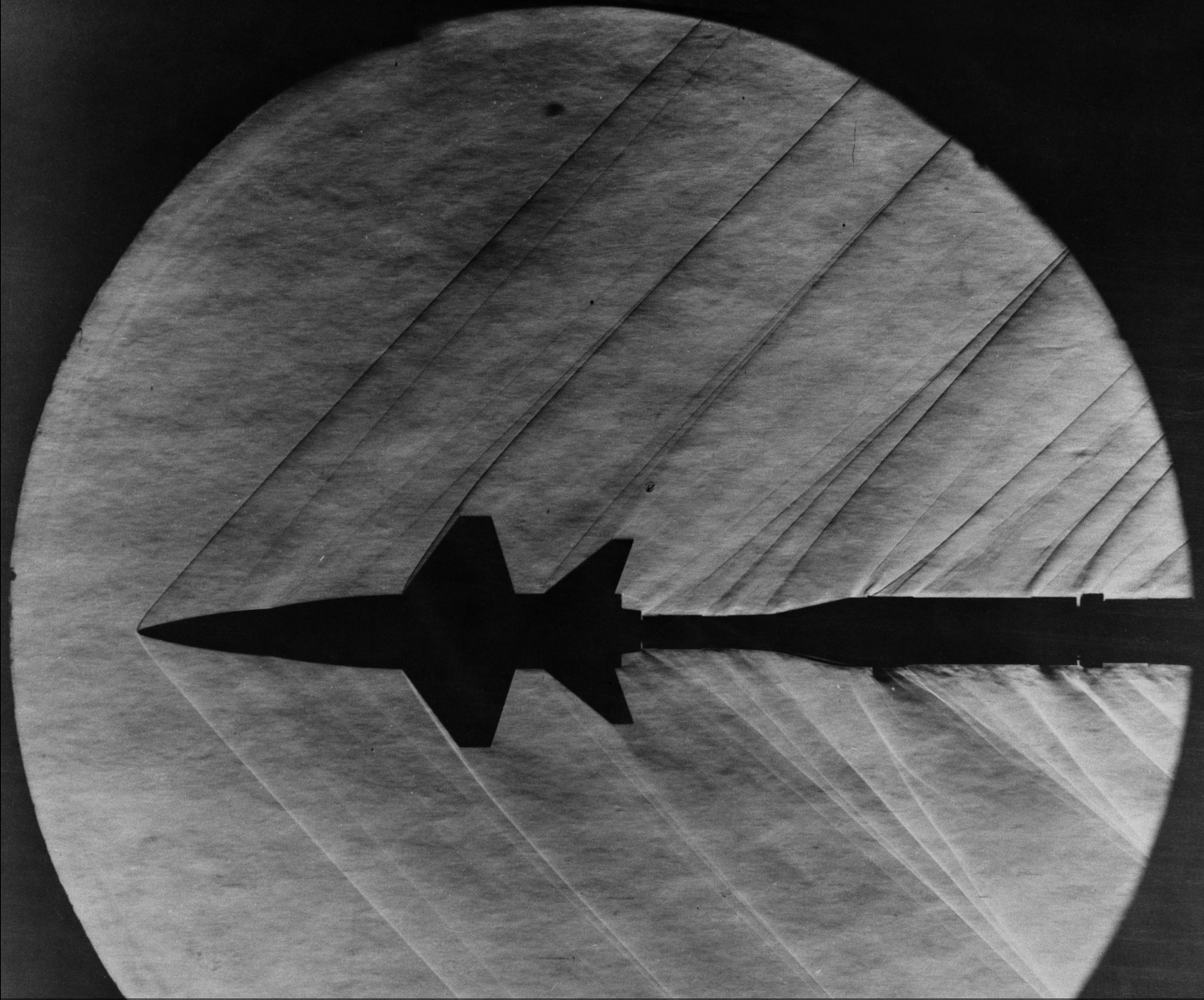


The concepts behind the solution of the "Market Formation Problem"



Real-Time Dynamic Ridesharing on a Transit Exchange



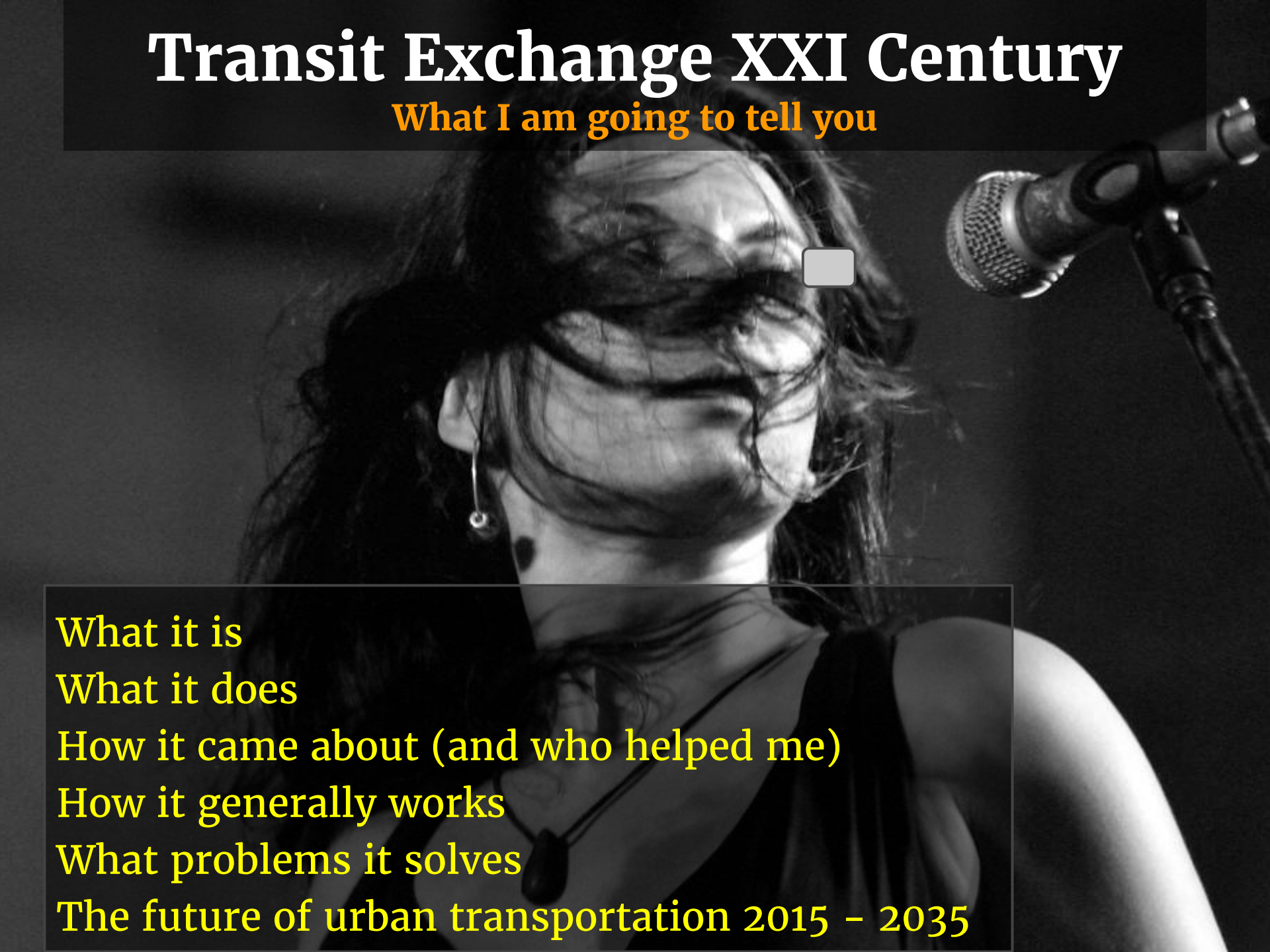
Transit Exchange XXI Century

What I am going to tell you



Transit Exchange XXI Century

What I am going to tell you



What it is
What it does
How it came about (and who helped me)
How it generally works
What problems it solves
The future of urban transportation 2015 – 2035

The Six Pillars

Spatio Temporal Order Matching and Fulfillment

Topology

Social Networks / Credit Contagion

Conformal Mapping

Complex Analysis / Simplex Method

Futures Exchanges

Market Makers / Price Discovery

Electricity Markets

Constraints

Genetic Algorithms

NP Hard Problems

Integrated Battlespaces

ADS-B + Link 16



Most automobiles carry one person and are used for less than one hour per day

"Carsharing in Europe and North America: Past, Present, and Future"

- by Susan Shaheen, Daniel Sperling, and Conrad Wagner

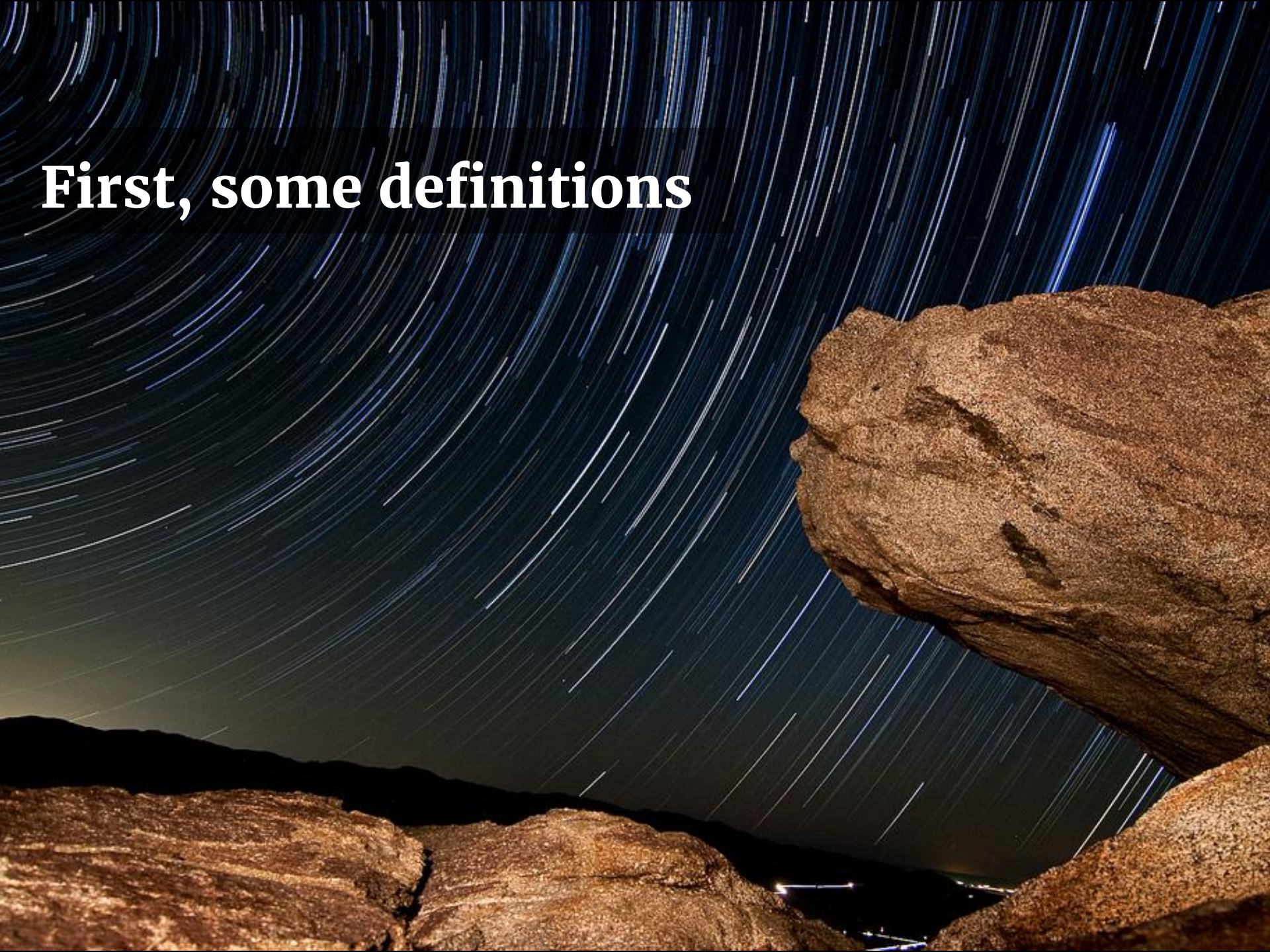
Printed in Transportation Quarterly (Summer 1998), Vol. 52, Number 3, pp. 35 -52



! A more economically rational approach would be to use vehicles more intensively

The 7-passenger vans provided by Enterprise Rent-A-Car give the New Braunfels group plenty of room for their commute. (US Army Photo by Tim Hipps)

First, some definitions



Carshare – A service like ZipCar.

Users can use the same car, but not usually at the same time



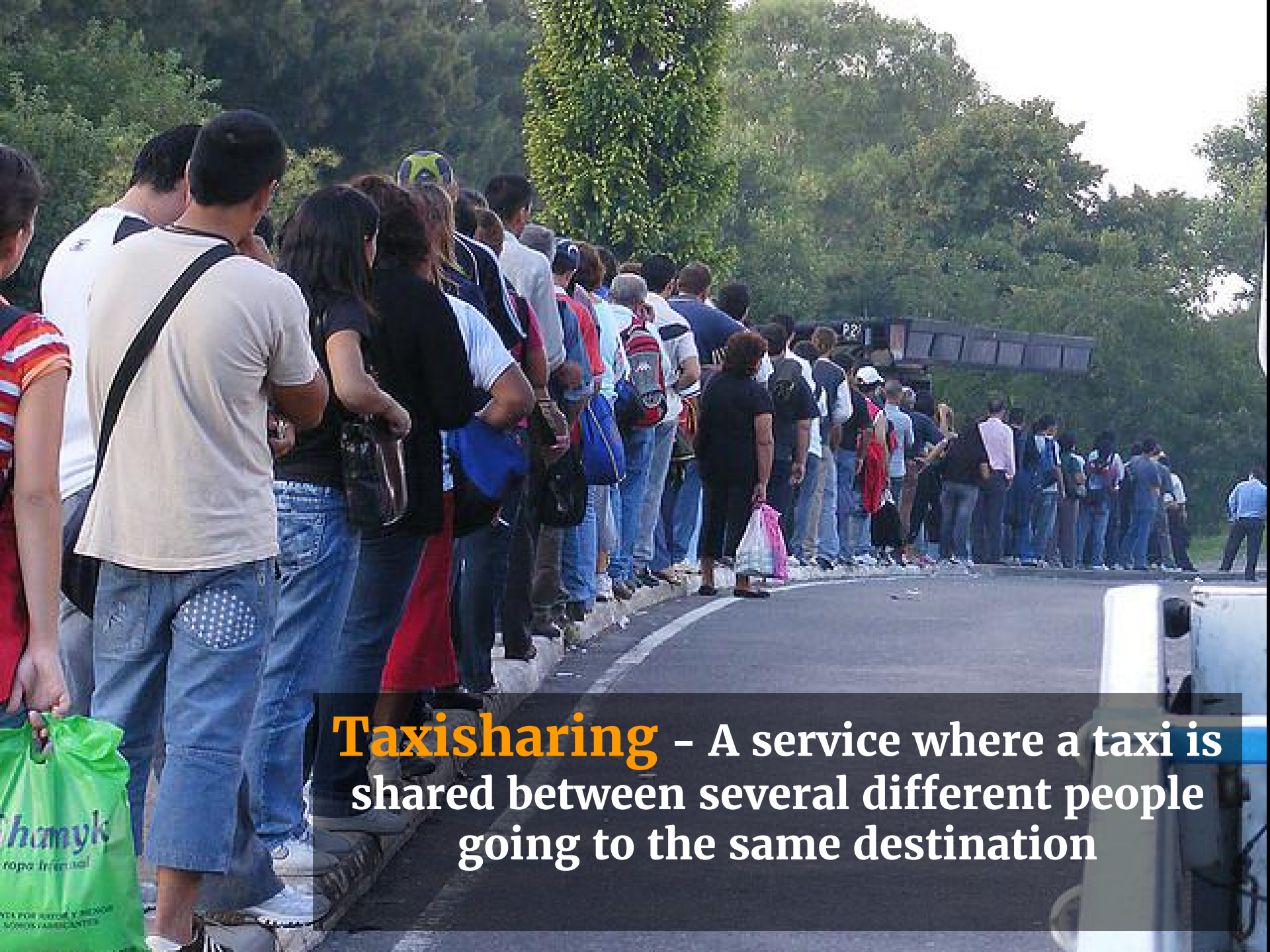
A photograph taken from the interior of a car. In the foreground, a woman with long dark hair and glasses is seen from the side, looking out the open driver-side door. Outside the car, another woman with long dark hair, wearing a light blue jacket and a white scarf, is smiling and leaning against the door frame. The background shows some greenery and a building.

Carpool – A service where several people get into the same vehicle (car) at the same time.

The vehicle (car) is driven by a private (i.e. not for hire/reward) person



Vanpool – A service like a carpool
but driven by a professional driver.



Taxisharing – A service where a taxi is shared between several different people going to the same destination

Ridesharing – encompasses carpools, vanpools, taxishares, buses, hitchhiking, etc



dynamic real-time ridesharing

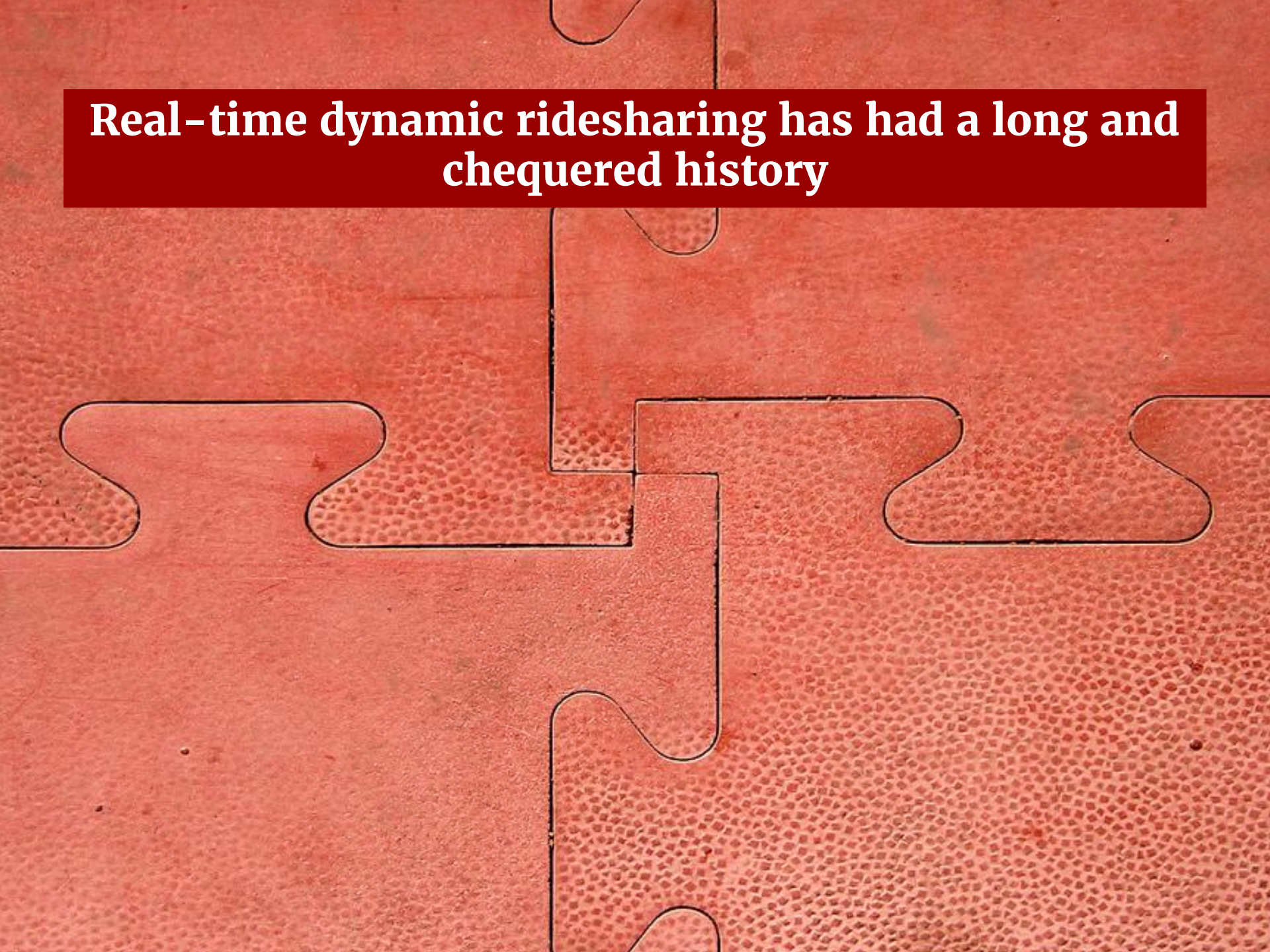
The Quest Prize



**Summoning a vehicle in
real-time rather than e.g. week
ahead or day ahead
(not trivial due to the "Market Formation
Problem")**

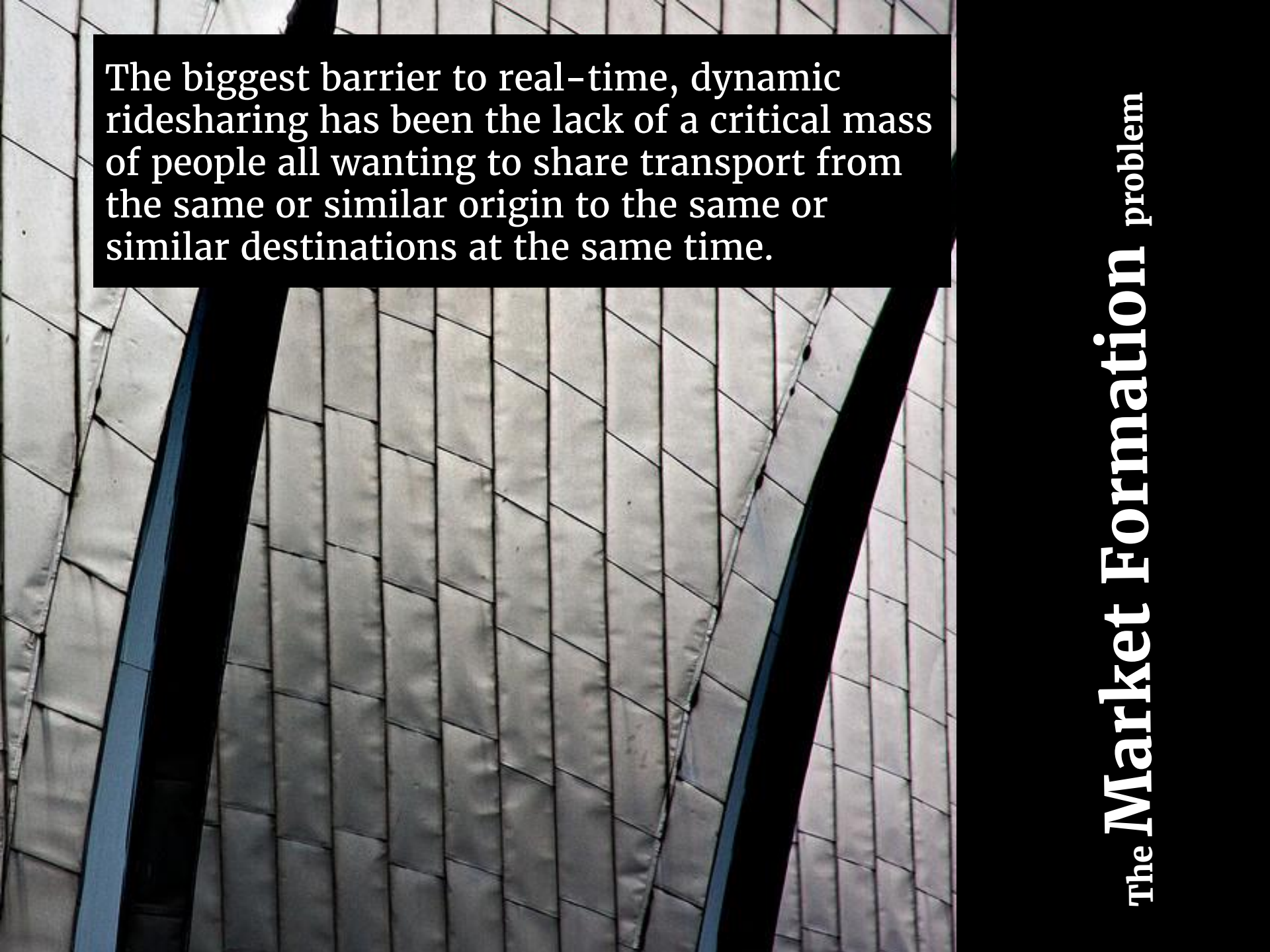


Real-time dynamic ridesharing has had a long and chequered history



A photograph of a modern building with a blue-green perforated facade. In the foreground, there is a white tensile canopy supported by dark poles. The building has multiple floors with windows visible through the perforations. The sky is blue with some clouds. The text is overlaid on a dark semi-transparent rectangle in the center of the image.

Variations of it have been tried continuously since the 1960s by most major Universities and countless private organisations



The biggest barrier to real-time, dynamic ridesharing has been the lack of a critical mass of people all wanting to share transport from the same or similar origin to the same or similar destinations at the same time.

The Market Formation problem

The exchange is thus a system that, using **Market Makers**, enables the dynamic pricing and allocation of the “river of empty seats” in all the vehicles within an urban automotive fleet within specific time windows and additionally allows buyers of those seat-rides to rate their co-riders and experiences



What a Transit Exchange does

Free Market

This can only be achieved in a free market environment within an almost fully deregulated transport environment

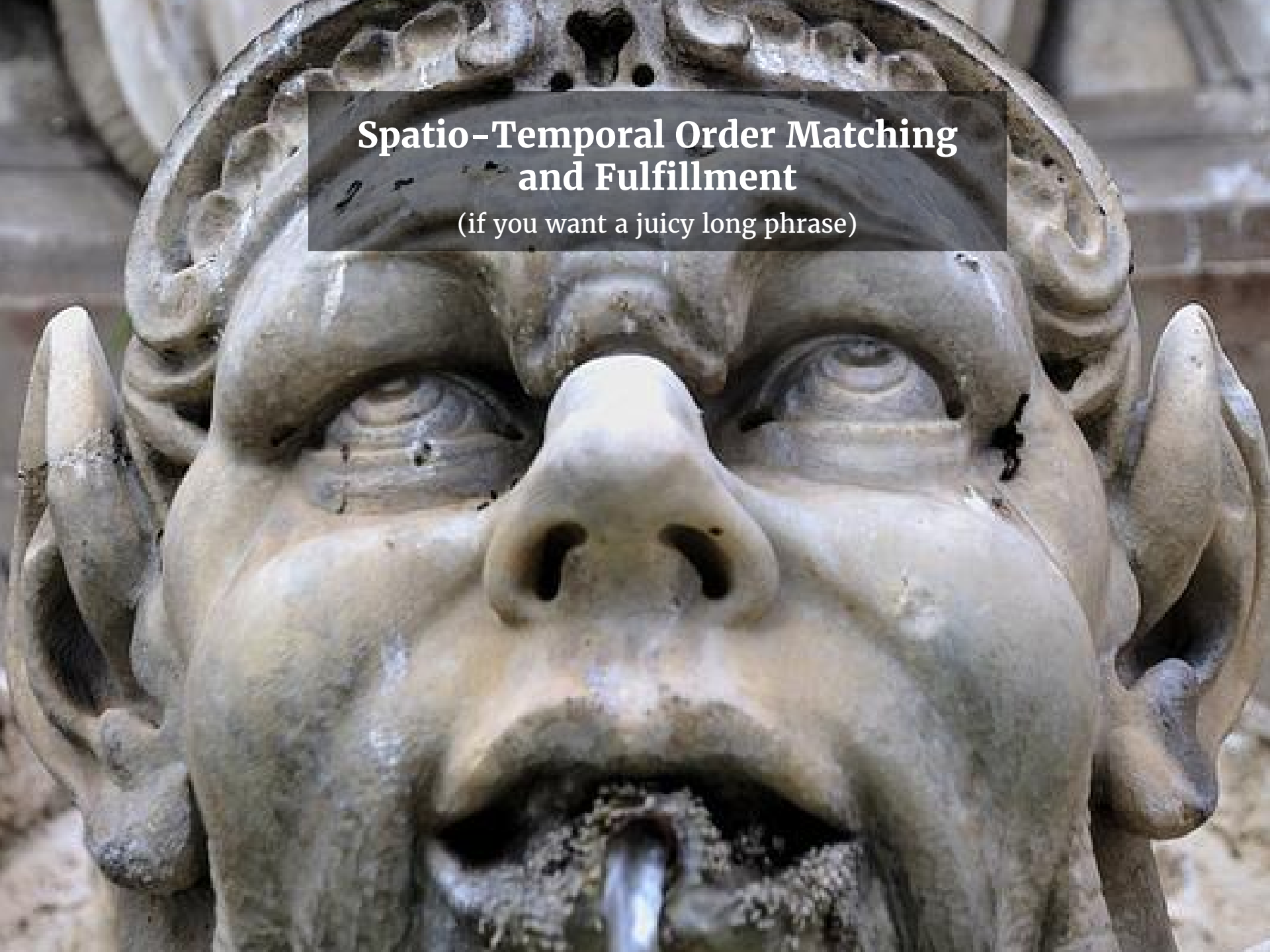
P O R T A L O F F R E E D O M



Such an exchange exists to impartially link suppliers of transport with those requiring transport – whatever the means of transportation

The exchange also serves to aggregate groups of individuals who are seeking rides to (roughly) the same destination at (roughly) the same time



A close-up photograph of a weathered stone sculpture of a face, likely a deity or a person of significance. The face has a serene expression with closed eyes and a slight smile. The stone is light-colored with some darker, possibly carved, areas around the eyes and mouth. A semi-transparent dark rectangular box is overlaid on the upper part of the face, containing white text.

Spatio-Temporal Order Matching and Fulfillment

(if you want a juicy long phrase)



A rider can indeed choose to travel alone – (s)he will just pay the (true) costs of the empty seats

which is what happens when you own a personal vehicle for your exclusive use in any case **or** you rent / charter a vehicle



This finally allows transport systems to adapt themselves around the needs and itineraries of passengers / customers / users – **not the other way around.**



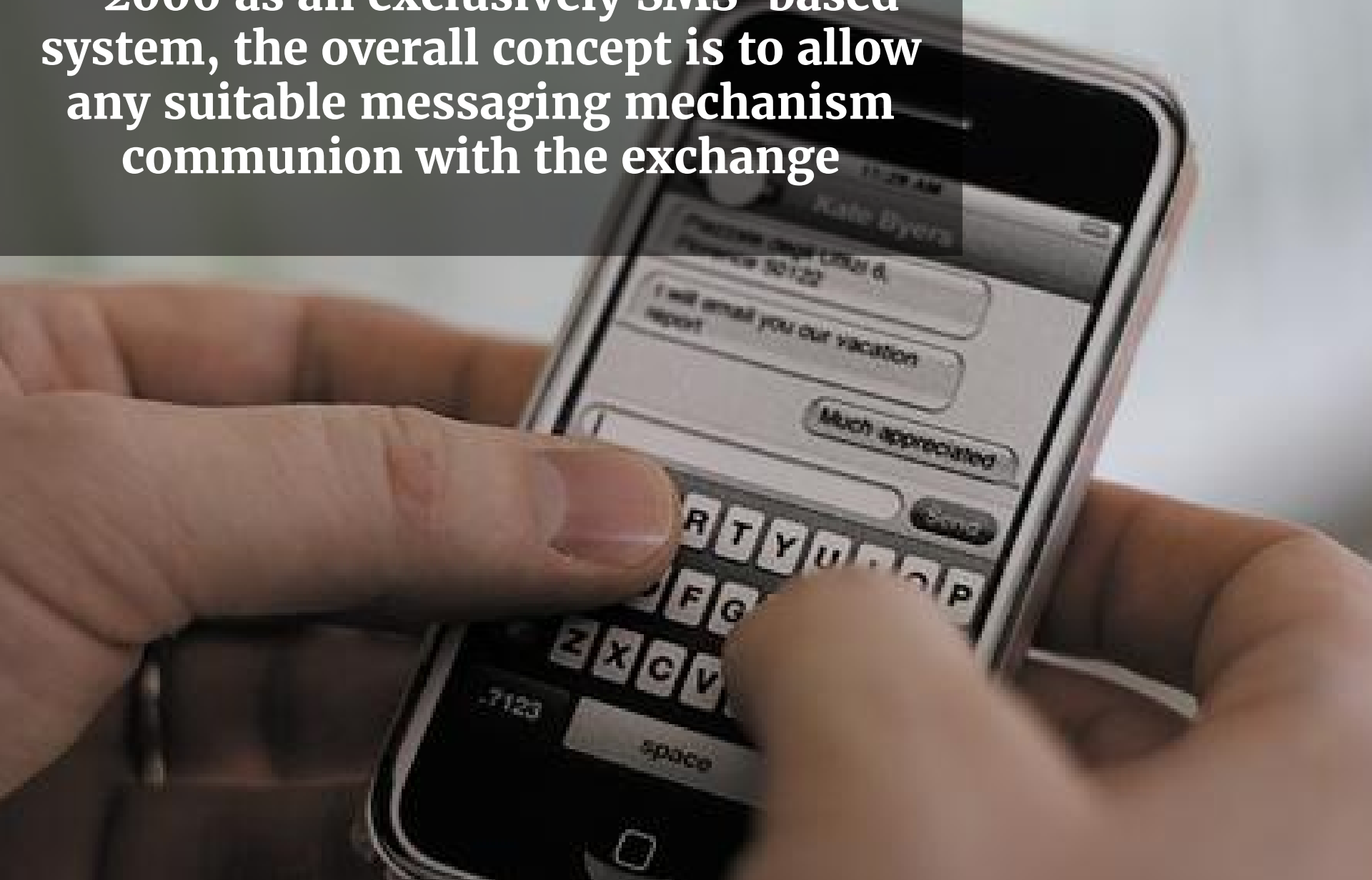
With a solution to the **"guaranteed ride home"** problem that has plagued many dynamic rideshare initiatives



A blurred, long-exposure photograph of a highway at night. The image shows light trails from vehicles moving along the road, with a person visible in the upper left corner. The overall scene is dark with streaks of light from the cars and streetlights.

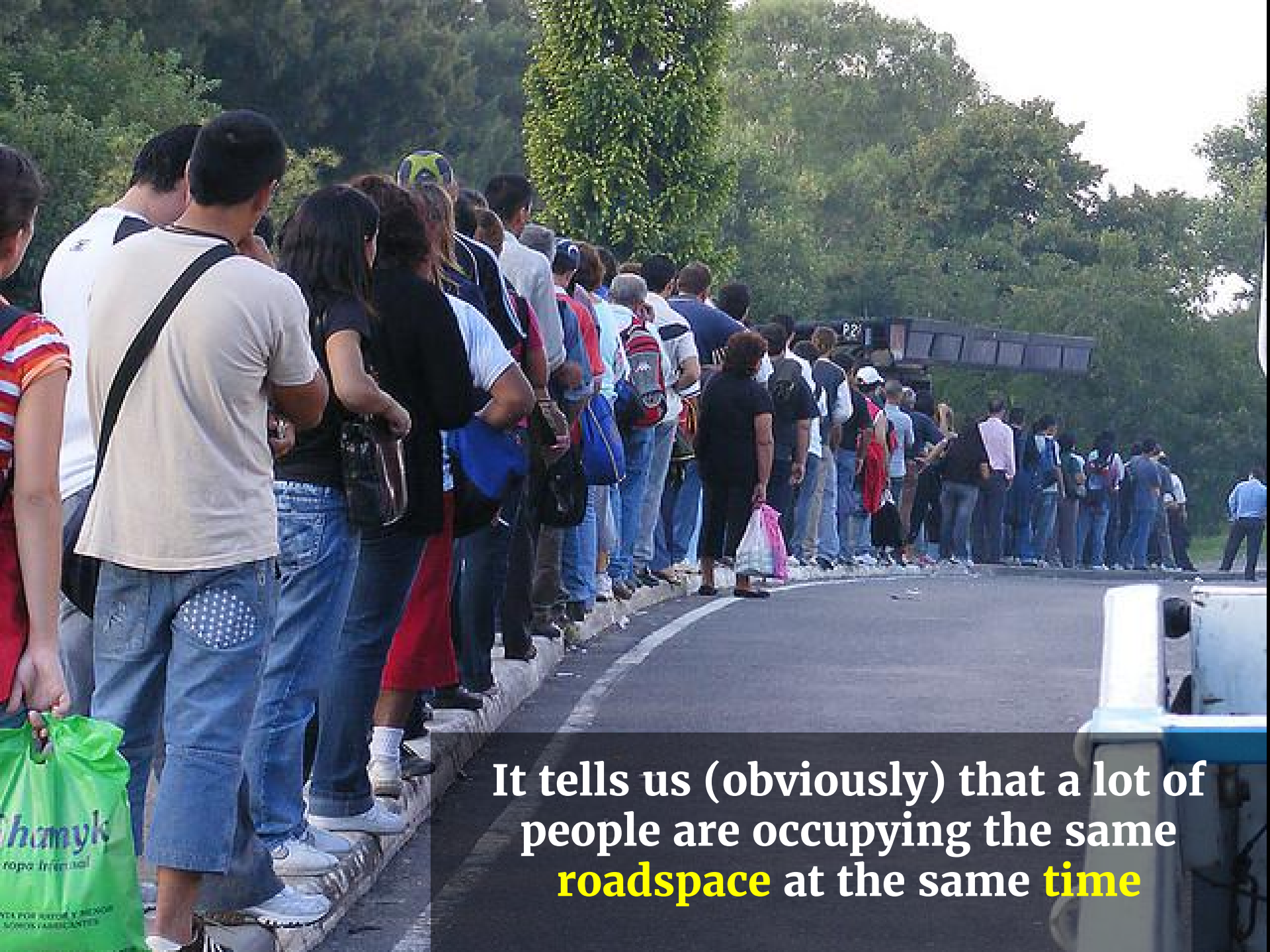
And also prices **roadspacetime**

**Although initially demonstrated in 2005
– 2006 as an exclusively SMS-based
system, the overall concept is to allow
any suitable messaging mechanism
communion with the exchange**

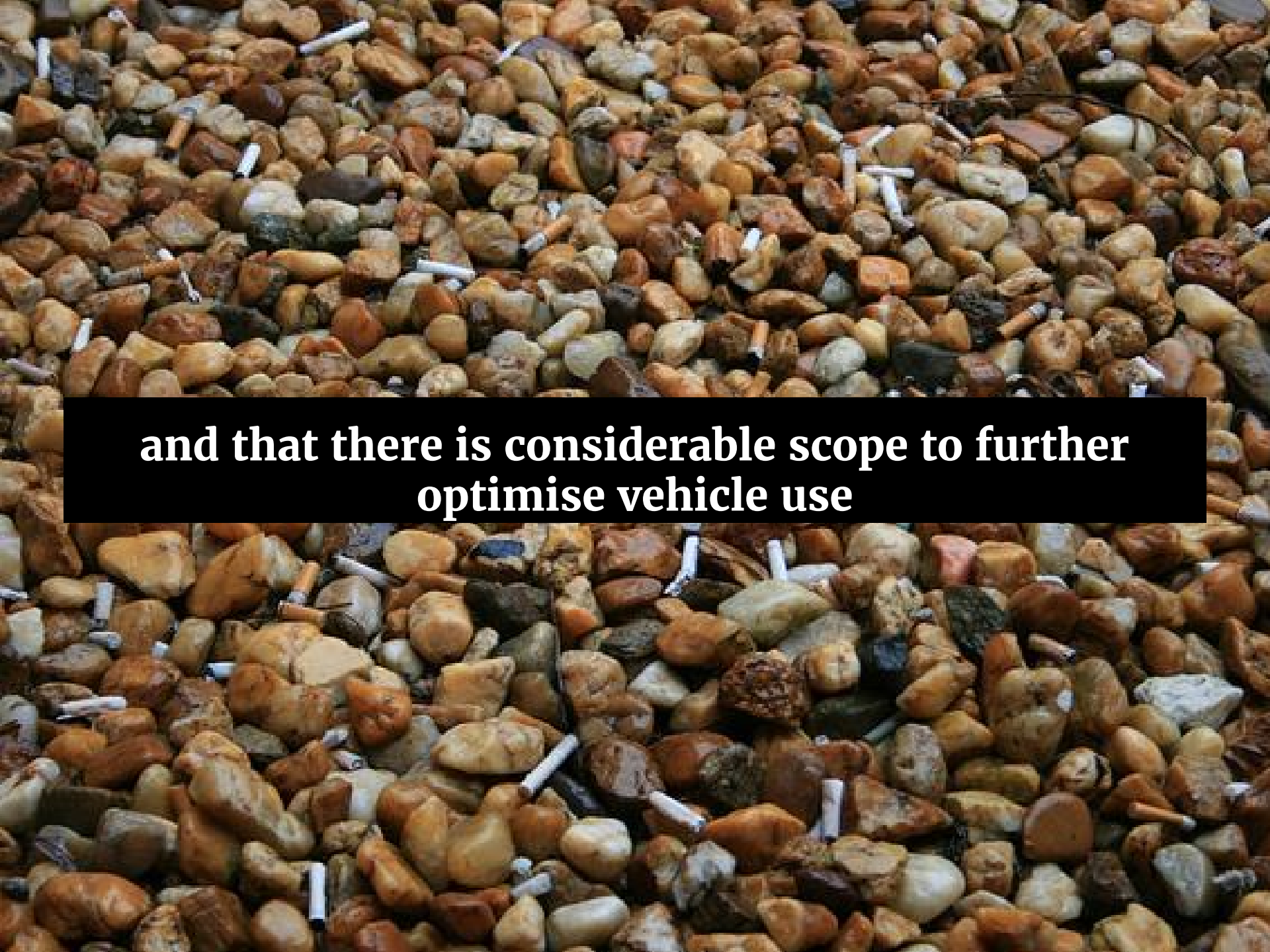


Congestion is a **useful** signal





It tells us (obviously) that a lot of people are occupying the same **roadspace** at the same **time**



**and that there is considerable scope to further
optimise vehicle use**



So what connects to a Transit Exchange ?



Applications that hail vehicles

	USA	USD	0.8962	0.8962	92.377
	JAPAN	JPY	115.594	110.582	
	UNITED KINGDOM	GBP	0.9683	0.9683	0.3858
	NEW ZEALAND	NZD	1.2284	1.2284	1.0284
	THAILAND	THB	31.505	31.505	29.197

Applications to compare the ask prices of transit service provider

	EURO	EUR	0.6837	0.6837	0.5696
	CANADA	CAD	0.977	0.959	0.813
	MALAYSIA	MYR	3.2862	3.2862	2.5356
	SINGAPORE	SGD	1.4516	1.4516	1.1571
	PAPUA NEW GUINEA	PGK	2.956	2.956	2.956



Applications to get data from ridesharing

Applications to calculate carbon use and miles travelled per user for particular times of day

The image shows a desk with several items: a map of a city, a checklist with various items and checkboxes, a pen, and a document titled "MASH 1-YEAR RACE Voluntary Release, Acknowledgment and Acceptance of Risks by Participant". A hand is pointing at the document. The checklist includes items like "Volunteer", "Hubbards", "3rd Army", "Up, 3 Down", "Library", "7 ledges", and "7". The document is a form for a 1-year race, with fields for "Participant Name" and "Date".

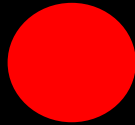
Applications to compare **achieved** prices for transit



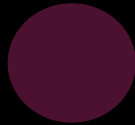
It is an **open** platform that allows any transport provider a level playing field to compete with all others in a locality



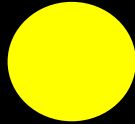
How it all came about



RAF
(1993 - 1995)



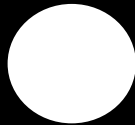
RAEng / National Grid
(1992 - 2001)



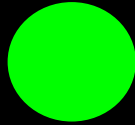
Aeronautical Engineering
(Imperial College, UK & ECL, France)
(1993 - 1998)



IMDB / Social Networks



Computers / Networking



**Investment Banking / Hedge
Funds**

UK Royal Air Force





While at university I was lucky enough
to indulge my passion for aircraft by
flying in an RAF University Air
Squadron

University of London Air Squadron



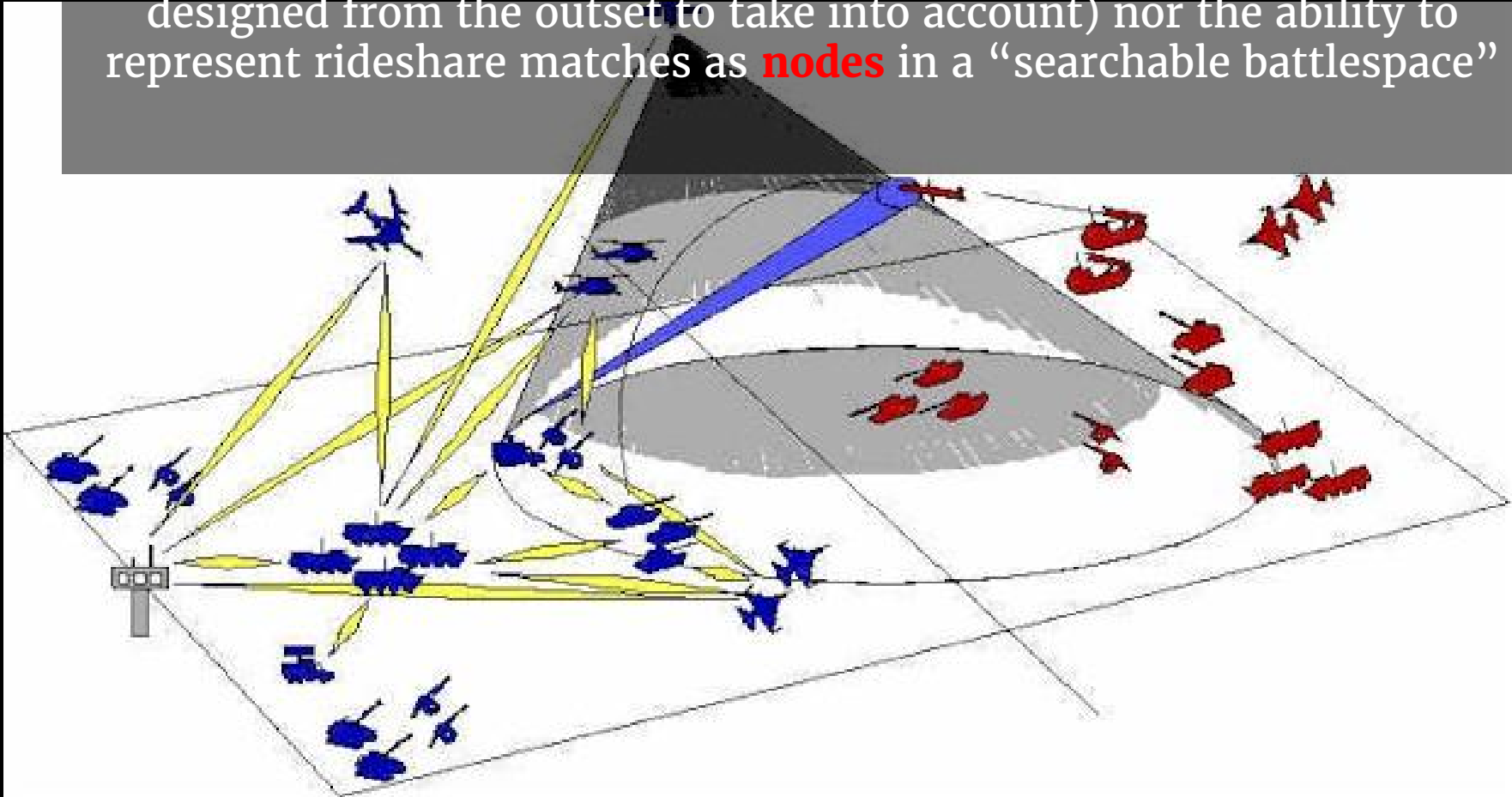
I had some idea of the general operation
of **integrated air defence**
systems and the way that modern
battlespaces are set up.





The key thing that separates grouping applications on a transit exchange from all other ride-sharing initiatives before it is the **integration** of certain operational concepts

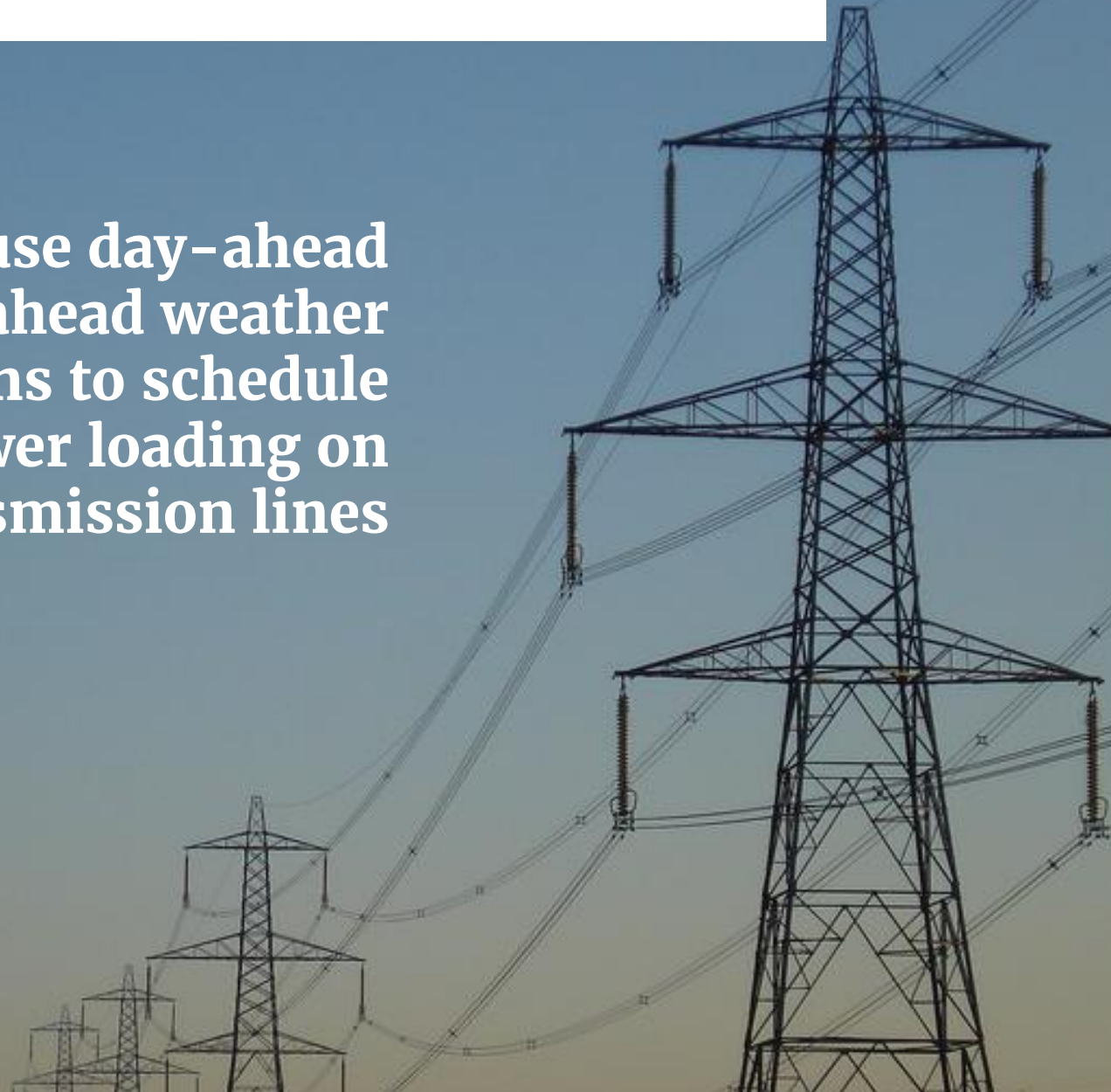
As with joint operations in a modern battlespace, the marketing of the scheme **cannot** be separated from the messaging and grouping technology, the **futures exchange** ideas, the use of a databases of transit intentions, the **effect of social networks** (which Texxi was designed from the outset to take into account) nor the ability to represent rideshare matches as **nodes** in a “searchable battlespace”

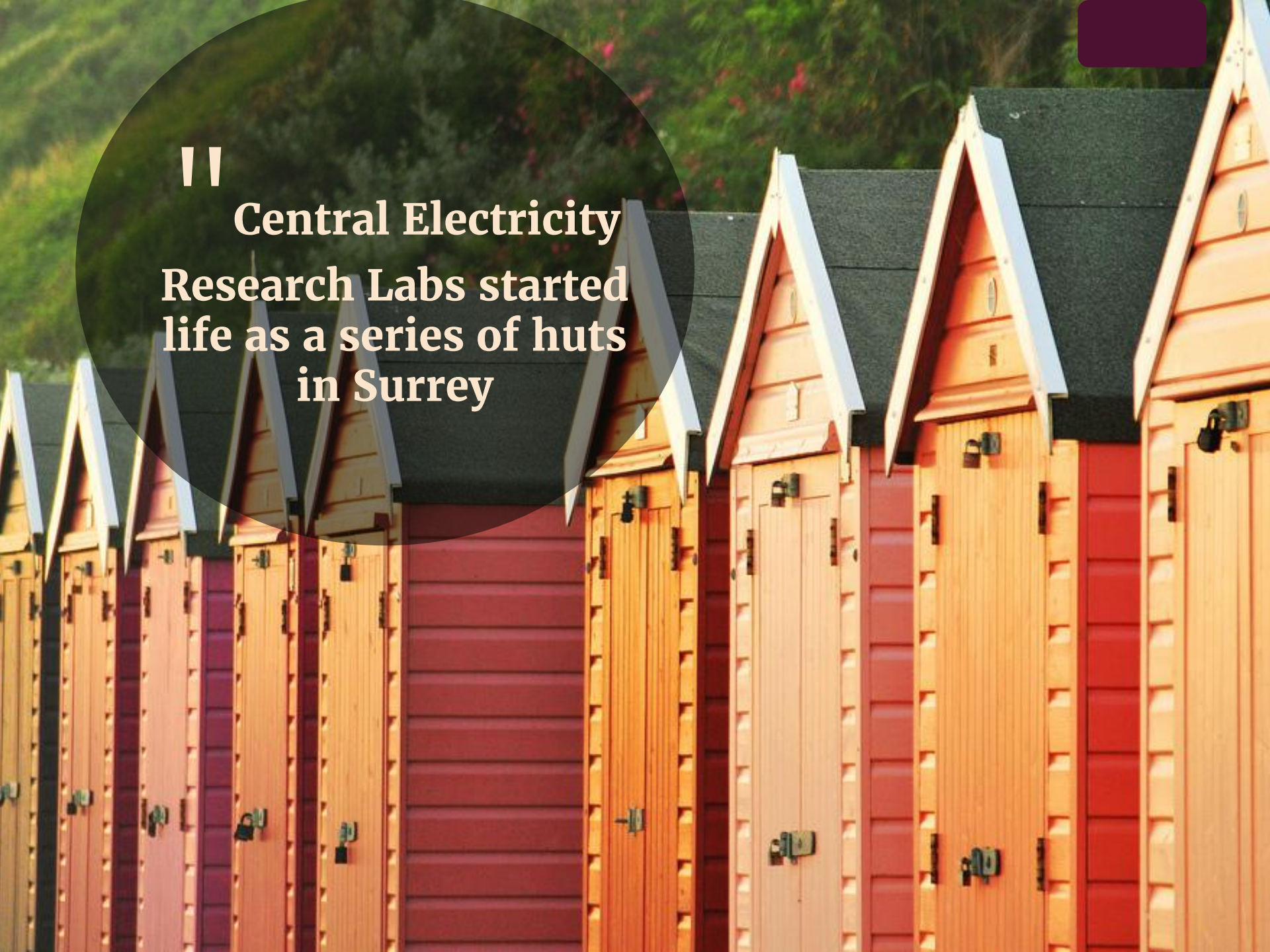


Year in Industry Programme

Industrial Placement 1992 - 1993

**Project to use day-ahead
and week ahead weather
predictions to schedule
more power loading on
transmission lines**





“
**Central Electricity
Research Labs started
life as a series of huts
in Surrey**



High team with

team snatched during the gruelling Challenge — great from start to finish. The team's stamina and ingenuity, despite the state of Weston driving rain on the road conditions

tough, especially for the overnight camp.

The challenge involved orienteering, ropework, code-breaking, and puzzle-solving, and was based on an espionage theme, with teams required to navigate by following cryptic clues.

They bivouacked out at night, and

My project was to create a database of overhead lines conductors and their thermal characteristics to link in with the statistical modelling

they had made from cardboard and Sellotape.

TSD finished 50th out of 64 teams and captain Andrew Dicker said: "The team was great. They put everything they had into it. I was disap-

next time."

Thanks to terrific support from workmates, team members were the winners when it came to raising money

They collected £1,000 for Opera-

expeditions.

Team members were: Andrew Dicker, Adrian Summers, Michelle Clark, John M Downes, Rachel Storey and James Fisher with reserve Noel McGoldrick.

known head of transformer more than 20 years. Keith, States for 14 years, said he commercial values associate adopted by the electricity privatisation.

TROUBLESHOOTER Jim I guson, overhead lines section is playing a major role in helping the Civil Engineering Centre fulfil a contract Seeboard. He is a specialist tower corrosion and was instrumental in developing tower-leg corrosion meter the 1980s. Jim is acting as consultant for the contract which involves condition assessment their foundations in just five

FOUR Burymead House while raising money to buy for Surrey County Hospital. They joined seven contestants Centre, who moved in to the staff Simon Woods and Justine Amore, light current Corrine Sherwood helped Organiser Brian Quigley achieved a good result through the £60 entrance fee each for Carl Lomas (CEC) the team

JOHN M DOWNES has trained he worked in technology management. His new telecommunications engineering, partnership, and he is responsible for telecommunications services



Danny Cheng

Hello Danny

ENGINEER Danny Cheng joined TSD's power system and business modelling section at Leatherhead last month, fresh from commissioning and testing software with the Five Centre Project. Danny was team leader in advanced applications — power systems analysis — at Wokingham. Now he is working on developing software for the ancillary services business. Danny is married to Virginia and they have a baby son Colin.

Happy year for Eric

ONE of four school-leavers taken on by NGC as part of the Year in Industry scheme 1992/93 is Eric Masaba, 19, who has been working in the overhead lines section at Leatherhead.

The scheme is supported by the Royal Academy of Engineering and is aimed at encouraging young people to follow a career in industry by giving them a year's experience between school and university.

Eric, from Liverpool, has been working on collating a database for use in predicting the thermal ratings of overhead lines.

Engineer Mike Tunstall has been impressed with his ability and enthusiasm for the job. "He is a pleasure to have around," he said.

Eric who leaves in September to study aeronautical engineering at Imperial College, London has enjoyed his year with TSD.

"It has been a really good experience. Being given a live project has been exciting and has meant I've had to learn computing skills which will put me a step ahead at university.



Helping hand ... Mike Tunstall helps Eric solve a problem

"I couldn't have hoped for a more friendly environment and I feel I've fitted in well — it's been great."

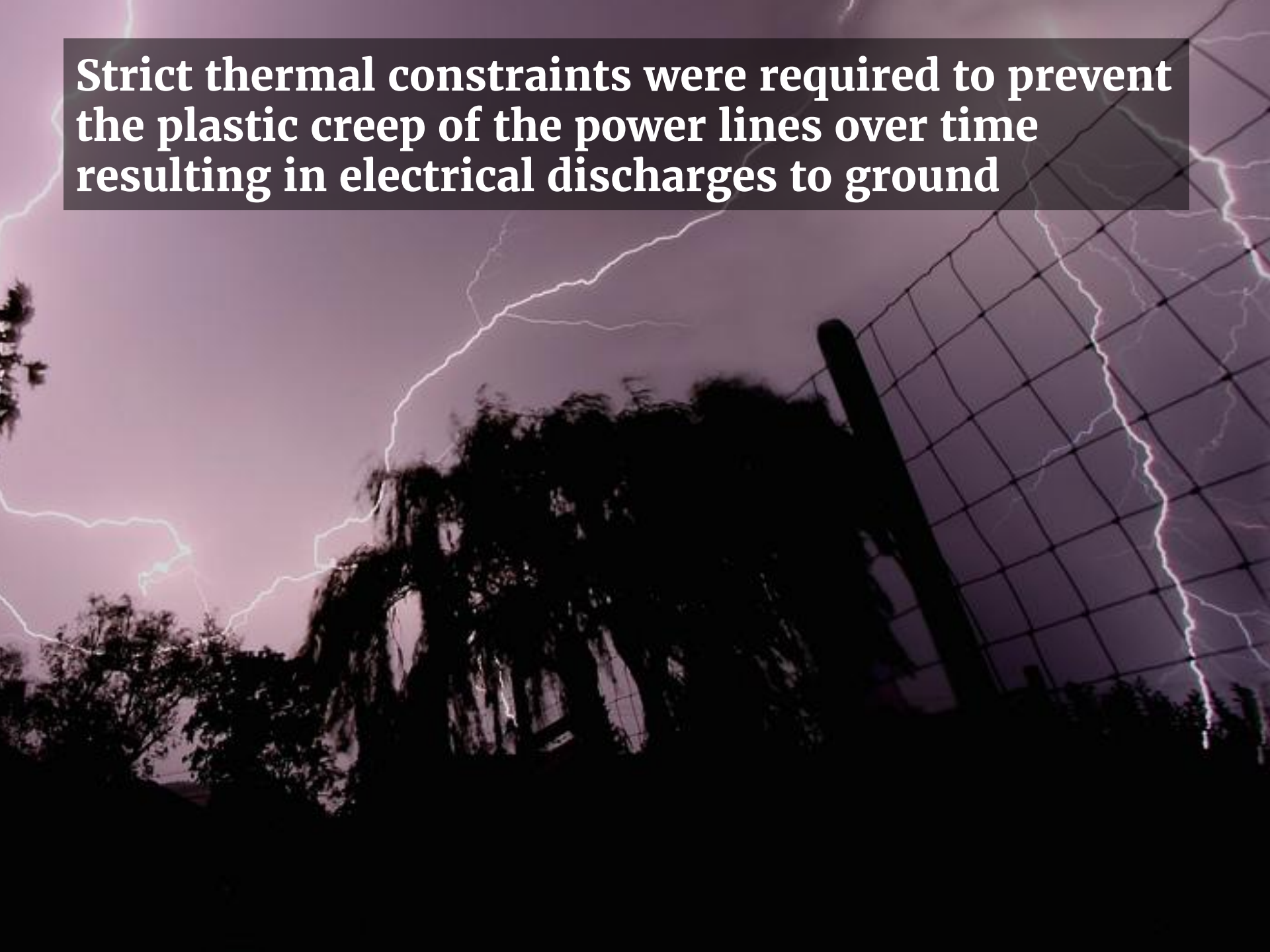
Eric's three contemporaries in the Year in Industry scheme have been based at NGC sites in Wales.



**Using those weather predictions in
making line loading decisions**

(a type of demand response balancing)

Strict thermal constraints were required to prevent the plastic creep of the power lines over time resulting in electrical discharges to ground



As was proved in that project, rethinking and challenging commonly held assumptions sometimes results in great solutions





An RAEng project in 1995 called

**"The Role of Computers in
Transportation Technology"**

**NASA Space Shuttle Trainer at
Marshall Space Flight Centre,
Alabama**

During an internship at Swiss Bank Corporation, in 3 weeks, I travelled to;

**New York – Atlanta – Huntsville
Miami – San Francisco – Los Angeles**

To see;

Automated highway technology
(thanks Kate Bellingham)

ACM SIGGRAPH '95
(thanks Paul Brown, Len Breen and Daniel Brown)

NASA bases

(organised by the RAF, MoD and paid for by the Royal Aeronautical Society and the Royal Academy of Engineering)

Engineering Mathematics Concepts

Structural Matrices

(a type of social network for forces)

Genetic Algorithms

(a way to "cheat" hard problems by borrowing from Biology)

Wing Design

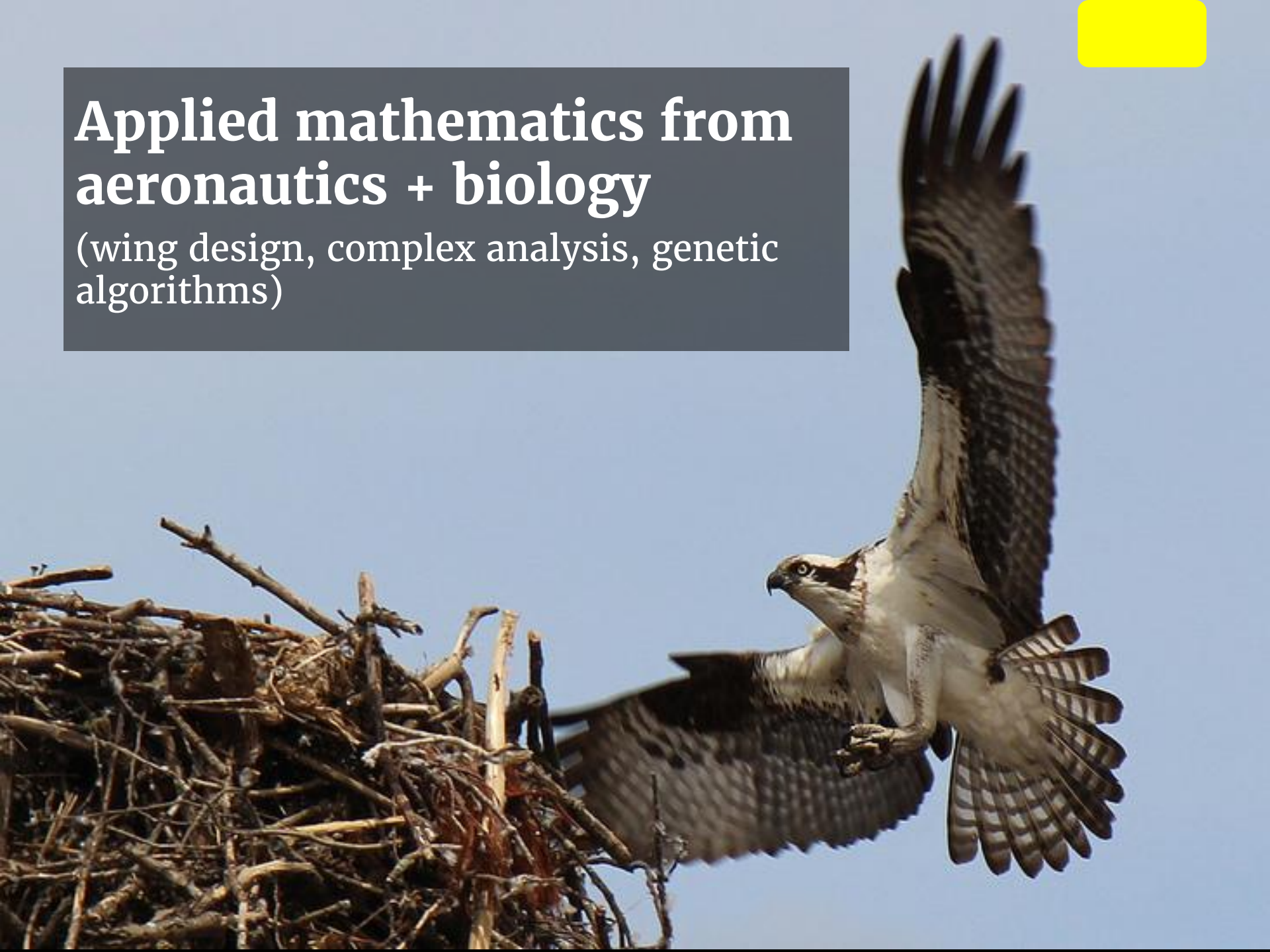
(How solving for a wing shape is like figuring out the best route)

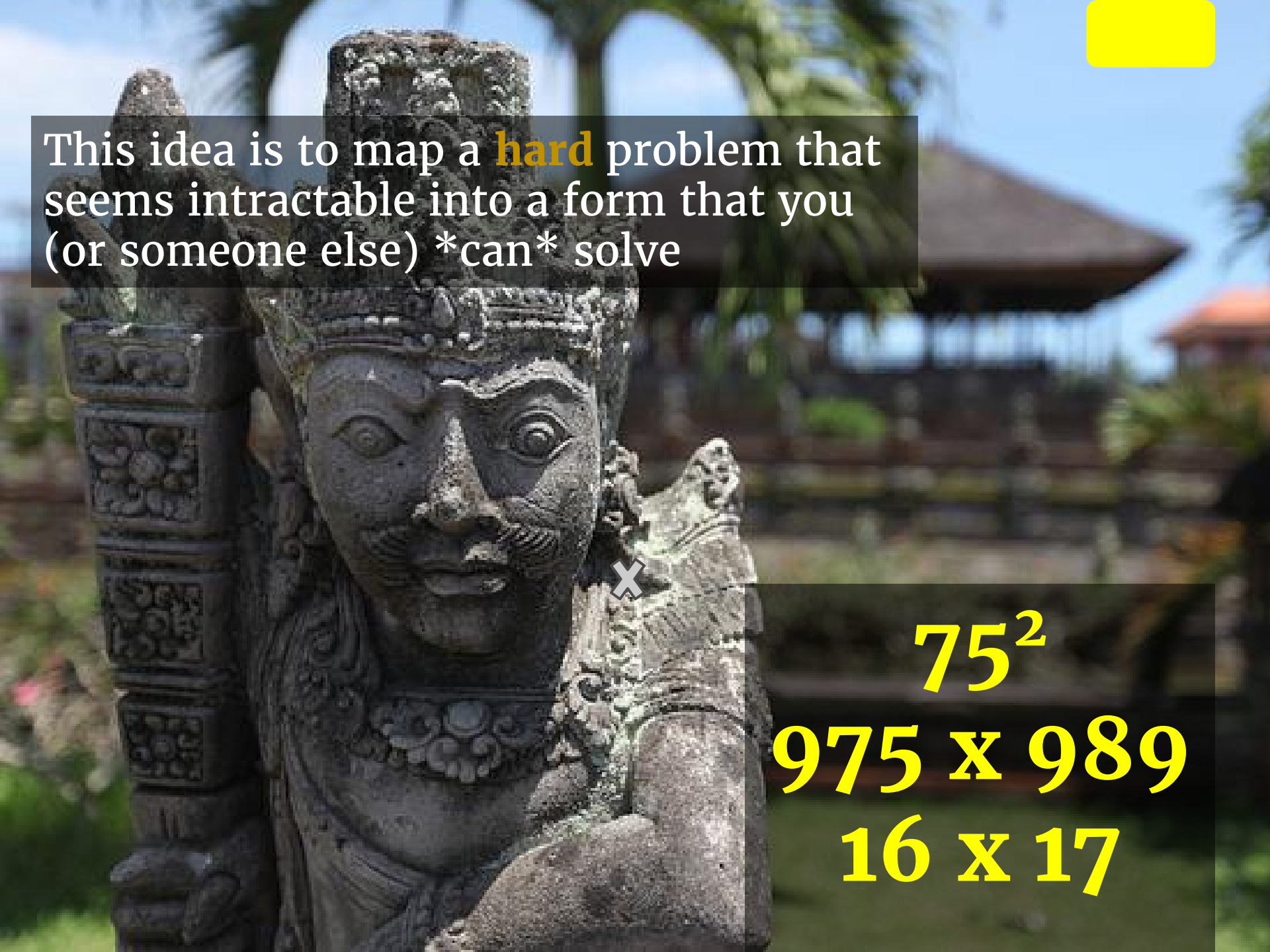
Complex Analysis / Conformal Mapping

(Once you map a problem to another domain, it may no longer look like a problem)

Applied mathematics from aeronautics + biology

(wing design, complex analysis, genetic
algorithms)





This idea is to map a **hard** problem that seems intractable into a form that you (or someone else) **can** solve

x

$$75^2$$

$$975 \times 989$$

$$16 \times 17$$



e.g. | a 2nd Order Linear Differential
Equations with constant coefficients

$$a \frac{d^2 y}{dx^2} + b \frac{dy}{dx} + cx = f(x)$$

$$ay'' + by' + cy = g(x)$$

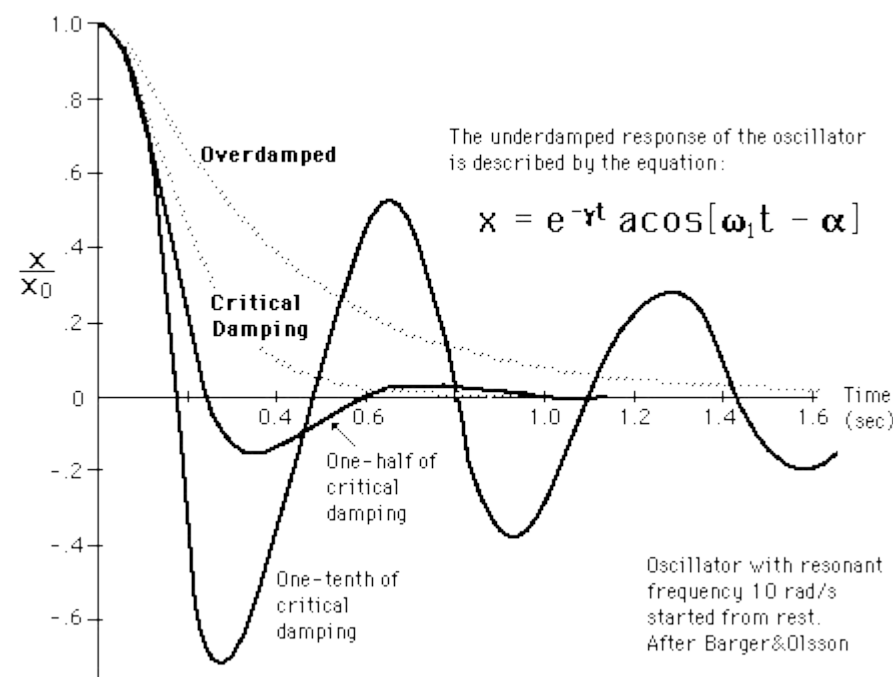
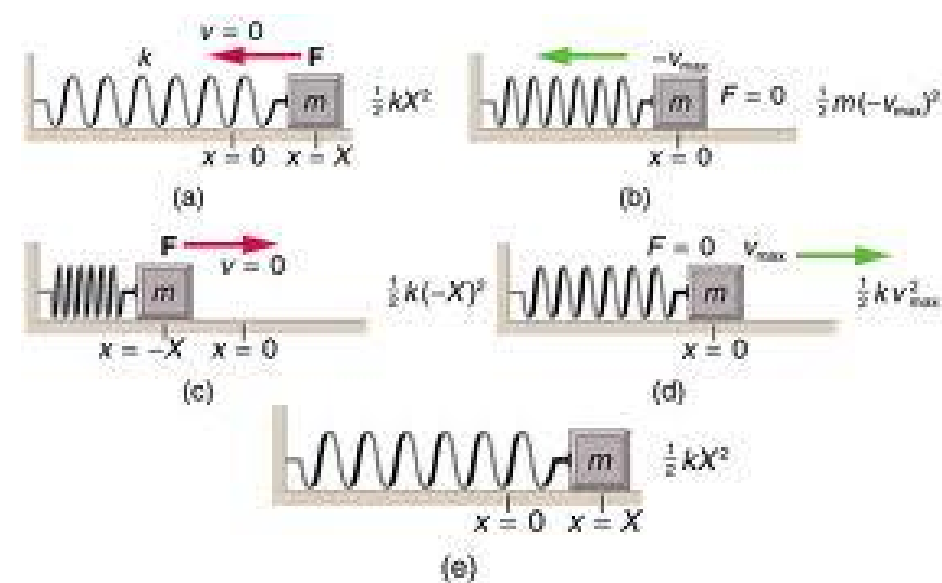


$$\begin{aligned}\mathcal{L}\{f(t)\} &= \int_{0^-}^{\infty} e^{-st} f(t) dt \\ &= \left[\frac{f(t)e^{-st}}{-s} \right]_{0^-}^{\infty} - \int_{0^-}^{\infty} \frac{e^{-st}}{-s} f'(t) dt \quad (\text{by parts}) \\ &= \left[-\frac{f(0^-)}{s} \right] + \frac{1}{s} \mathcal{L}\{f'(t)\},\end{aligned}$$

Become simple algebraic expressions once transformed by a Laplace Transform



e.g. | Forced harmonic motion equations with damping



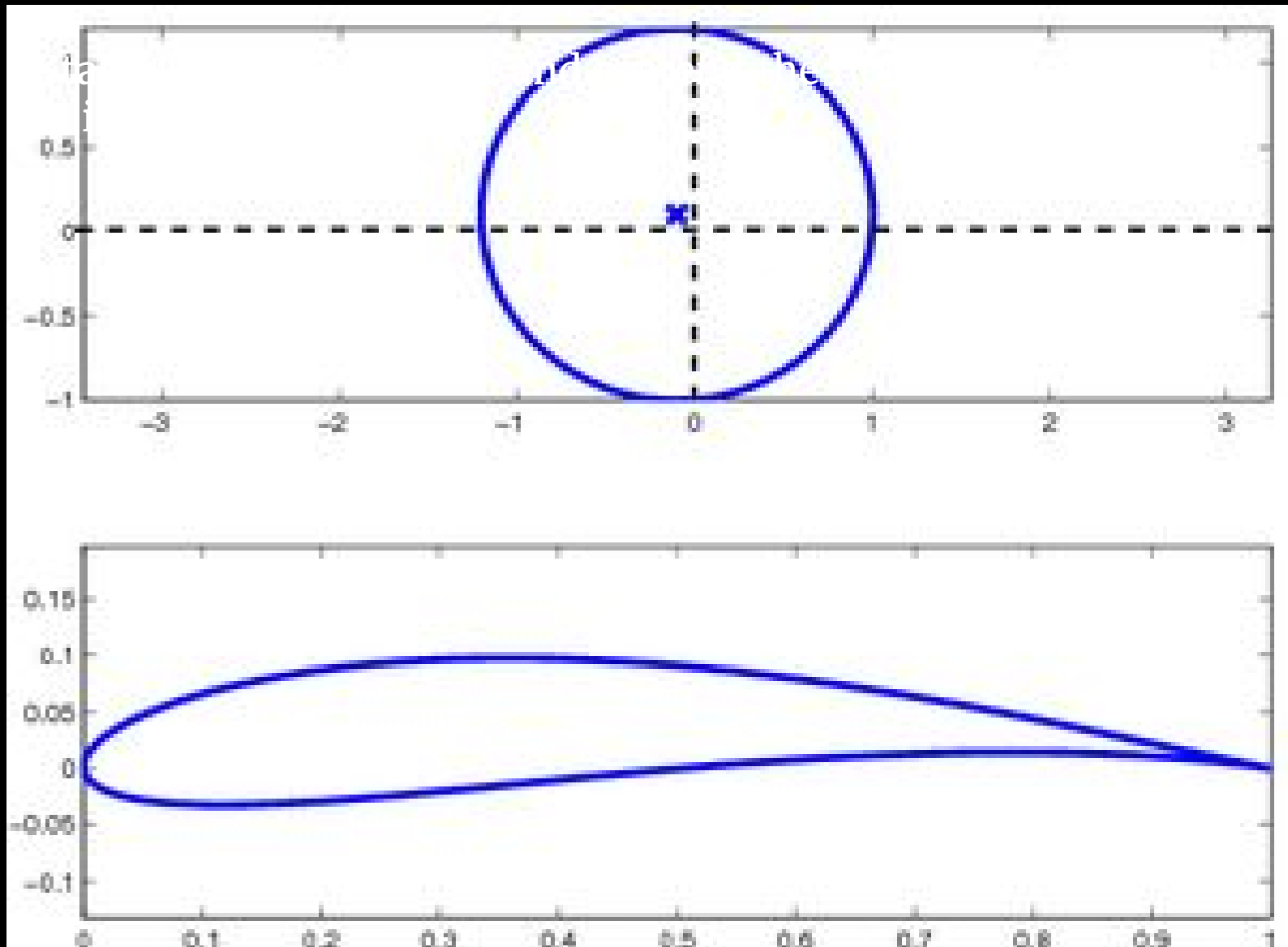


Become simple electrical circuits (or vice versa)

e.g. | Finding the separation point of airflow
over complex wing shapes



Used to require months and dozens of prototype wings



then use a **Kutta-Joukowski** transform to map the cylinder into the actual shape you want

ERASMUS Scheme for year abroad in Europe



A ridesharing project at Ecole
Centrale de Lyon using groupware



The University wanted a way to help students to get home by sharing rides if possible (France has toll roads, high taxes and petrol is expensive there)

The Internet Movie Database

(database / social network of actors and films)



Box Office **Mojo**





What's this got to do with ridesharing?

Sometime in 1990, an intrepid group of enthusiasts decided to make a comprehensive database of every film with all its actors and crew listed

This led to the Internet Movie Database and although there were (many) others, this one survived and was turned into a company



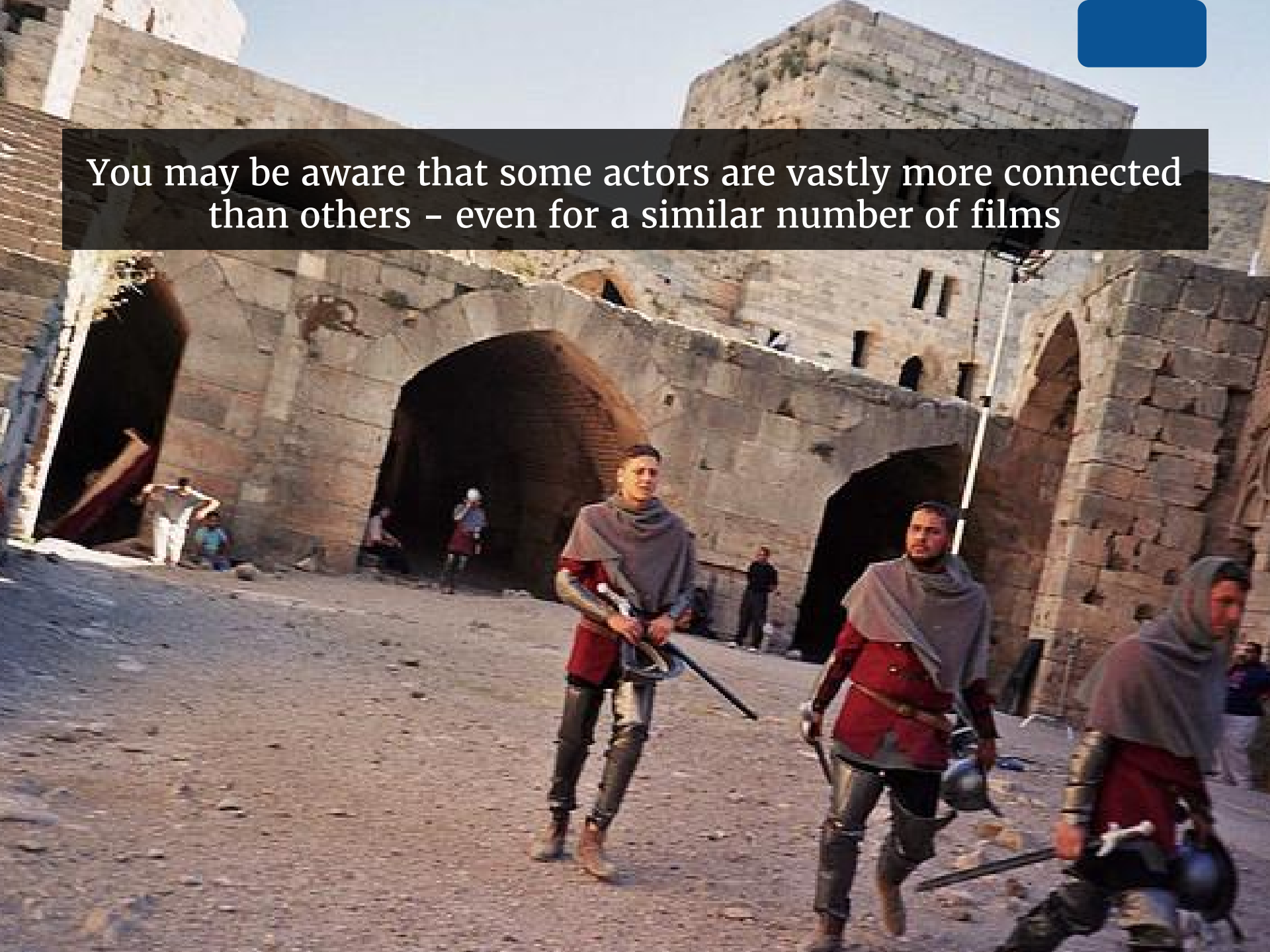
A photograph of Jeff Bezos, the founder of Amazon, sitting in a dark brown leather armchair. He is wearing a dark blue blazer over a light blue button-down shirt and khaki pants. He is looking slightly to his right with a calm expression. The background is a warm, out-of-focus interior with a painting of a landscape and a colorful, abstract sculpture. A blue rectangular graphic is in the top right corner.

which was eventually bought
by Amazon in 1998



coupled with BoxOfficeMojo, it is quite amazing what "live" statistics you can pull out of this system now

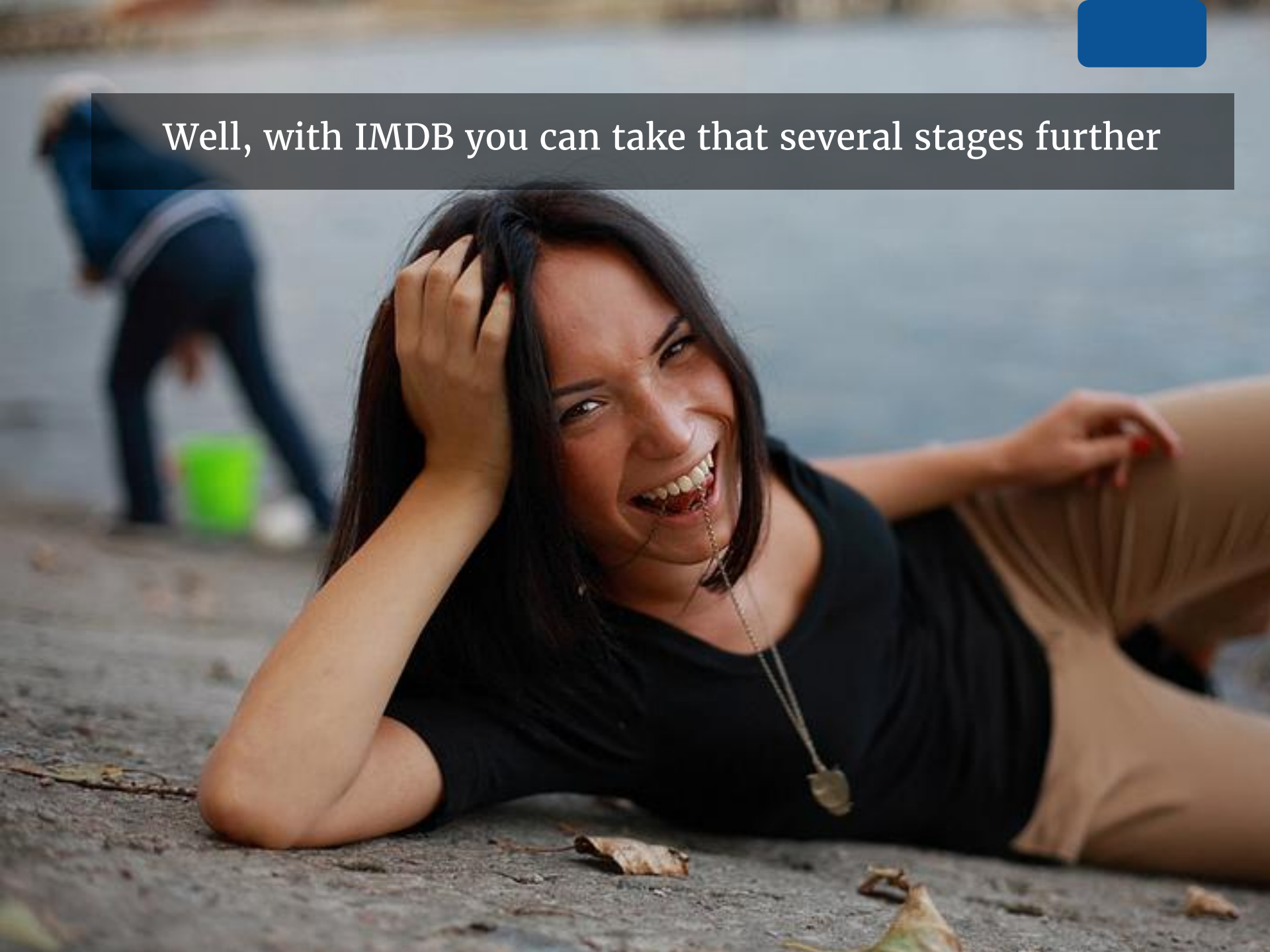
You may be aware that some actors are vastly more connected than others – even for a similar number of films



Ever played "6 degrees of Kevin Bacon" ?



Well, with IMDB you can take that several stages further





Much of what I was trying to model with both a **credit contagion** system AND dynamic ridesharing (Texxi) is very similar to finding actors who have acted in the same films or that have a connection in common

Computers & Networking Protocols





Computers achieve so much more when they talk to other computers



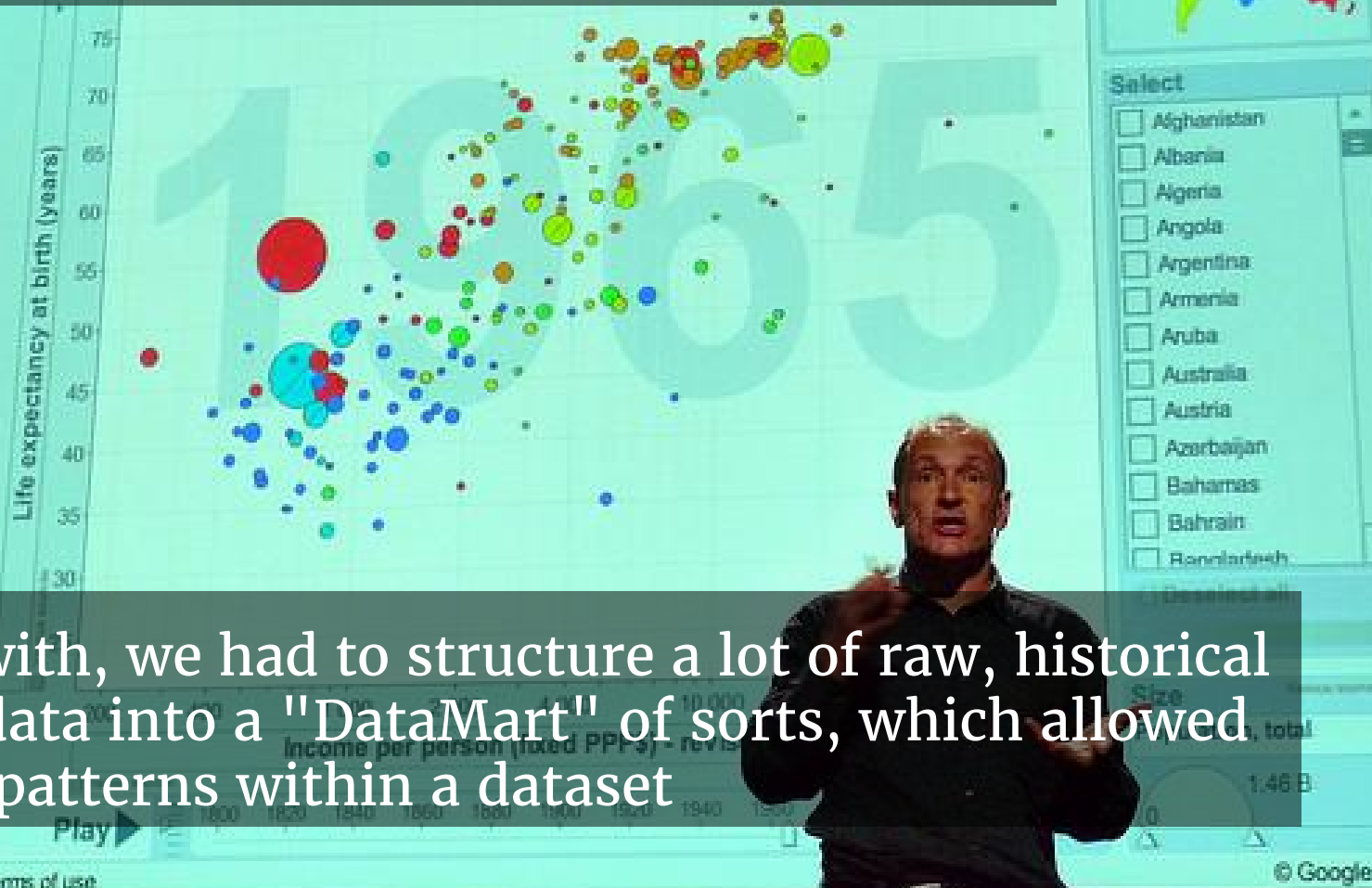
But they need some sort of "common ground" where they can all communicate – that is called the Internet
(a network made up of many joined peering points)

A low-angle photograph of the Chicago Board of Trade building, a historic stone structure with a large clock face at the top. An American flag is flying on a tall pole in the foreground. The text "CHICAGO BOARD OF TRADE" is visible on the building's facade. A solid green square is in the top right corner.

Trading & Futures Exchanges

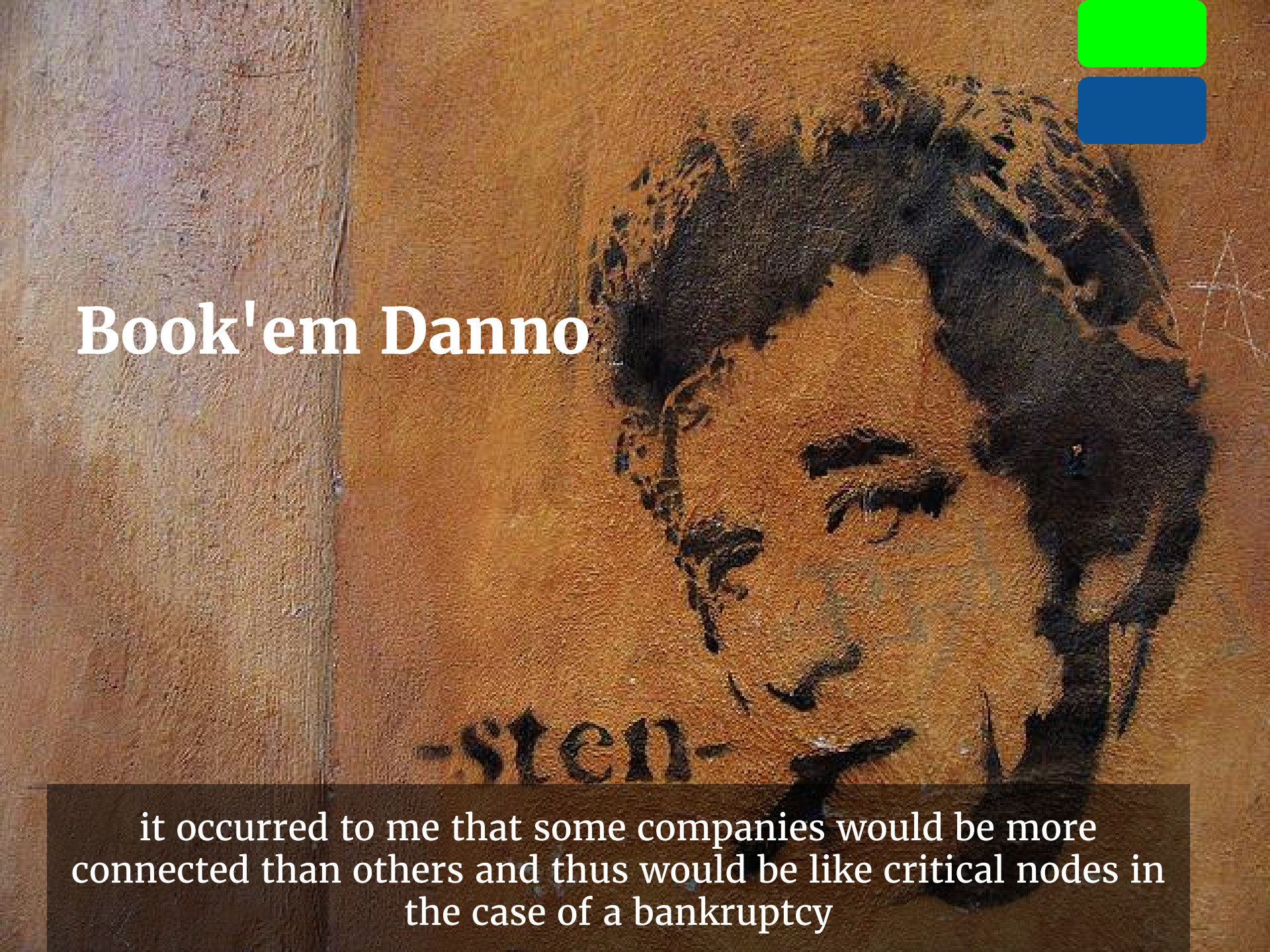
In November 2003, I started work on a paper for a capital structure arbitrage hedge fund to explain the effect on CDS prices of credit contagion between companies

Connectedness + Contagion



To begin with, we had to structure a lot of raw, historical volatility data into a "DataMart" of sorts, which allowed us to find patterns within a dataset

TED



Book'em Danno

it occurred to me that some companies would be more connected than others and thus would be like critical nodes in the case of a bankruptcy

In times of economic stress, where either many companies face similarly challenging conditions or a few very large and well connected companies are at risk of failing, fatter tails in loss distributions of large loan portfolios are observed.

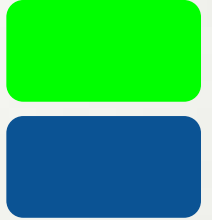


A close-up photograph of a baby wearing a white knit hat, looking intently at a newspaper held open. The baby's face is in profile, showing concentration. The newspaper text is visible but slightly out of focus. In the top right corner, there are two overlapping colored squares: a bright green one on top and a blue one below it.

Recent papers (since 2010) on credit contagion have now empirically confirmed the presence of fat tails in observed loss distributions due to credit defaults from the correlative aspect of companies in a trading space

A photograph of a crowded airport terminal. In the background, a large group of people is standing in a queue, waiting for a service. The terminal has a modern design with large pillars and overhead lighting. A digital display screen is visible in the upper right, showing a green screen with the number '2'. Green directional signs with arrows are also visible. In the foreground, several people are walking past the queue, some carrying bags. The overall atmosphere is one of a busy, high-traffic public space.

The corollary in ridesharing is situations in which a lot of people want transport at the same certain times (rush hour, concert or sports events, school start and end times, industrial action and inclement weather)



The correlations increase dramatically making finding matches that much easier than would be apparent at first glance



and while using a ridesharing analogy, I realised that the
market for ridesharing was of the order of
\$1,000bn p.a. in the USA + EU5 countries alone.

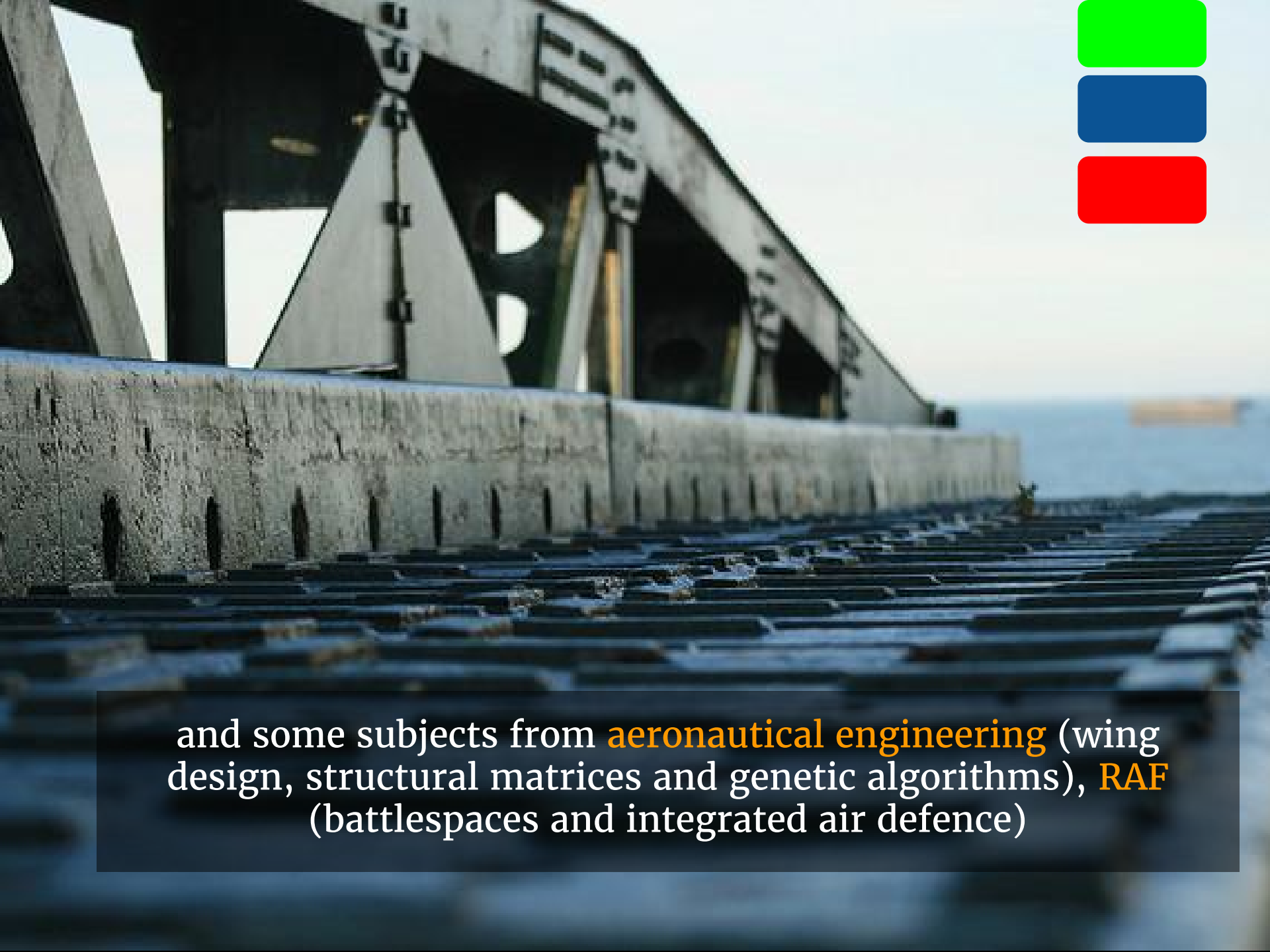
Yes, you got it right



\$1 TRILLION



Later in 2004 - 2006, applying further ideas from commerce (the Long Tail by Chris Anderson)



and some subjects from **aeronautical engineering** (wing design, structural matrices and genetic algorithms), **RAF** (battlespaces and integrated air defence)



I became confident that this problem was indeed resolvable in a real, largescale live environment.

The issue at hand is identical to the same problems that agricultural producers experienced in commerce before the adoption of “futures exchanges”

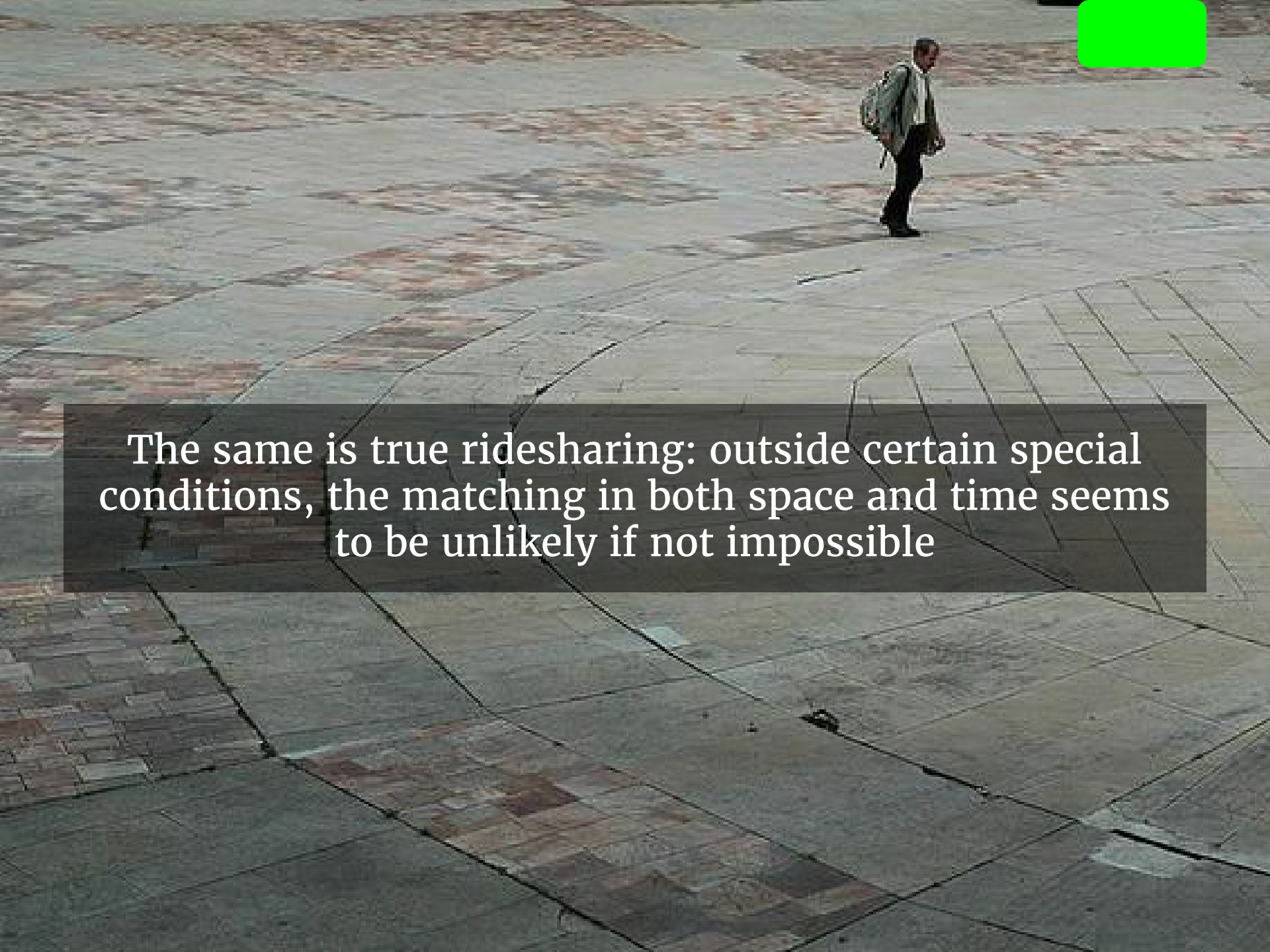




The attitude to ridesharing is one of risk aversion (much like how farmers sought to minimise risk trades with buyers)

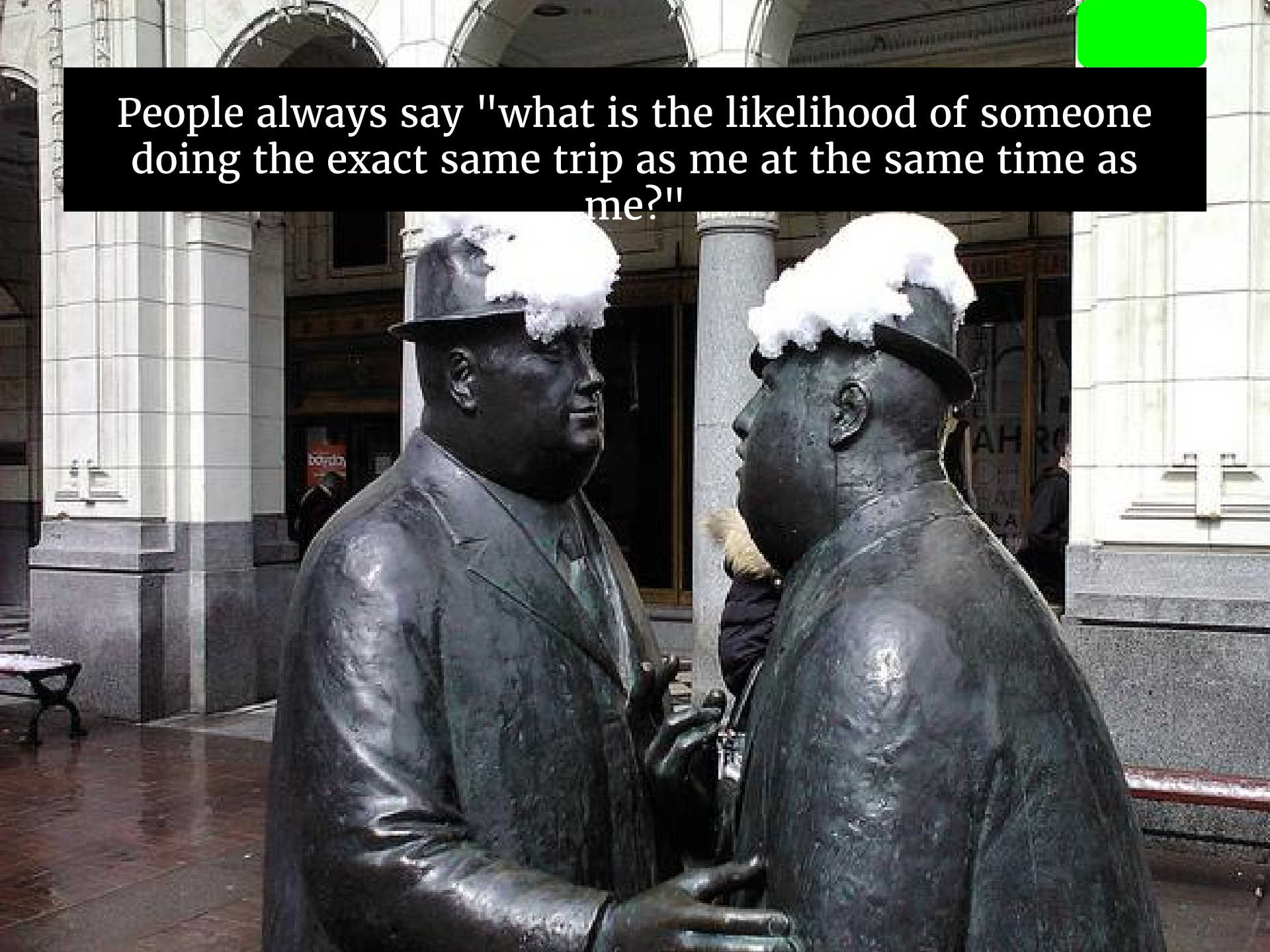
A black and white photograph of two individuals in elaborate, theatrical costumes. The person on the left wears a tall, feathered hat and a mask, holding a small book. The person on the right wears a large, leafy headdress and a mask, holding a small object. They are standing in front of a building with large doors and a potted plant.

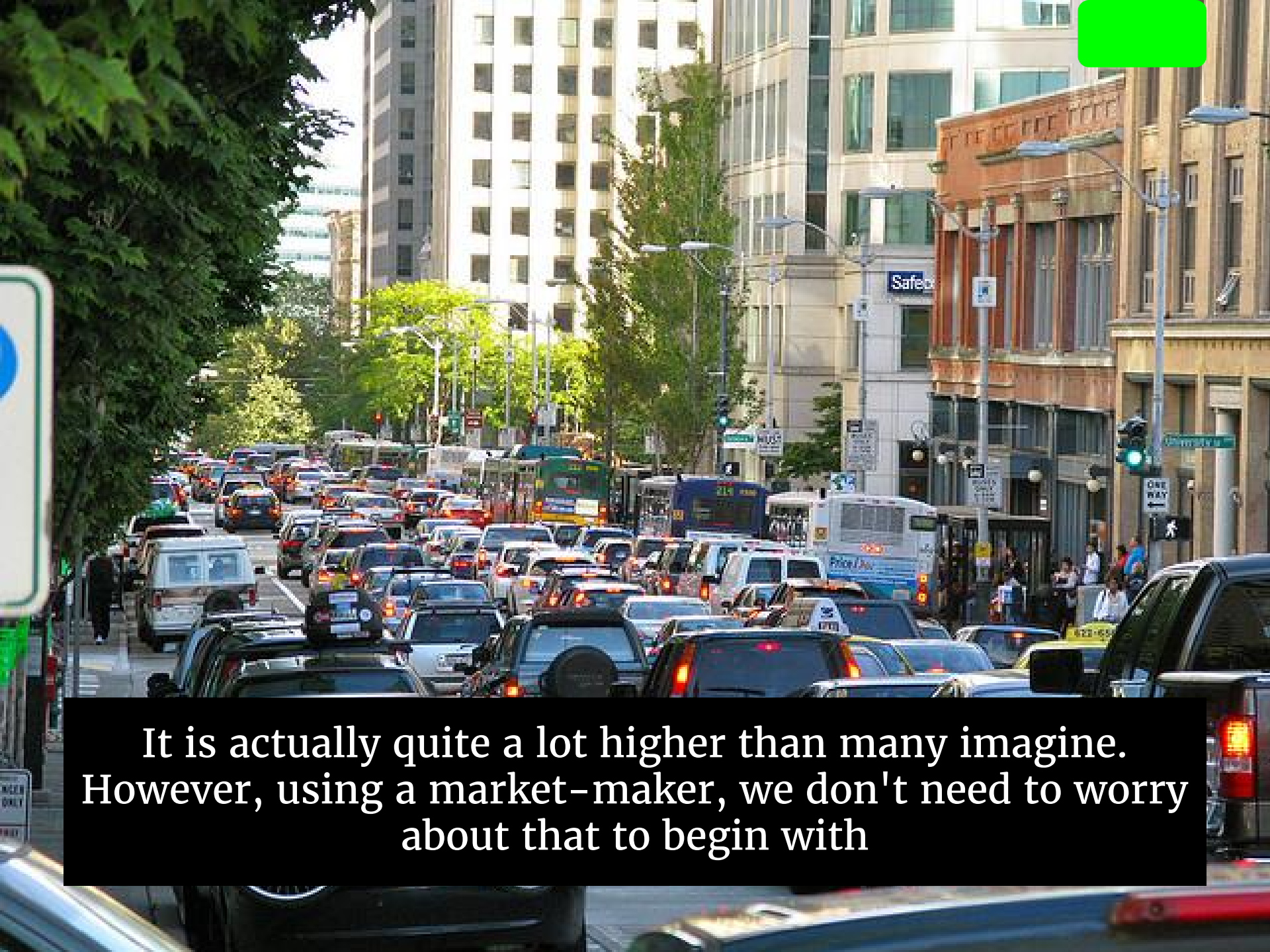
Trading will not happen if people cannot have some sort of good knowledge or guarantee of their counterparties

A high-angle, wide shot of a person walking across a vast, cracked, and uneven stone pavement. The person is wearing a light-colored jacket, dark pants, and a backpack, walking from the upper right towards the center. The pavement is composed of large, irregular stone tiles in shades of grey, brown, and tan, with prominent cracks and uneven surfaces. A semi-transparent dark grey rectangular box is overlaid on the lower half of the image, containing white text. In the top right corner, there is a small, solid red square.

The same is true ridesharing: outside certain special conditions, the matching in both space and time seems to be unlikely if not impossible

People always say "what is the likelihood of someone doing the exact same trip as me at the same time as me?"





It is actually quite a lot higher than many imagine.
However, using a market-maker, we don't need to worry
about that to begin with



The market-maker effectively buys the empty seats from "producers" and holds them until it finds a buyer



Name: Ms Ying Lui
Works: Investment Bank
Status: Single
Route: Woolton - James St.
Leaves Home: 6:45am
Spare Seats: 3
Would share with:
Professional Women.

A photograph of a young woman with long dark hair, smiling and looking towards the camera. She is sitting in the driver's seat of a convertible car with tan leather upholstery. Three arrows originate from a text box in the top right and point to different parts of the car's interior: one to the headrest, one to the seat, and one to the center console area.

3 spare seats (rides) for sale in a convertible for professional women only

To give the sellers a guarantee that **someone** will buy at **some** price and to give customers confidence that they can **always** get a ride at an advertised price



This actually happens anyway with buses which drive around empty



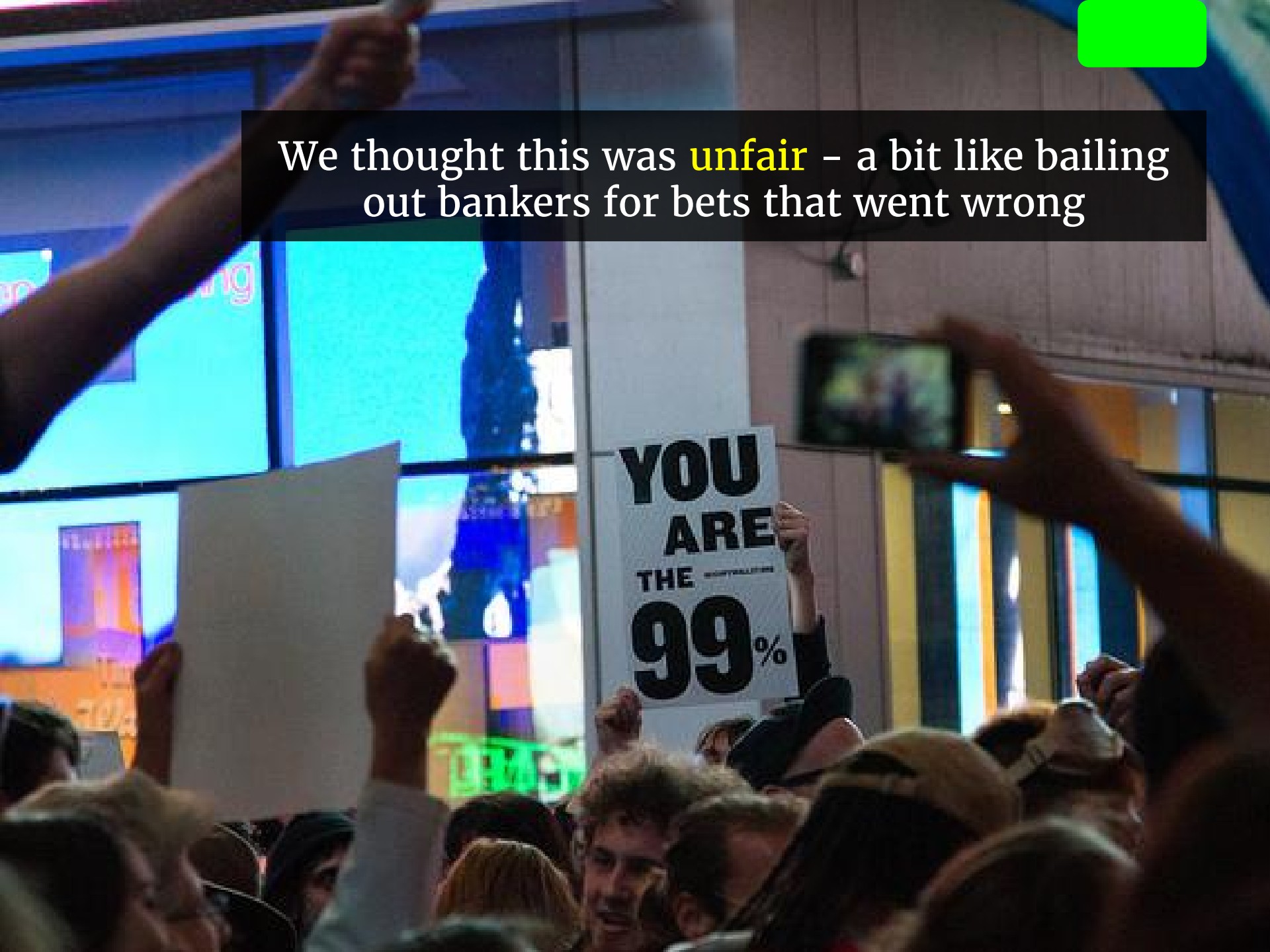
It is just that the person paying
for those empty seats is a
taxpayer

**Can't Pay the IRS?
Let Us Help You.**

Whether that taxpayer ever uses the bus or not



We thought this was **unfair** – a bit like bailing out bankers for bets that went wrong





Why not let a private entity take the risk (and reward) instead?



Ironically, the bandwidth industry also uses “transit exchanges” to link fibre carriers in locales called “peering points” – think of these as bus stations for data packets

The Six Pillars

Spatio Temporal Order Matching and Fulfillment

Topology

Social Networks / Credit Contagion

Conformal Mapping

Complex Analysis / Simplex Method

Futures Exchanges

Market Makers / Price Discovery

Electricity Markets

Constraints

Genetic Algorithms

NP Hard Problems

Integrated Battlespaces

ADS-B + Link 16

The Transit Exchange is a way to get people to share transport resources – dynamically and in realtime –



by using an online transit marketplace to connect buyers and sellers of whichever transport services
(car, taxi, bus, limousine, private jet, ferry, dollar van or train)



It overcomes the long observed problems of market formation issues, guaranteed ride home worries, legal constraints about taxi booking and accessibility (being agnostic to the type of device used to hail a ride match / summon a vehicle)

It needed ideas from the military, aeronautics ,
futures exchanges, credit contagion, social network
modelling and electricity research to be fully
realised

A photograph of two women in traditional Japanese geisha attire. They are wearing elaborate kimonos with floral patterns and have their hair styled in traditional buns adorned with many colorful flowers. The woman on the right is holding a small yellow object. They are standing outdoors, with a stone staircase visible in the background. A semi-transparent black box with white text is overlaid on the right side of the image.

And even then, in order
to effect the behaviour
change in a population
and keep people coming
back to buy more trips,
clever and repeated
integrated marketing is
vital

Hence why the marketing **cannot** be separated from the technology in any deployment.





Much like modern warfare requires joint operations and the integration of financial, cultural and information assets in concert with combatants and their machines on the battlefield.

By coincidence Texxi also stands for
"The **T**ransit **E**xchange for the **XXI** Century"



Thank you for watching!



Crane Dragon 2004 - 2013 | Transit Exchange Concept / Texxi