people."*
- Charles Darwin: *"I have tried lately to read Shakespeare, and found it so intolerably dull that it nauseated me."*
- Albert Einstein: *"Two things are infinite: the universe and human stupidity; and I'm not sure about the universe."*

# Creativity

- Albert Einstein: *“Creativity is intelligence having fun.”*
- Nikola Tesla: *“I don't think there is any deeper fulfilment that can capture a human heart than the feeling of an inventor seeing his ideas materialized. Such feelings make man forget food, sleep, friends, love, everything.”*



# Passionate Characteristics

- Curiosity
- Pattern Thinking
- Perseverance
- Independent Thought
- Dissent
- Creativity

# My Passion for Computing

- 42 years in the industry and still going ...
  - Strong feeling of play
  - Too soon to put away the toys and get a real job
- For me, computing is ...
  - Fascinating
  - Mathematics in motion
  - Data choreography
  - A game where I get to write the rules

# How I Experience Engineering

- Engineering is fun!
  - Discover something new every day
  - Challenge – it's no fun if it's too easy ...
  - Figure out how to do something new
  - Figure out how to do something better
  - How does that work?
  - Why doesn't it work?
  - How can we make it work?
  - Can we make it work better?
- High level of engagement ... positive spiral of intrinsic motivation
- There is a rich vein of autistic talent in engineering (and STEM)



# Junk Computing

## Southlands Asperger Special School

- Taught **hands-on** computer engineering once a fortnight
  - Class of 3 students
- Colleagues would donate unwanted / broken computer equipment
  - Test, repair, scavenge parts
- Build into computer systems running Linux
- Nest box with camera, images captured to a server, presented on a web page.
- Taught programming mainly in Perl
- Outcomes
  - Student went on to study web design in evening classes
  - Student became the youngest ever to pass a university Cisco Networking course

# Guy Martin

- Truck Mechanic
- Racer
- Record Holder
- TV Personality
- Passion for Life

"I'm addicted to work, I don't like routine but I like things to be a certain way, if that makes sense.

I like doing things my way, the right way. I've had my eyes opened for the last ten years or more and I'm still learning. **I'm always looking for a new challenge but sometimes the challenges seem to find me."**





Martin had shown an interest in working on trucks as early as age 12. As a child he was fascinated by engines, and would take apart lawnmowers to try to make them go faster. (Wikipedia)

# Reverse Engineering

- Reverse engineering is *taking something apart to find out how it works*.
- Before throwing out that broken gadget, why not take it apart ...
  - Get practice at taking things apart
  - Discover how it works.
  - Salvage parts for re-use
  - You might be able to fix it.
- Safety first: high voltages, batteries, sharp edges, radioactivity ...
- “Right to repair” movement (USA) – devices must be made in a way that allows owners to repair them.



# Repurposing

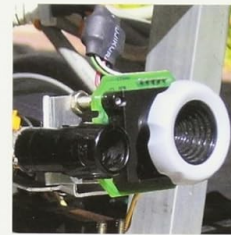




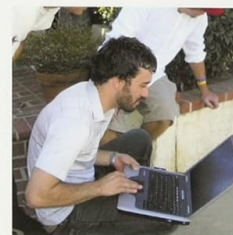
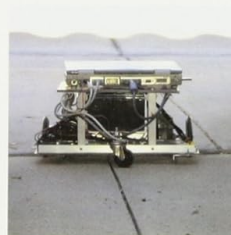
# Repurposing



# Makers



**Makers:**  
All Kinds of People Making Amazing Things  
In Garages, Basements, and Backyards  
**Bob Parks**  
From the Makers of MAKE Magazine



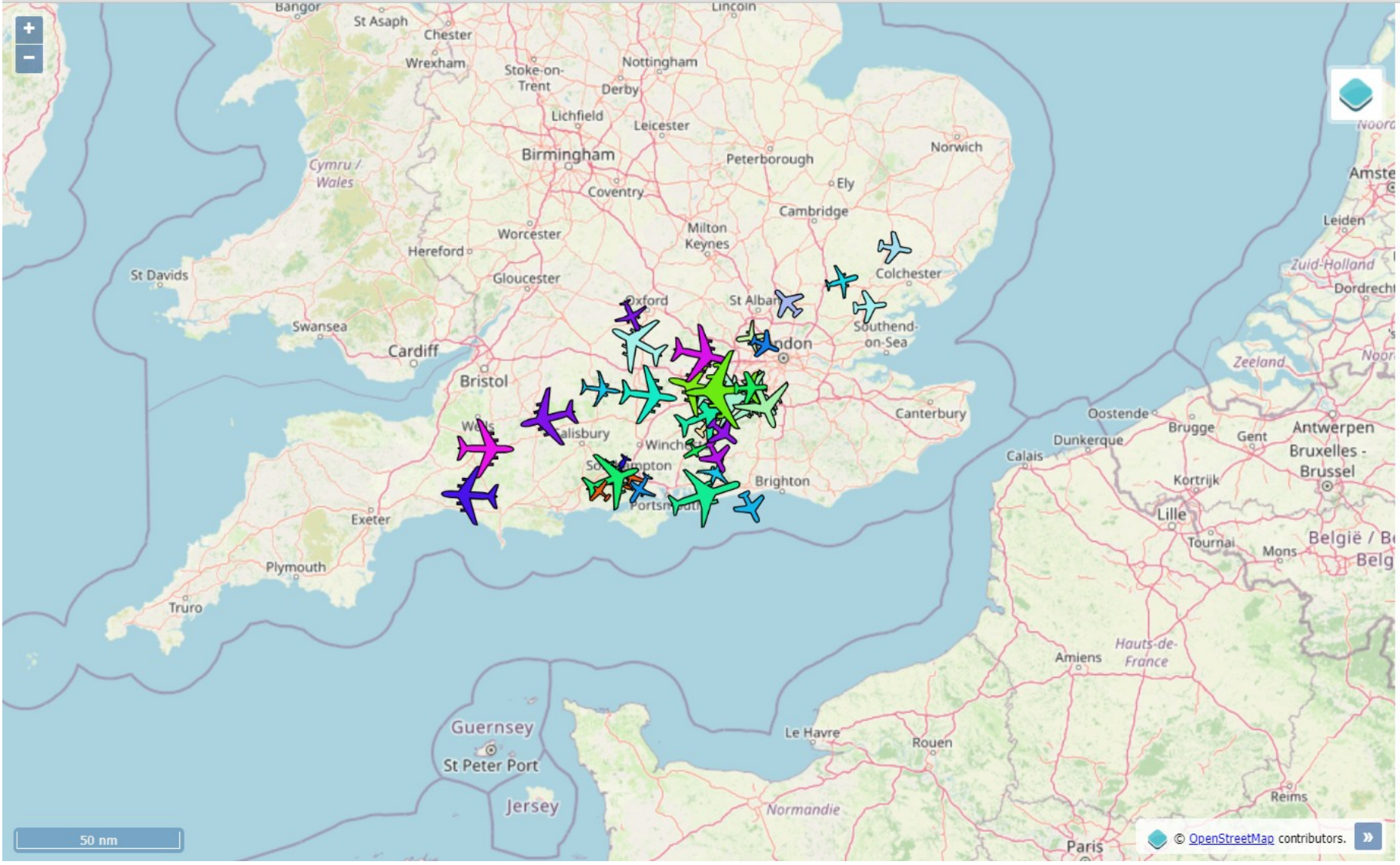
# Aircraft Tracker

## (Automatic Dependent Surveillance–Broadcast)

- Aircraft transmit live flight data
  - Position
  - Speed
  - Direction (Track)
  - Altitude
  - Squawk code
  - Unique plane identification
  - Flight number
- Primary purpose is flight safety
- Build an ADS-B receiver
  - Live feed to Flight Radar 24
  - Get a free business subscription in return



# Aircraft Tracker



UTC



Last Update

[ Reset Map ]

DUMP1090

EB\_VERSION

(no aircraft selected)

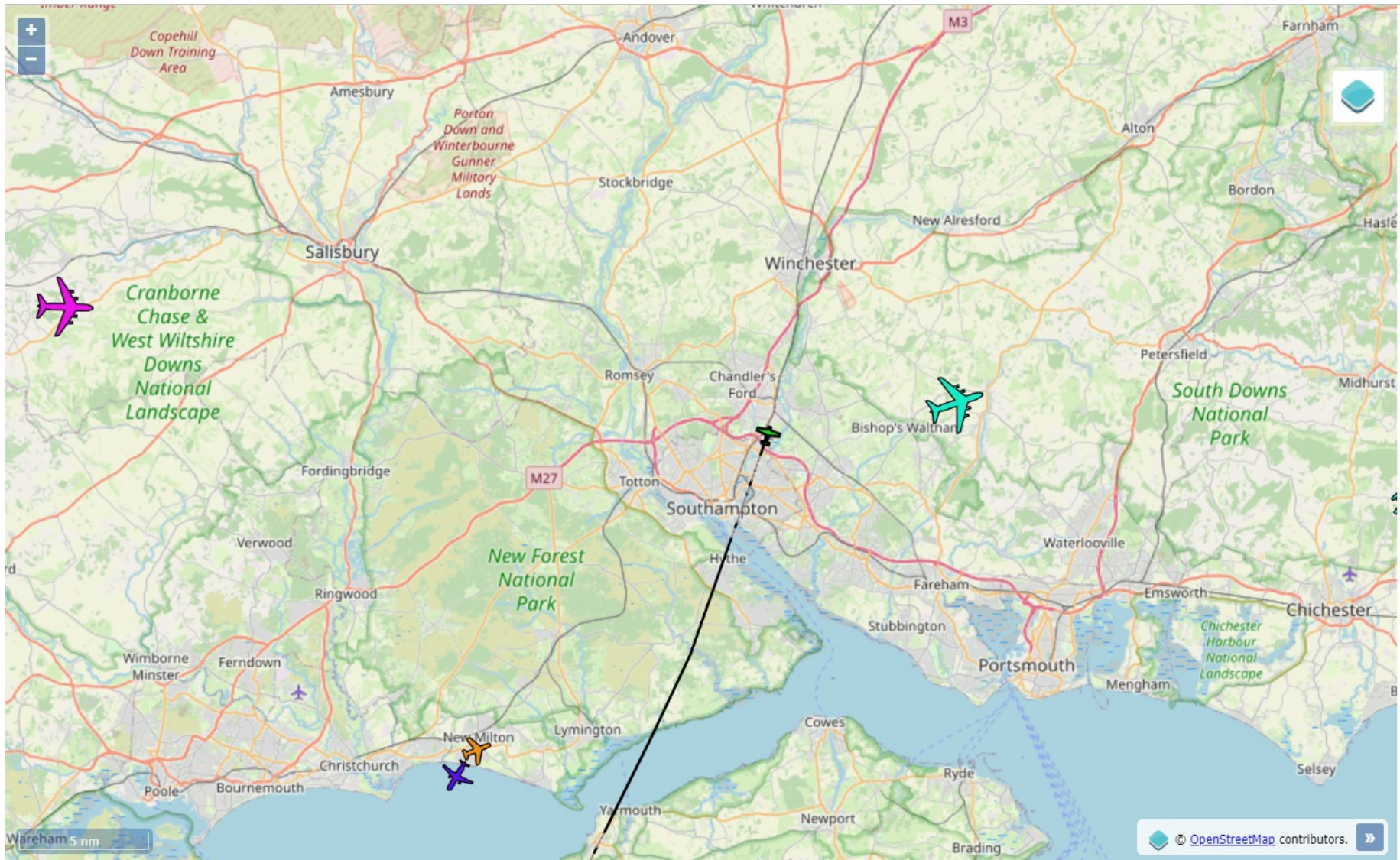
Aircraft (total): 62  
(with positions): 33

Messages: 325.3/sec  
History: 2529 positions

ICAO	Flight	Squawk	Altitude	Speed	Track	Msgs	Age
407675	AUR501	1213	1250 ▼	127	20	2768	1
4d02b1	JFA18W	7732	2050 ▼	173	309	199	0
a2f5d0	N290DL	2227	3625 ▼	218	42	10147	38
40787a		4771	3900			19	12
06a149		3474	4650 ▲	262	136	51	0
3c65d1	DLH6NT	3404	5925	275	118	745	38
4d242e		5614	5925 ▼	252	17	48	24
47921c	NOZ33B	1423	6400 ▲	277	100	97	21
407f2d	BAW98T	5153	6500 ▼	238	284	13619	0
44d068	BEL2AH	4424	7000	222	262	1157	4
40697b		2771	7000 ▼	257	323	138	25
406b21	BAW2X	5161	7000	234	266	8338	0
4aca14			8250			17	11
4d2534			8475			2	52
aaae4b	AAL731	1434	8675 ▲	239	267	97	3
a8cffd	UAL934	1416	9000	247	157	5360	54
493286		6776	9625 ▼	221	317	205	2
347288	IBE31RF	7451	10000	260	88	11842	0
43ec2b	ORT03A	6364	10275 ▲	241	152	2269	0
400f63	URO600	4651	10950 ▲	353	69	2297	0
4007f0	BAW2038	1417	11750 ▼	324	80	6275	26
407da5	VIR12E	7736	12000	275	121	6261	5



# Aircraft Tracker



UTC



Last Update

[ Reset Map ]

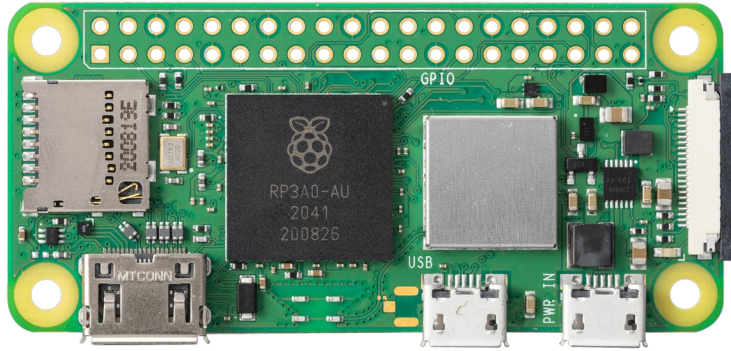
**AUR501** ⇒ 407675 [FlightAware] [FR24] [FlightStats] [PlaneFinder]

Country of registration: United Kingdom  
Altitude: on ground      Squawk: 1213  
Speed: 13 kt | 24 km/h      RSSI: -4.2 dBFS  
Track: 16° (North)      Last seen: 1.1s  
Position: 50.950°, -1.357° (1.1s)  
Distance from Site: n/a

ICAO	Flight	Squawk	Altitude	Speed	Track	Msgs	Age
407675	AUR501	1213	ground	13	16	2930	1
407812	APX248	4221	2900 ▼	205	68	7038	0
a2f5d0	N290DL	2227	2950 ▼	198	56	10212	11
000000		2037	5175			291	37
06a149		3474	5925 ▲	262	136	78	17
406b21	BAW2X	5161	6325 ▼	236	288	9906	0
44d068	BEL2AH	4424	7000	221	262	1217	27
40697b		2771	7000 ▼	257	323	145	7
345646	VLG9WK	2155	7975 ▲	234	219	96	0
a8cffd	UAL934	1416	8000	256	2	5682	0
493286		6776	9000 ▼	221	317	217	21
40787a	TOM408	4771	9225 ▲	296	92	343	0
4d24af			9475			9	22
347288	IBE31RF	7451	9800	247	129	12186	14
486265		6270	10000			15	9
3c65d1	DLH6NT	3404	10175 ▲	398	102	781	37
407da5	VIR12E	7736	10800 ▼	225	269	7389	0
4aca14			11125			20	52
aaaae4b	AAL731	1434	11475 ▲	346	294	950	13
406a35	BAW8DS	1402	13000	304	91	3483	33



# Aircraft Tracker



# Aircraft Tracker



# Hobbyist Tech Hardware

- e.g. Raspberry Pi Single Board computer (2012 onwards)
  - Credit card size computer - \$35
    - Originally intent was education, but it became much, much more
  - Sparked an ecosystem of plug together components
    - Displays – RGB lights, small screens, touch screens
    - Input devices – buttons, switches, rotary controls, cameras, DVB-T (freeview)
    - Sensors – air pressure, temperature, humidity, gases, accelerometers, magnetometers, gyroscope, GPS, PIR motion, Time of Flight distance, ultrasonics
    - Communication - Wi-Fi, Bluetooth, Cellular and other RF technologies
    - Cases and mounts, integration e.g. with Lego Mindstorms
    - Actuators – servos, motors, sounders, relays ...
- Other platforms are available e.g. microcontrollers, BBC micro:bit
- Adafruit (USA) designs & manufactures components in this space
- Online shops in UK are Pimoroni and The Pi Hut

# You Do You

*Sometimes it is the people no one can imagine anything of who do the things no one can imagine. – Alan Turing*