The shape of innovation:

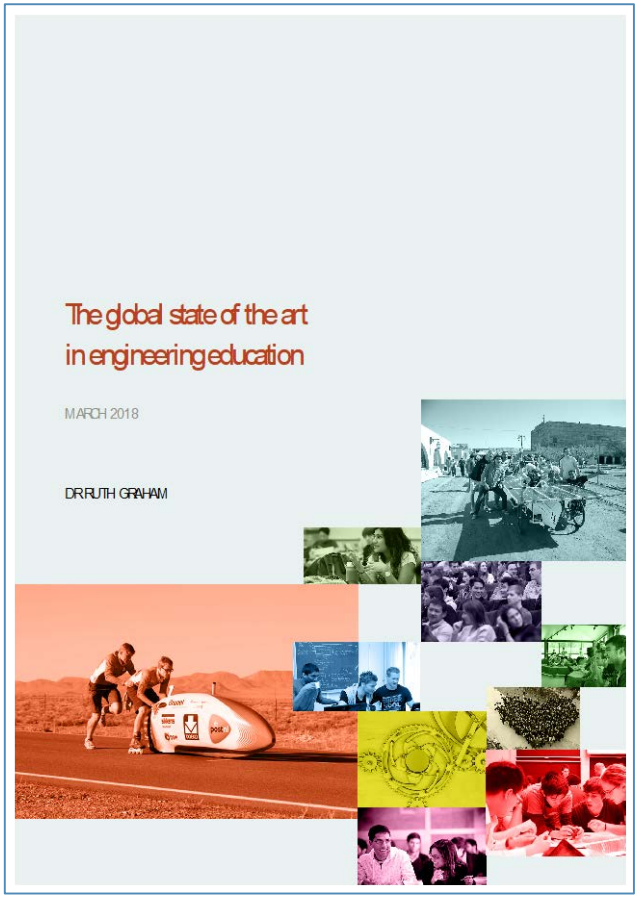
systemic approaches to embedding creativity, entrepreneurship and innovation in undergraduate engineering programmes

Dr Ruth Graham

17th September 2018

The global state of the art in engineering education

Commissioned by MIT
Published March 2018



Two phases of the MIT-commissioned study:

Phase 1 (Sept–Nov 2016)

Provided a snapshot of the cutting edge of global engineering education and a horizon scan of how the state of the art is likely to develop in the future.

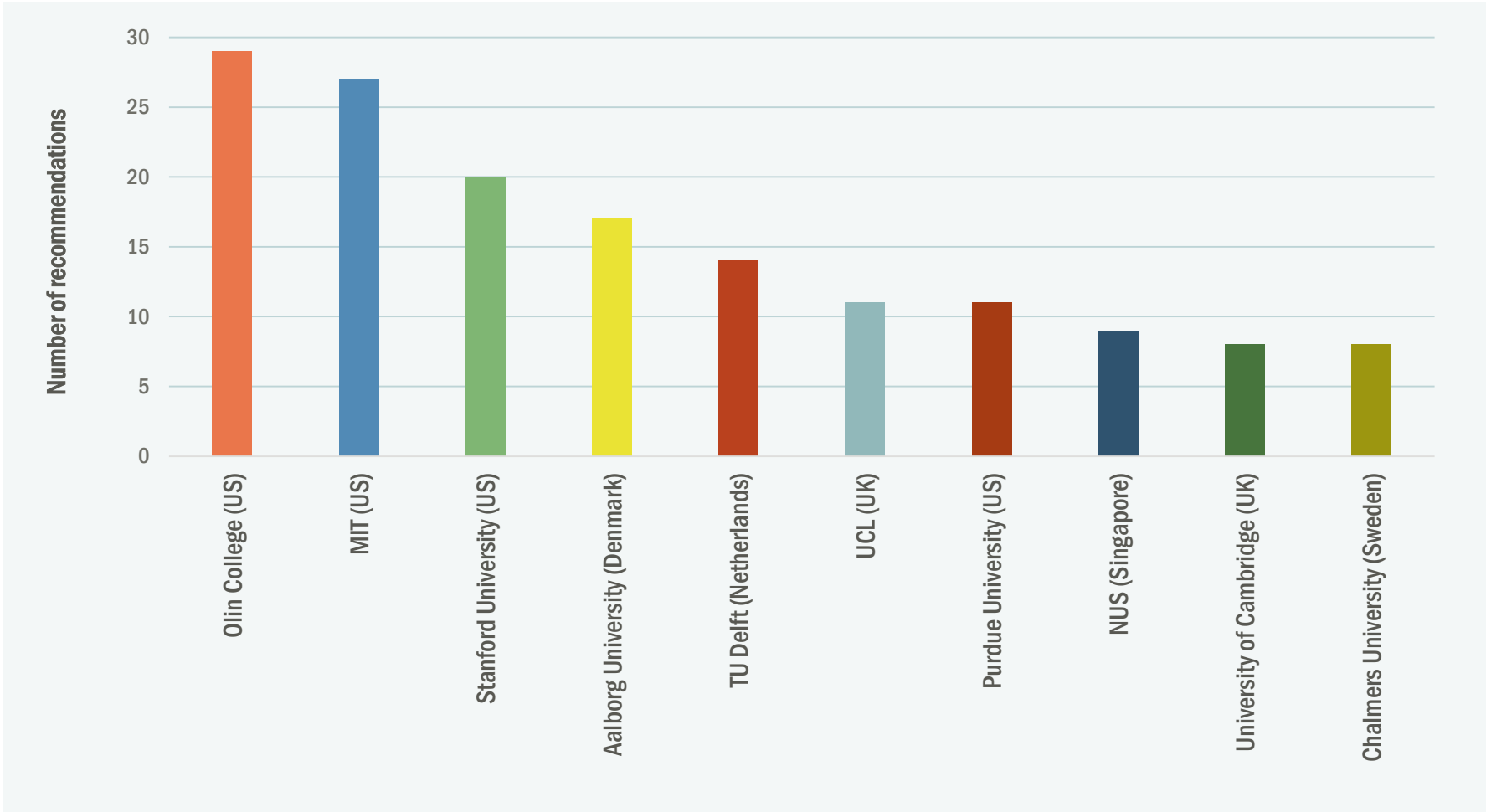
The analysis drew on interviews with 50 global thought leaders in engineering education and identified the most highly-regarded current and emerging university leaders in the field.

Phase 2 (March–Nov 2017)

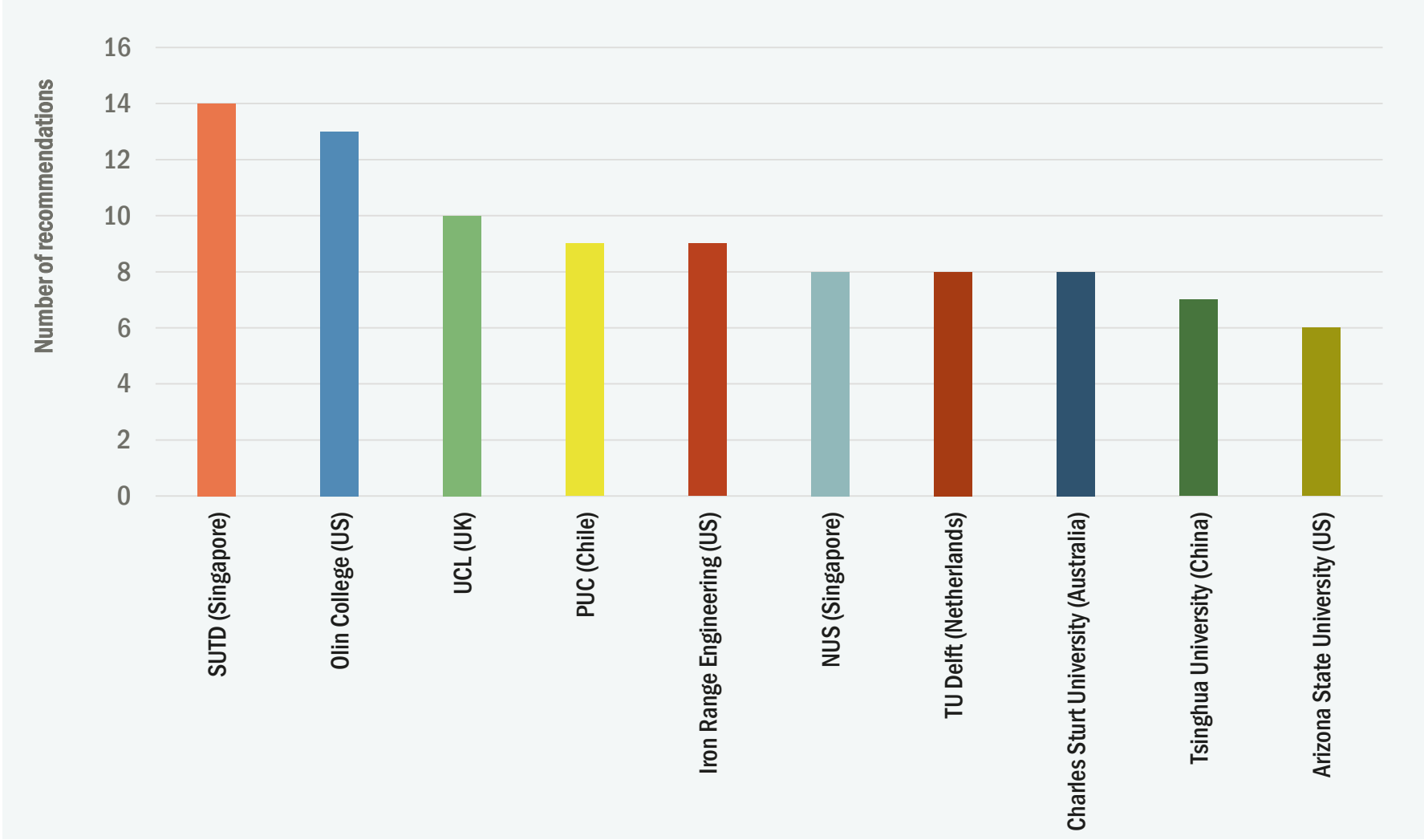
Case studies of four selected institutions identified during Phase 1 as being 'emerging leaders' in engineering education.

The universities selected were Singapore University of Technology and Design (Singapore), University College London (UK), Charles Sturt University (Australia) and TU Delft (Netherlands).

The 10 institutions most frequently identified as ‘current leaders’



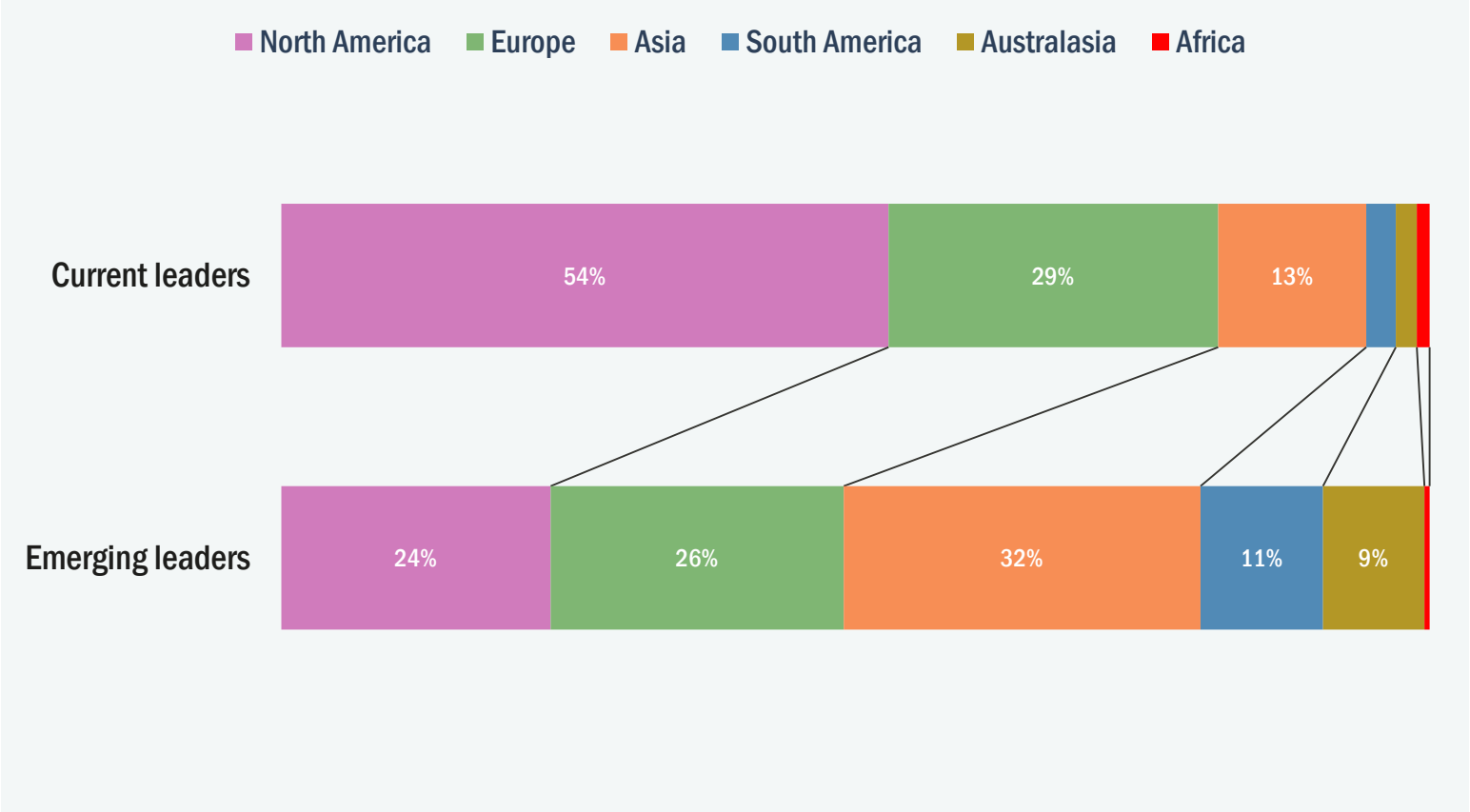
The 10 institutions most frequently identified as ‘emerging leaders’



Tilting of the global axis of educational leadership

… from north to south and from high-income countries to the emerging economic ‘powerhouses’ in Asia and South America

Tilting of the global axis of educational leadership



Features distinguishing the top-rated programs:

‘Current leaders’

Established international profile

For many, non-traditional practice is localised, confined to individual courses and experiences:

- undergraduate research opportunities
- application of user-centered design
- hands-on experiential learning
- online and blended learning
- experiences in creativity, innovation and entrepreneurship

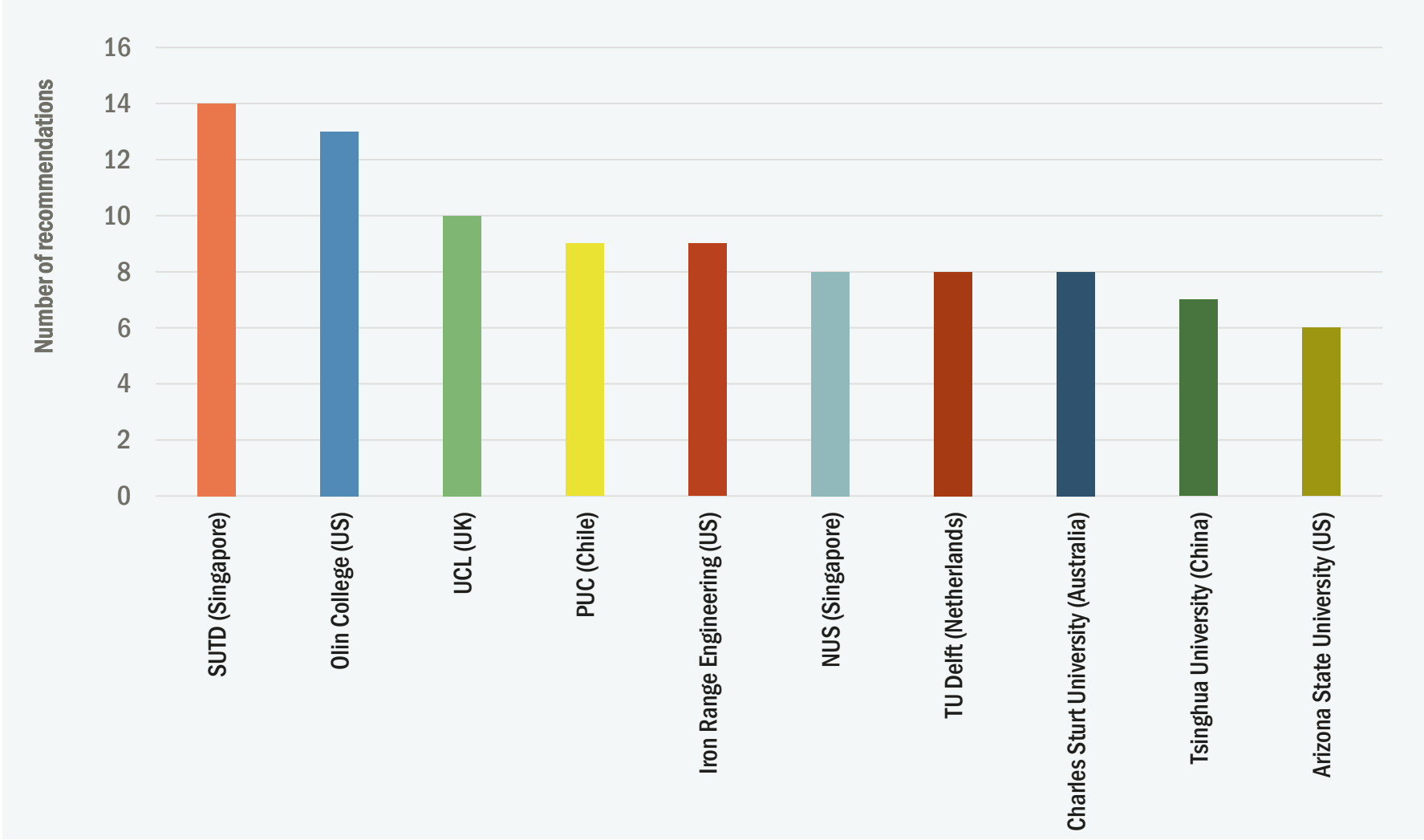
‘Emerging leaders’

Systemic and unified approach (most either a new start or systemic reform), with an emphasis on:

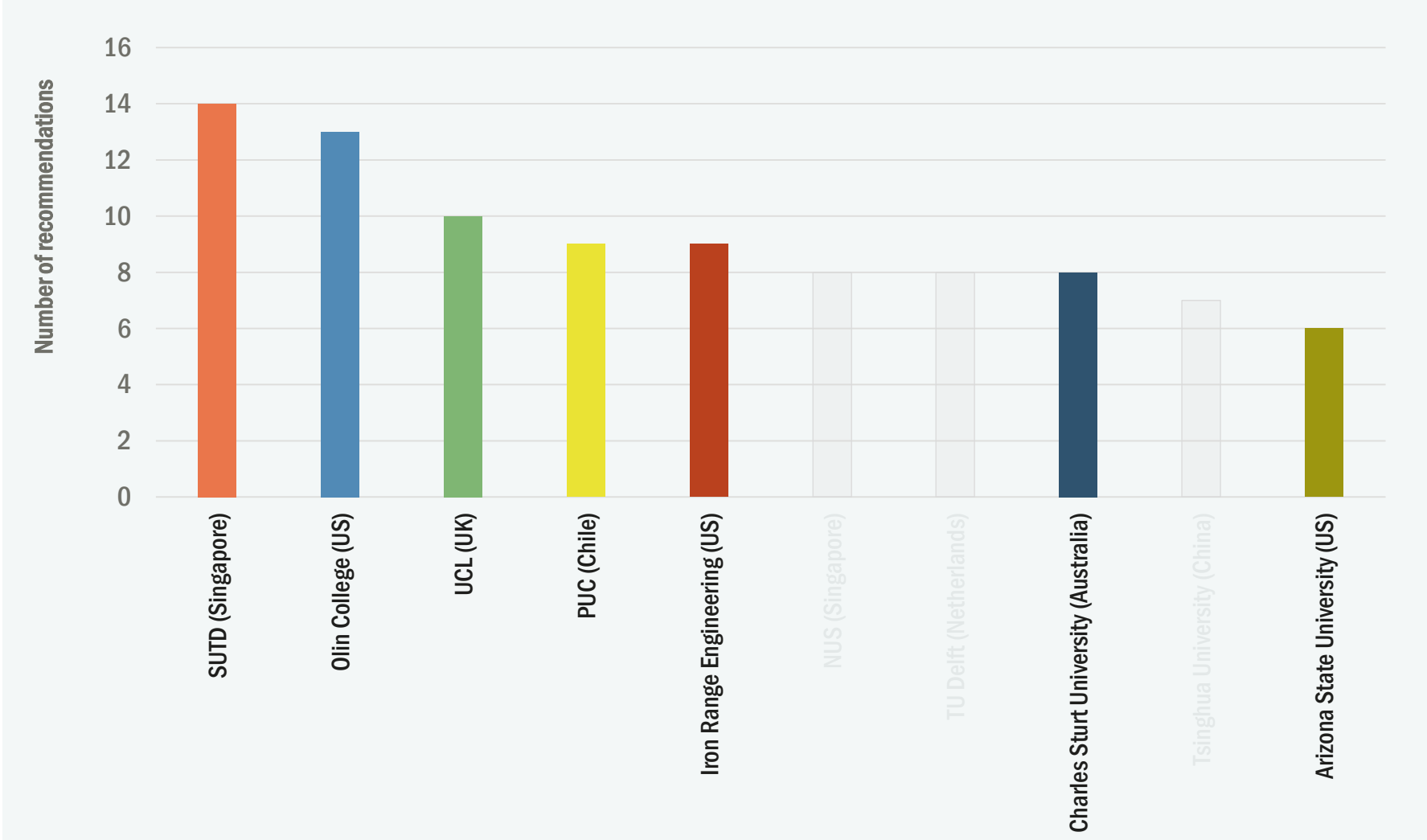
- work-based learning
- blending off-campus online learning with on-campus experiential learning
- creativity, innovation and entrepreneurship
- sustainable development goals

Development is typically shaped by regional needs or constraints, enabling them to take a more visionary approach

The 10 institutions most frequently identified as ‘emerging leaders’

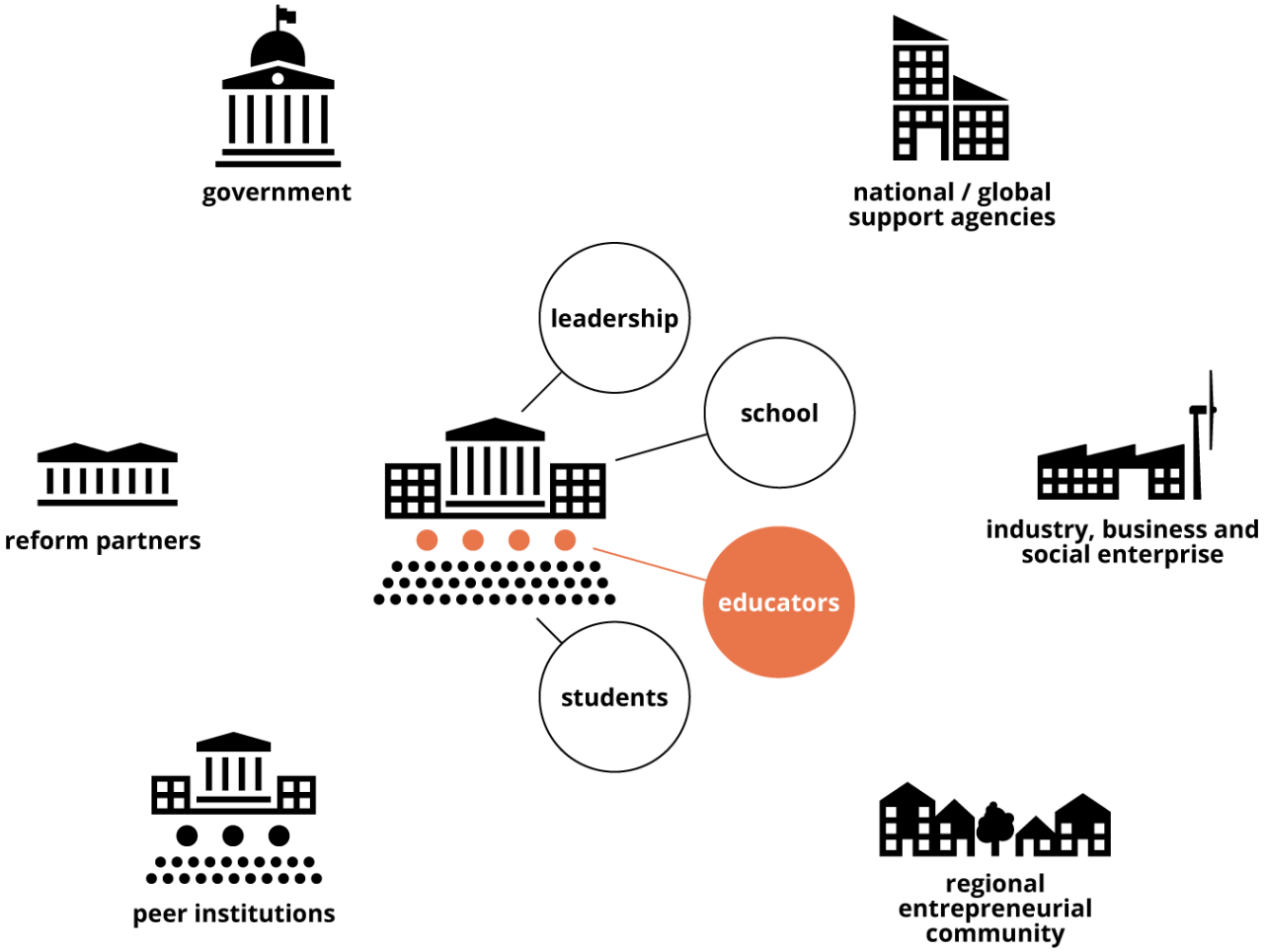


A clear systemic focus on creativity, innovation and entrepreneurship



Who are the agents of change at the ‘emerging leader’ institutions?

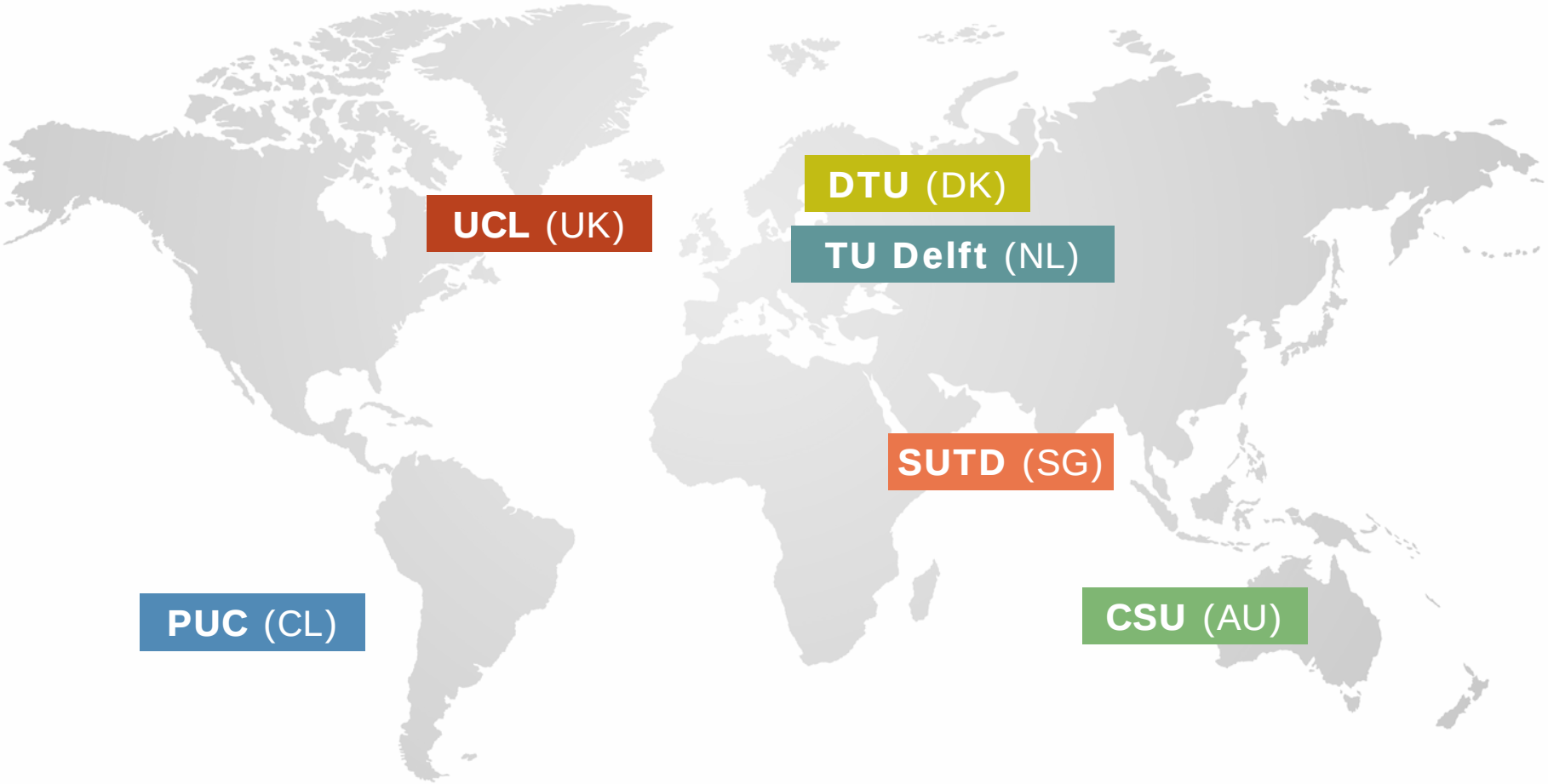
All agents of change



How different agents of change come together to drive systemic change:

exemplars from across the world

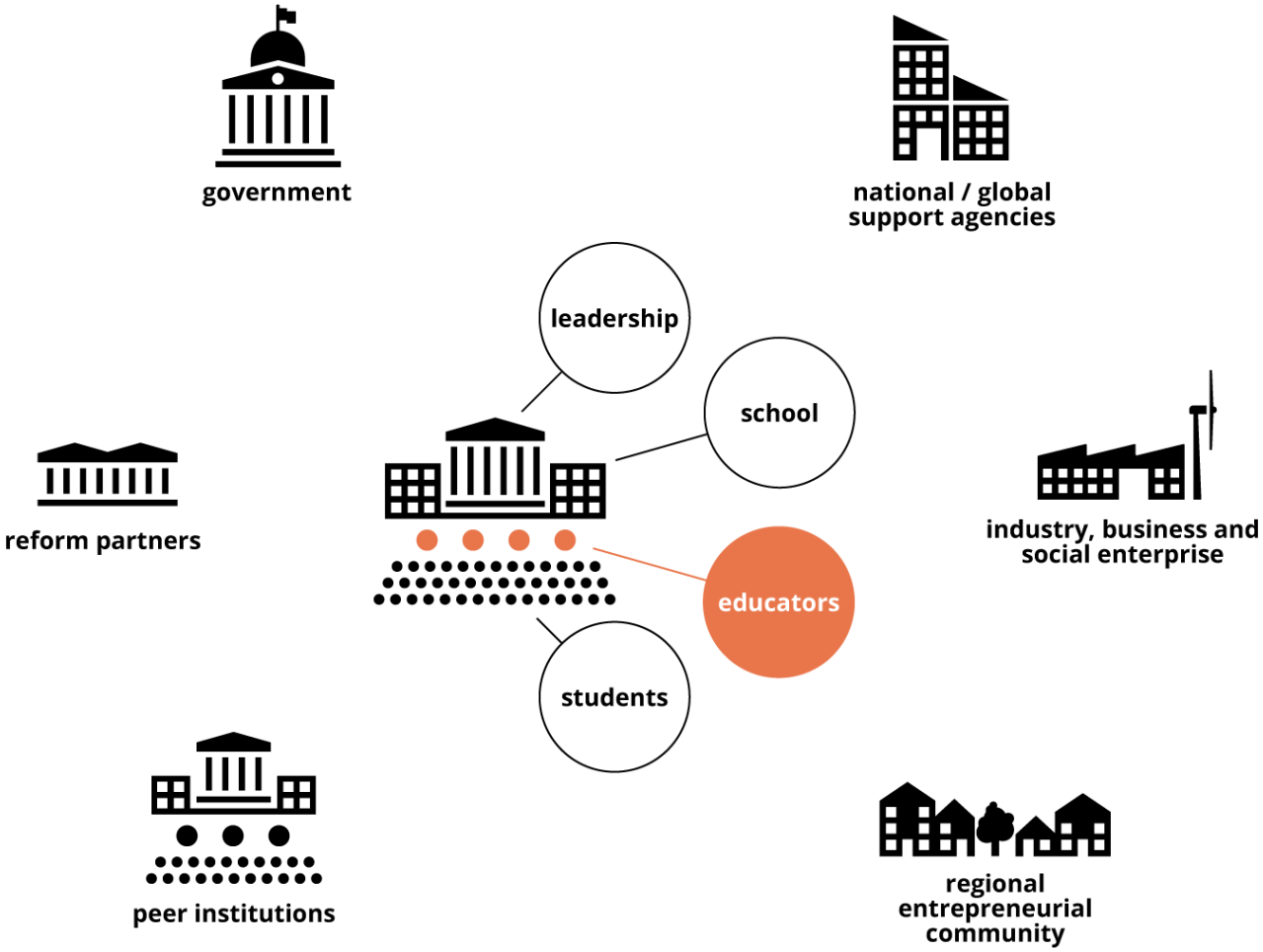
Exemplars



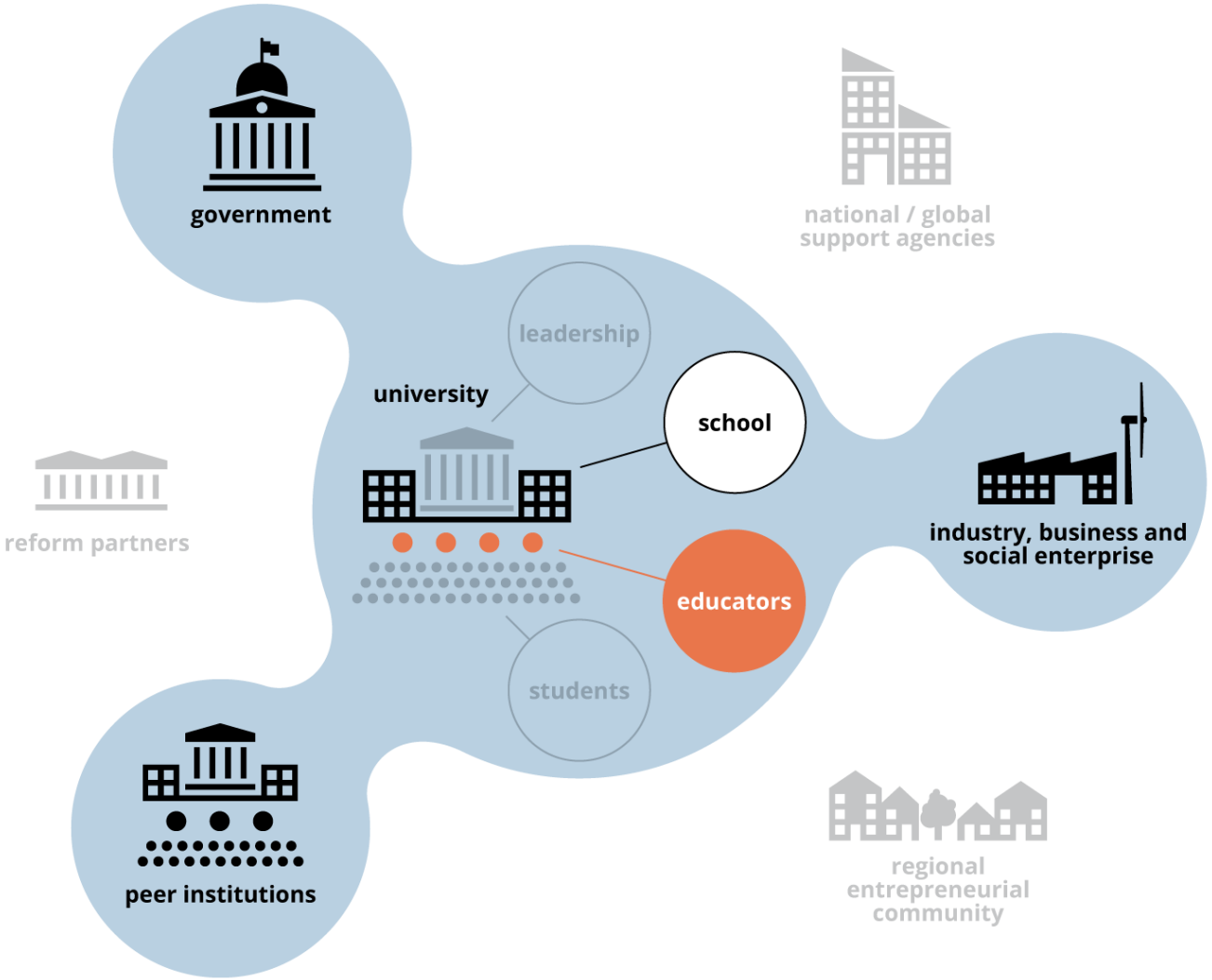
Case study – PUC (Chile)

PUC (CL)

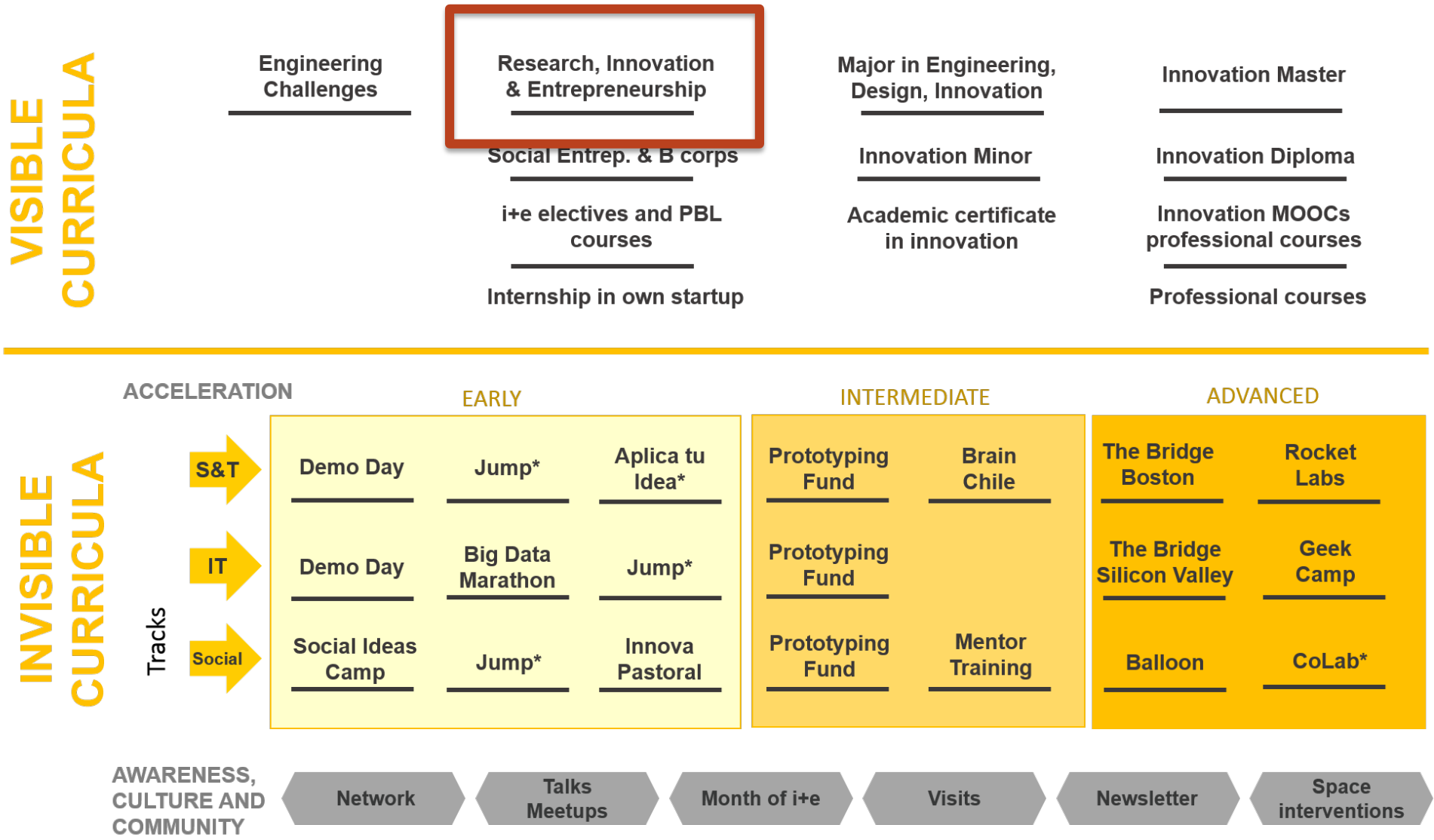
Case study – PUC (Chile) – agents of change



Case study – PUC (Chile) – agents of change



PUC (Chile) – visible and invisible curriculum



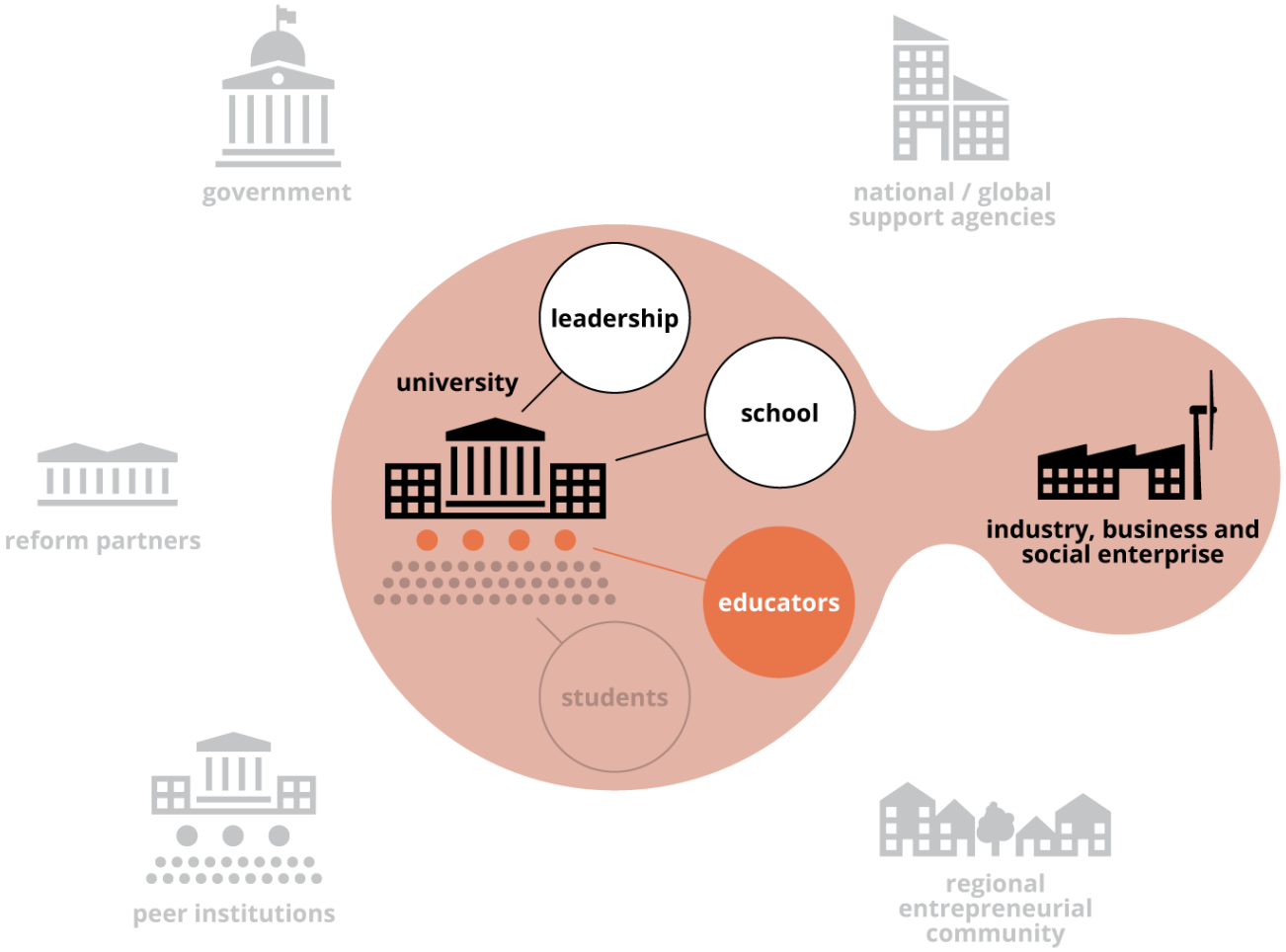
PUC: *Research, Innovation and Entrepreneurship* course

- mandatory hands-on 3rd year course for all 750 engineering undergraduates
- challenges cross-disciplinary teams to develop technology- based solutions to key problems facing Chile, with mentorship from regional entrepreneurs
- mid-way through the course, undergraduate teaching assistants deliver deliver two-weeks of workshops in a range of practical design and prototyping skills

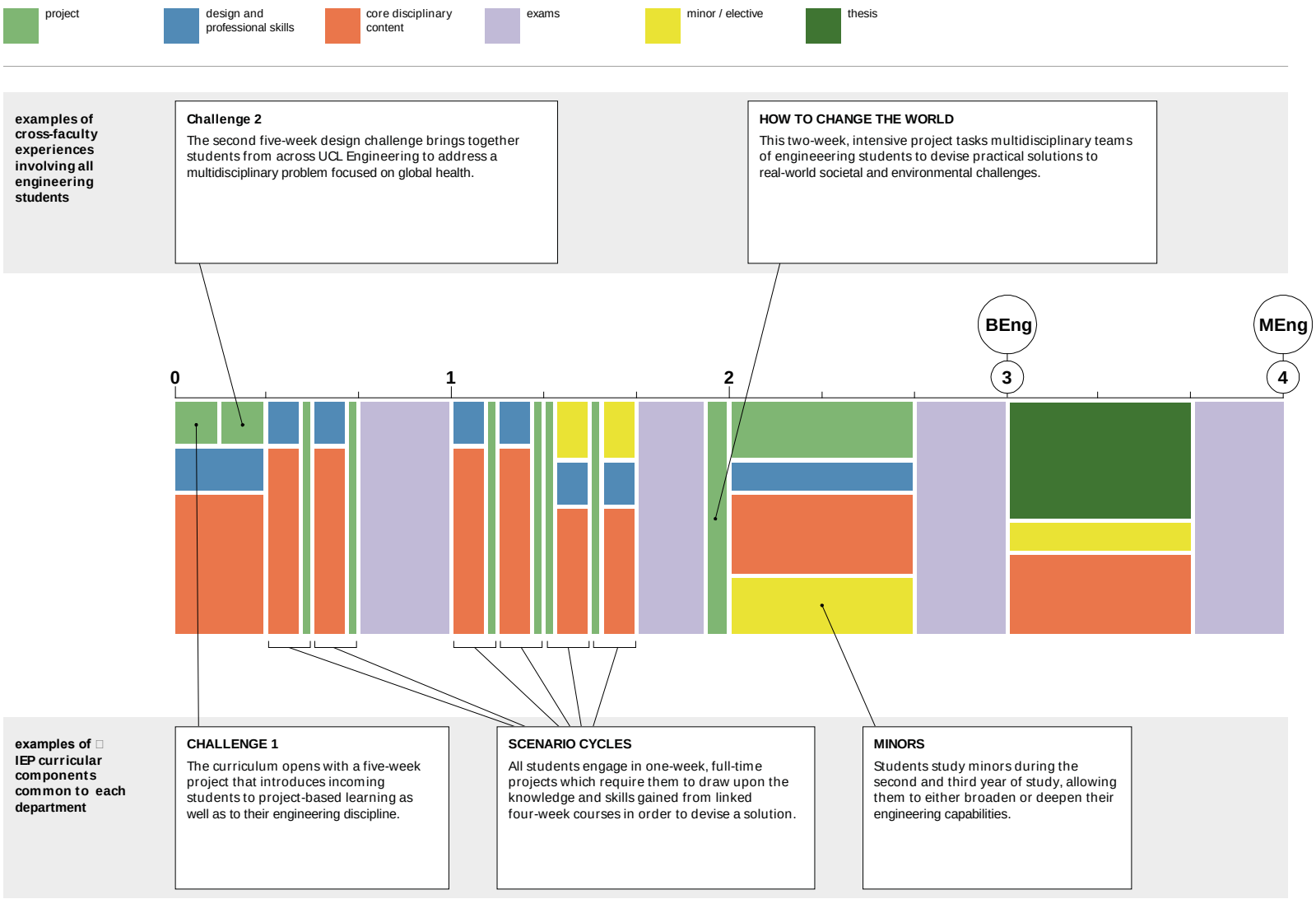
Case study – UCL (UK)

UCL (UK)

Case study – UCL (UK) – agents of change



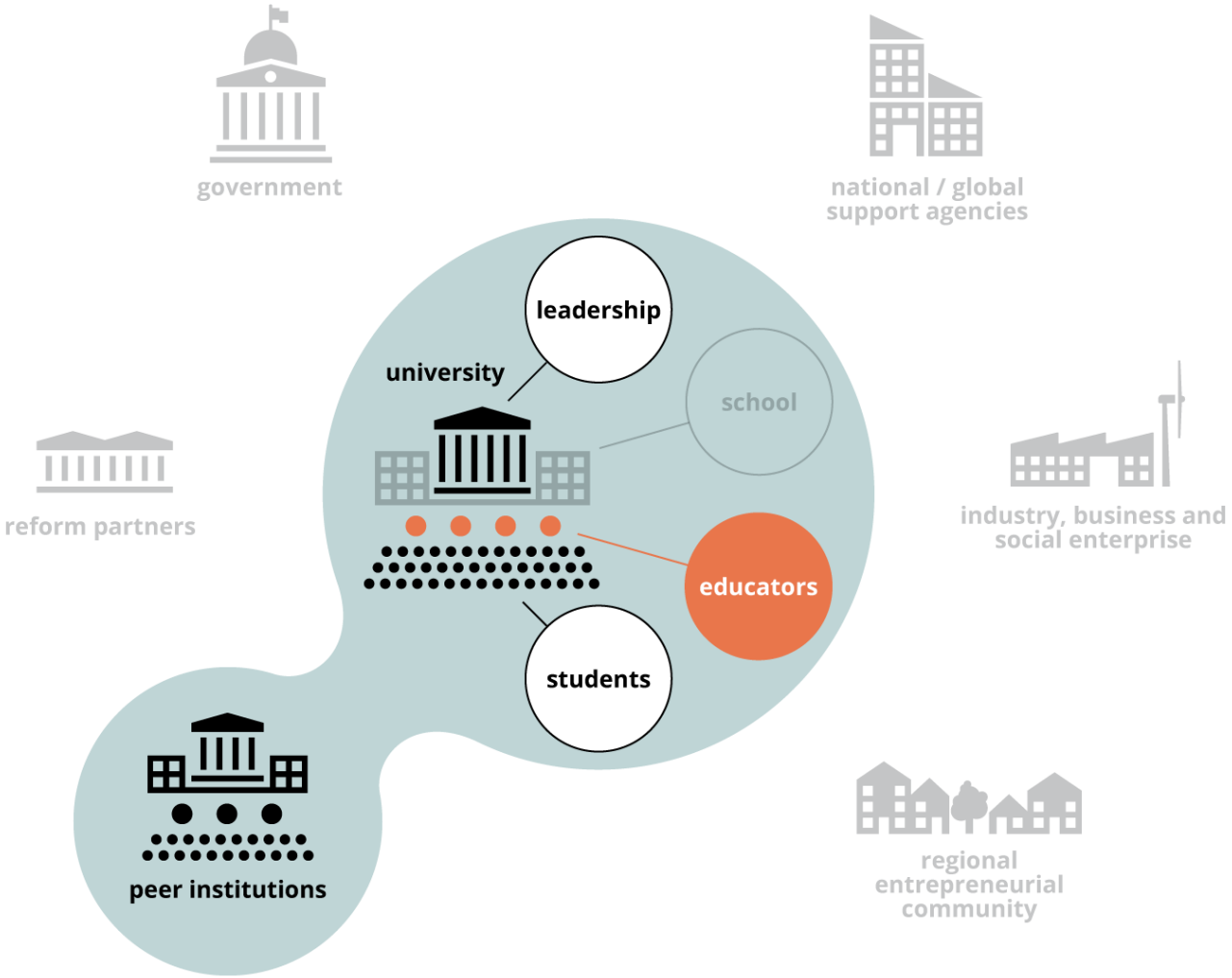
Case study – UCL (UK)



Case study – TU Delft (Netherlands)

TUD (NL)

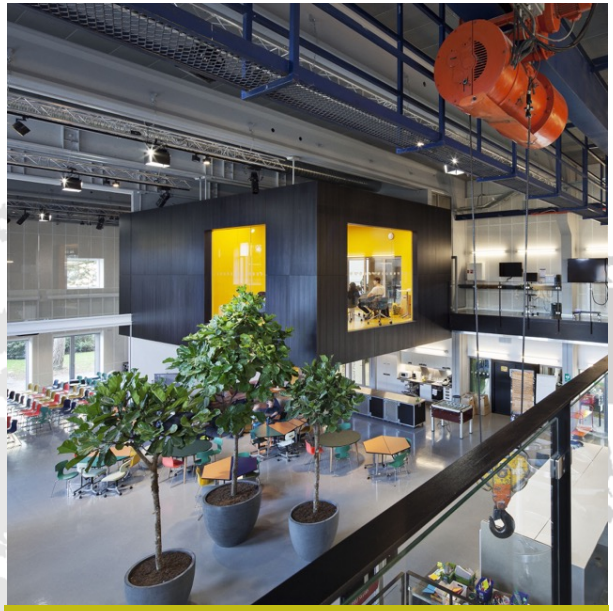
Case study – TU Delft – agents of change



DreamTeams (est. 2000)

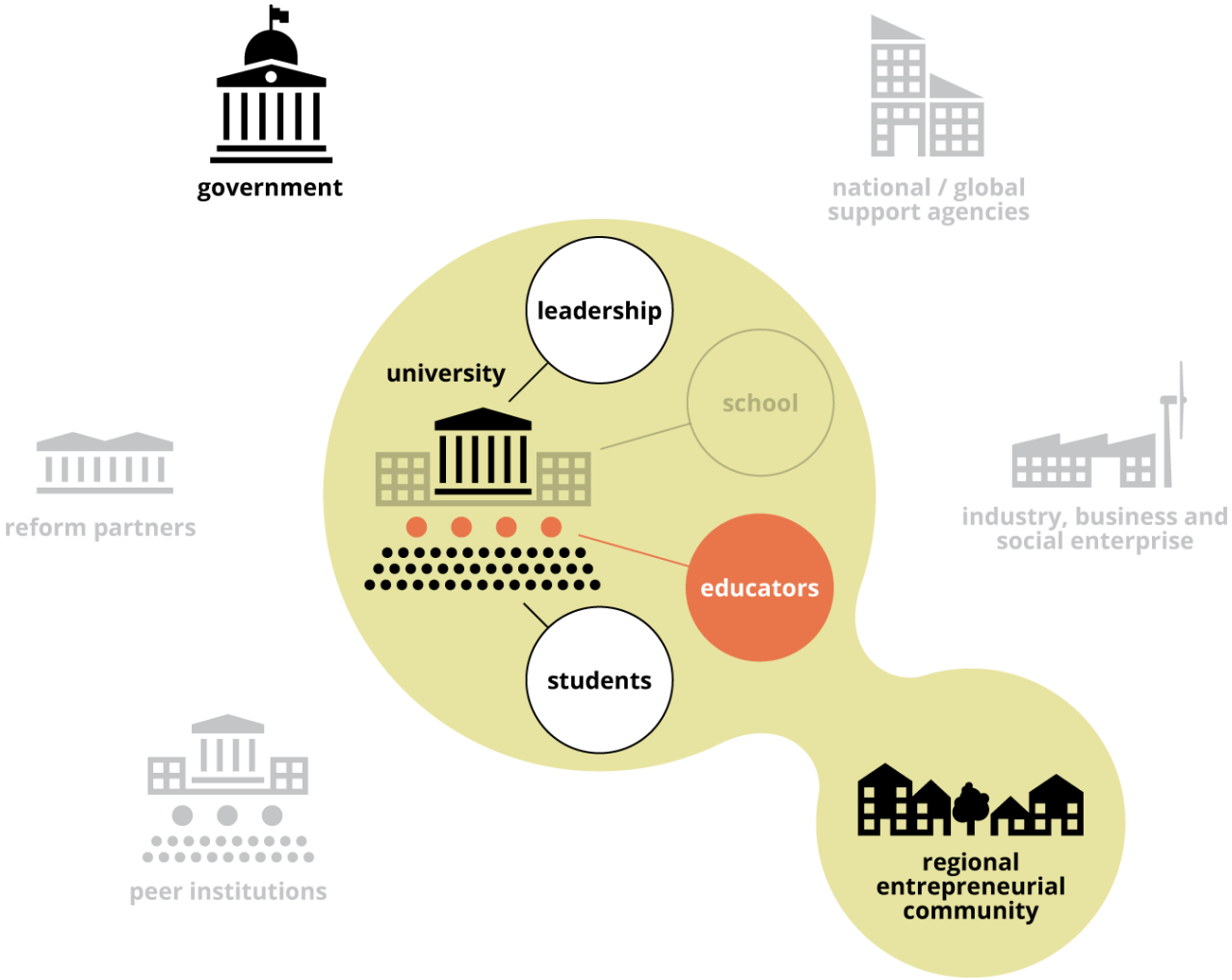
- wholly student-led teams engaged in technology-based project, often with an emphasis on social development
- many teams have set new records, such as the world speed record for a human-powered vehicle
- focus on renewal, rather than evolutionary development; most teams work on a 12-month cycle, with 85% of the team newly appointed each year to start afresh with a new design

Case study – DTU (Denmark)

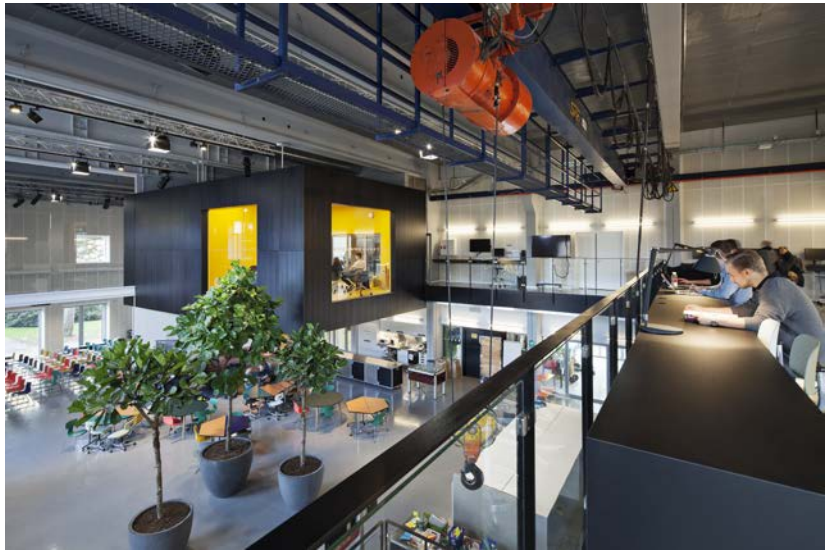


DTU (DK)

Case study – DTU (Denmark) – agents of change



Skylab– DTU (Denmark)

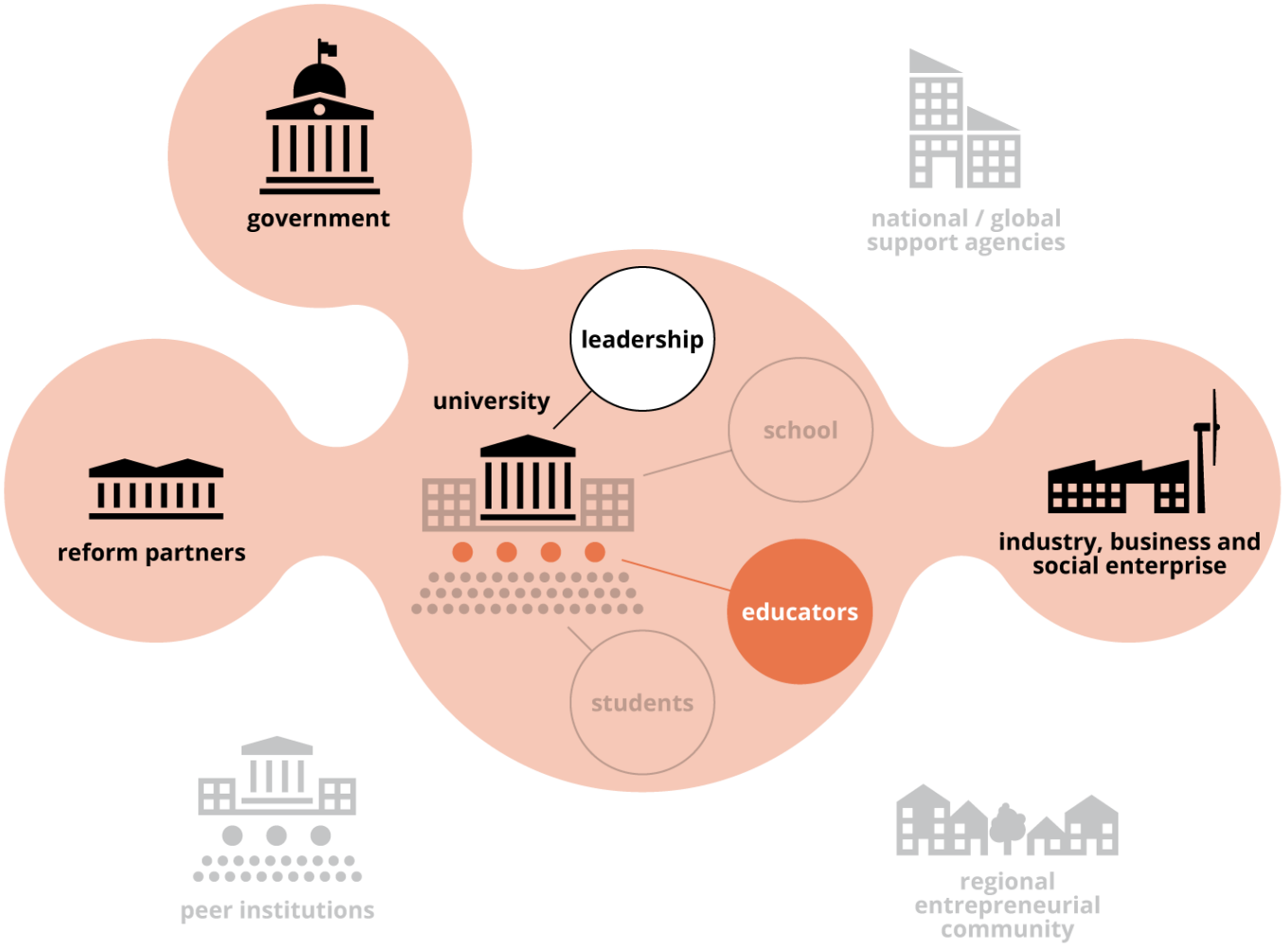


- designed as a catalyst to support and nurture a student-led entrepreneurial community
- launched in custom-designed building in 2014
- supports a wide range of curricular courses, extra-curricular activities and student innovations, including around 60 student-led start-ups each year

Case study – SUTD (Singapore)

SUTD (SG)

Case study – SUTD (Singapore) – agents of change



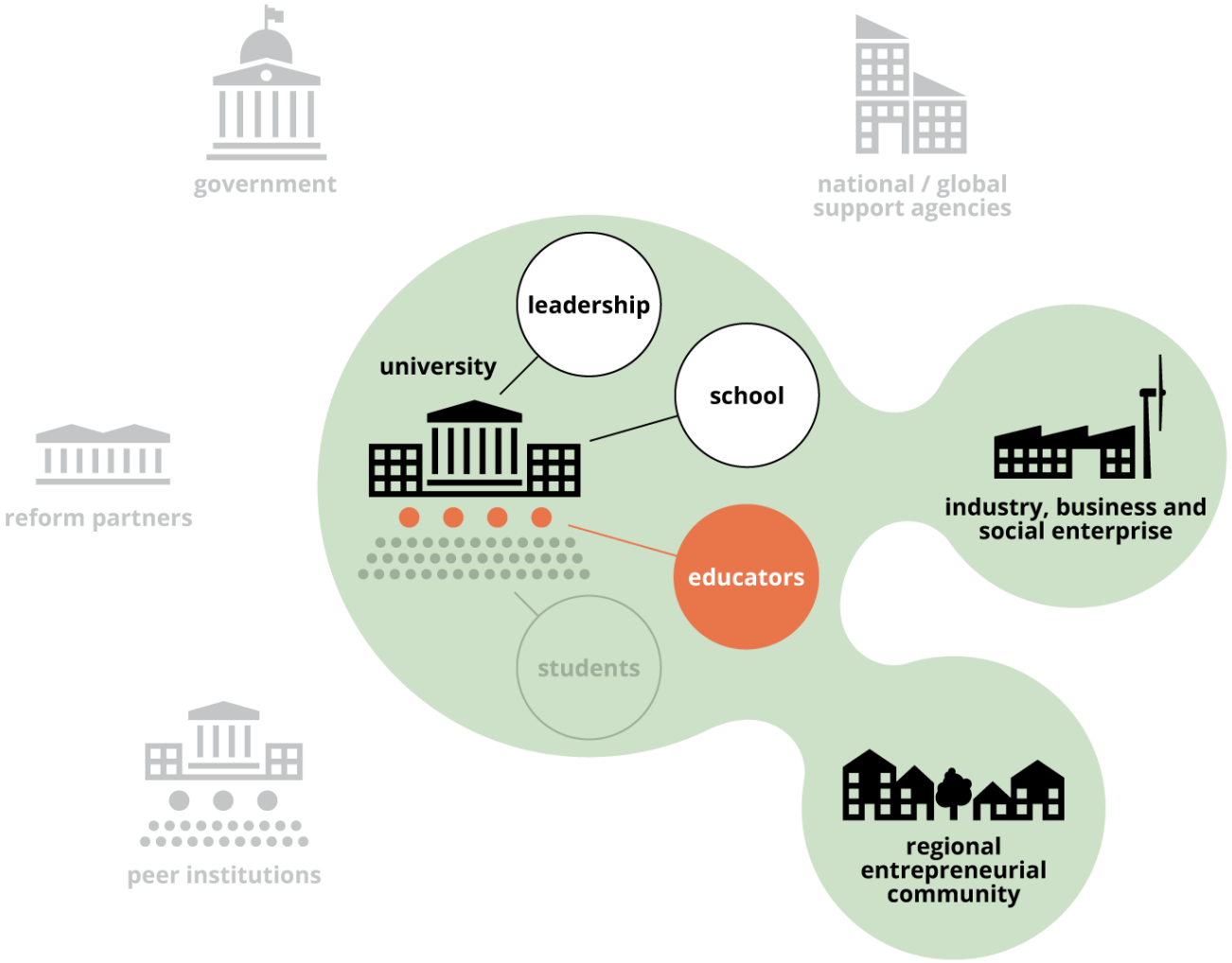
4D approach

- **1D design activities:** activities that allow students apply and explore concepts learned within a specific course
- **2D design activities:** integrate and apply concepts from across two or more courses that are studies concurrently
- **3D design activities:** activities that allow students to repeatedly revisit a single project over time, advancing it with each iteration
- **4D design activities:** student-led activities outside the curriculum, that allow them to explore and apply design principles

Case study – CSU (Australia)

CSU (AU)

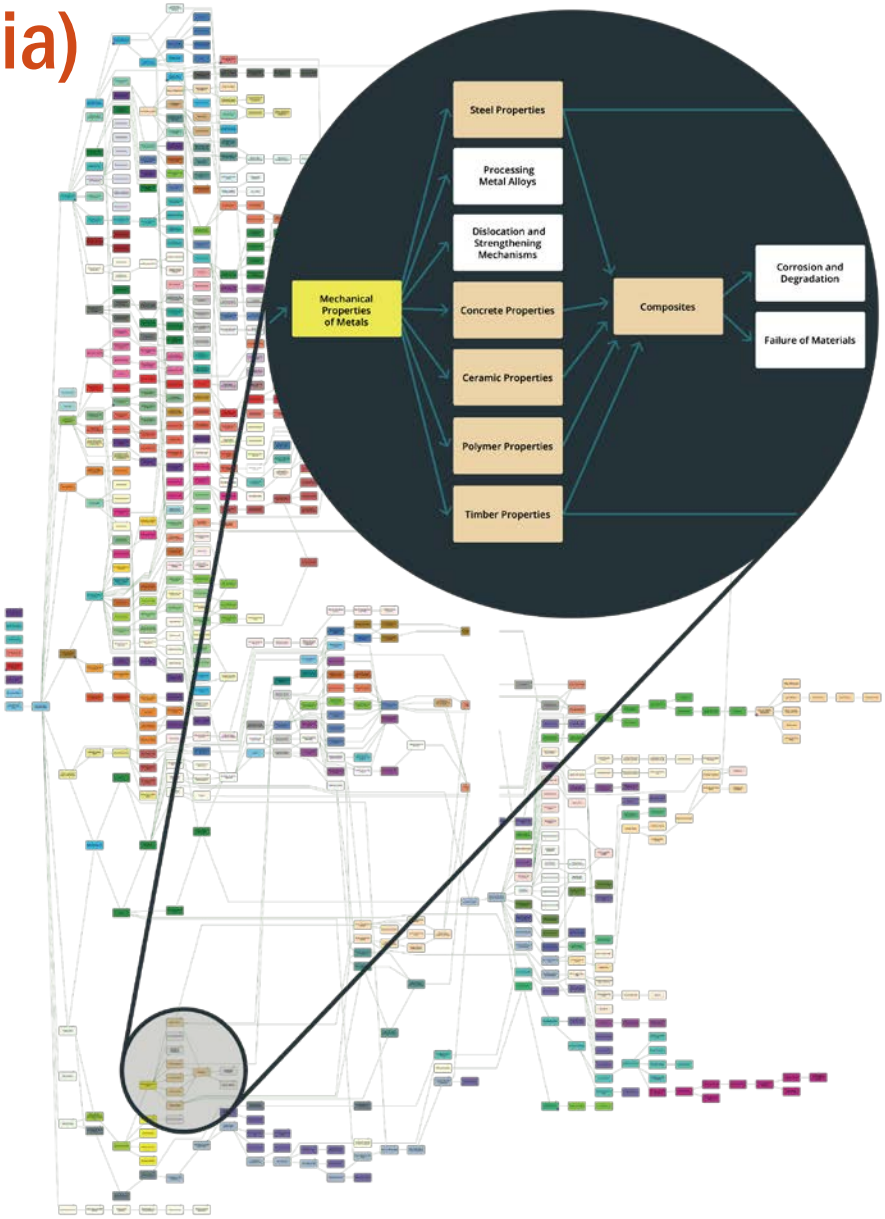
Case study – CSU (Australia) – agents of change



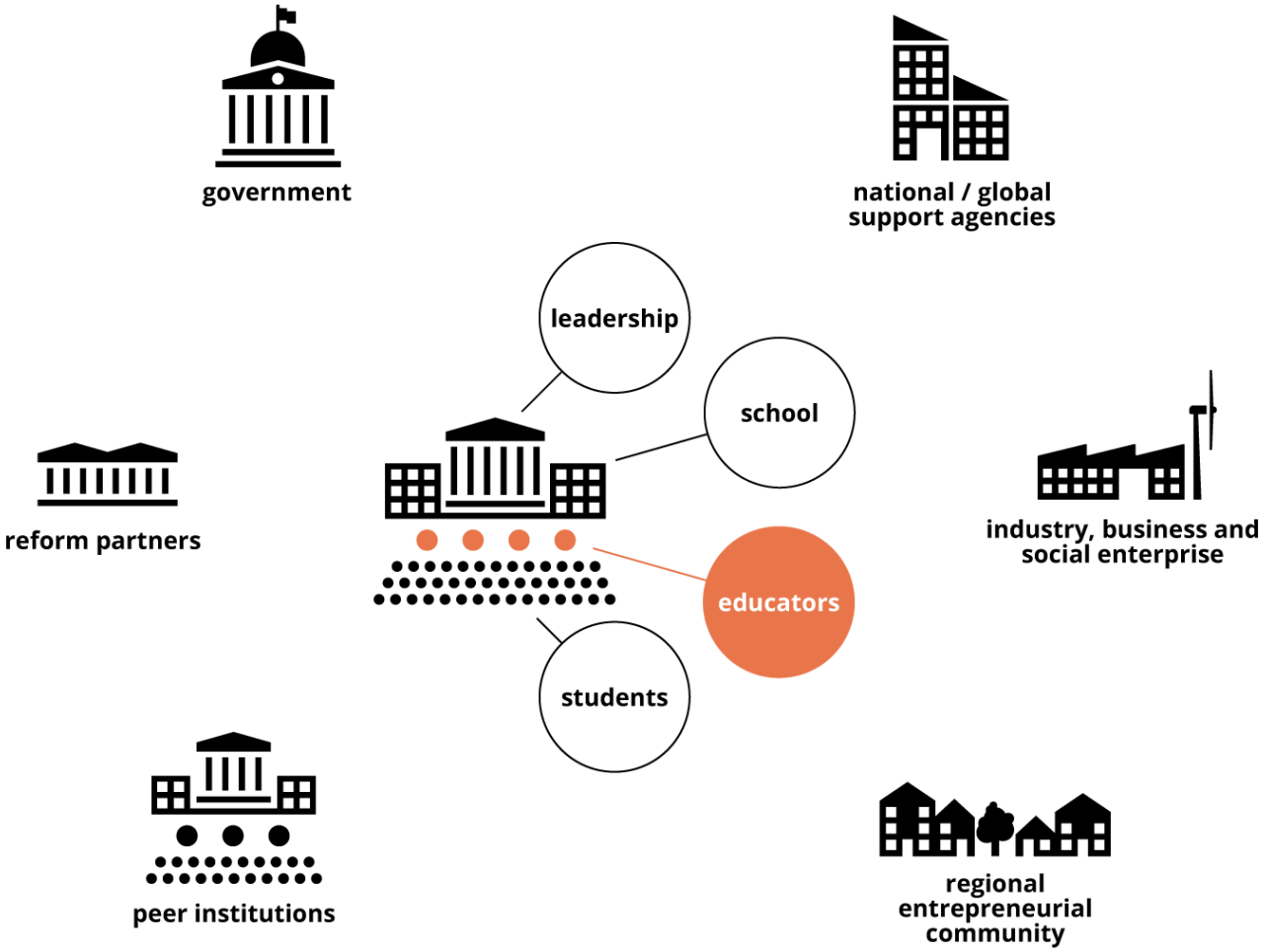
Case study – CSU (Australia)

Topic Tree

- core engineering concepts and skills are disaggregated into discrete three-hour topics and accessed independently online by students
- the topic tree offers a visual map of the relationships and dependencies between topics and branches of engineering
- students must complete 240 topics before their work placement and 600 topics by graduation



Introducing the invited guests


government
national / global support agencies
leadership
school
reform partners
industry, business and social enterprise
educators
students
peer institutions
regional entrepreneurial community

Where the invited guests fit in as agents of change

CHILE
Marcela Angulo González
Manager of Technological Capabilities of CORFO, Chilean Economic Development Agency

UCL (UK)
John Mitchell
Vice Dean Education, UCL Engineering

TUD (NL)
Eva Smeets
Masters Student, Aerospace Structures and Materials, TU Delft

DTU (DK)
Anne Sofie Larsen
Masters student, Design & Innovation, DTU

SUTD (SG)
Pey Kin Leong
Associate Provost Education, Singapore University of Technology and Design

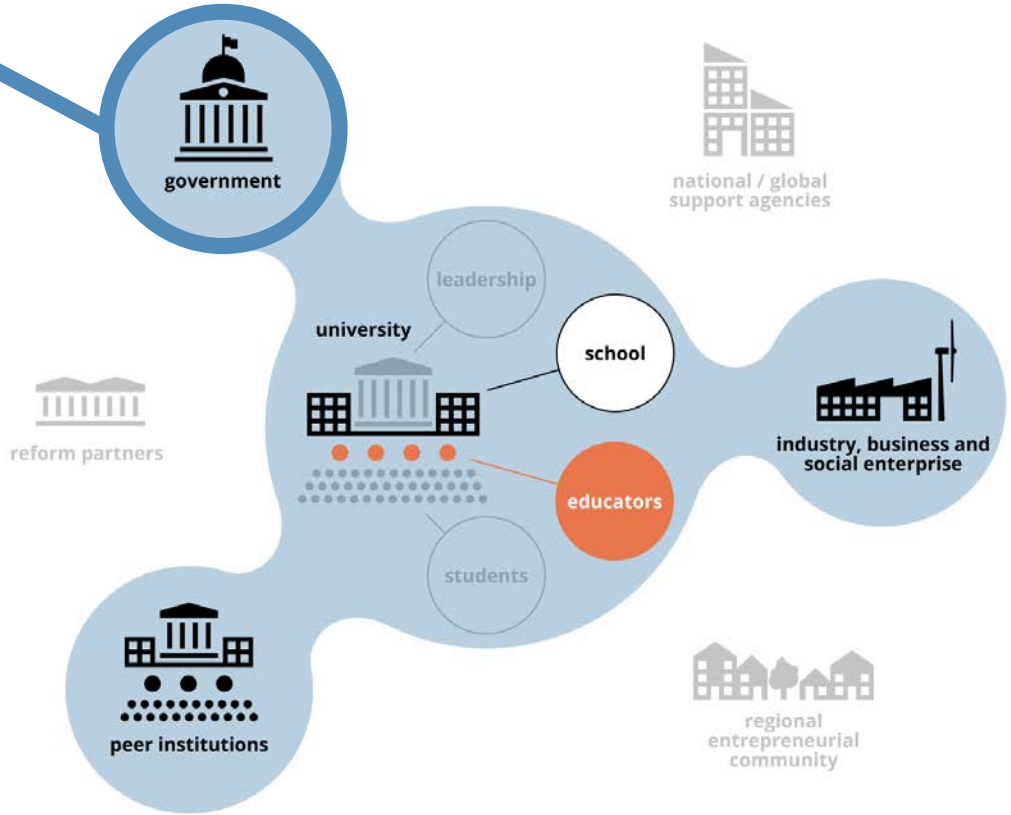
Where the invited guests fit in as agents of change

PUC
CHILE

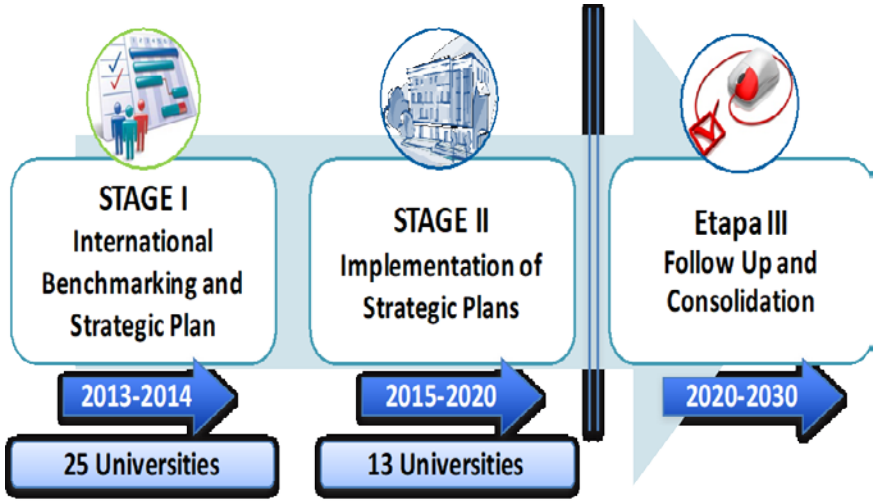
Marcela Angulo González

Manager of Technological Capabilities of CORFO, Chilean Economic Development Agency

Marcela is leading a government-funded programme of curricula reform in Chilean engineering schools, designed to nurture a new generation of technology-based innovators and entrepreneurs.



ENGINEERING 2030 PROGRAM - CHILE



50.000 students
~ 70% of total civil engineering students

Total Budget: MMUSD122
CORFO grants ~ 50%

CURRICULAR HARMONIZATION
WITH FOCUS ON TECHNOLOGY GRADUATE PROGRAMS

APPLIED R&D: MULTIDISCIPLINARY AND INDUSTRY LINKED

TECHNOLOGY COMERCIALIZATION AND ENTREPRENEURSHIP

INTERNATIONAL ALLIANCES AND MOBILITY

+ HUMAN CAPITAL AND CHANGE MANAGEMENT

+ GOVERNANCE AND SINERGIES

Key Focus

2020 GOALS

7000	New Students	40	New Licencies/year
450	New PhD Students	120	New Spin Offs
1100	New Engineers/yea	40	New Start Ups

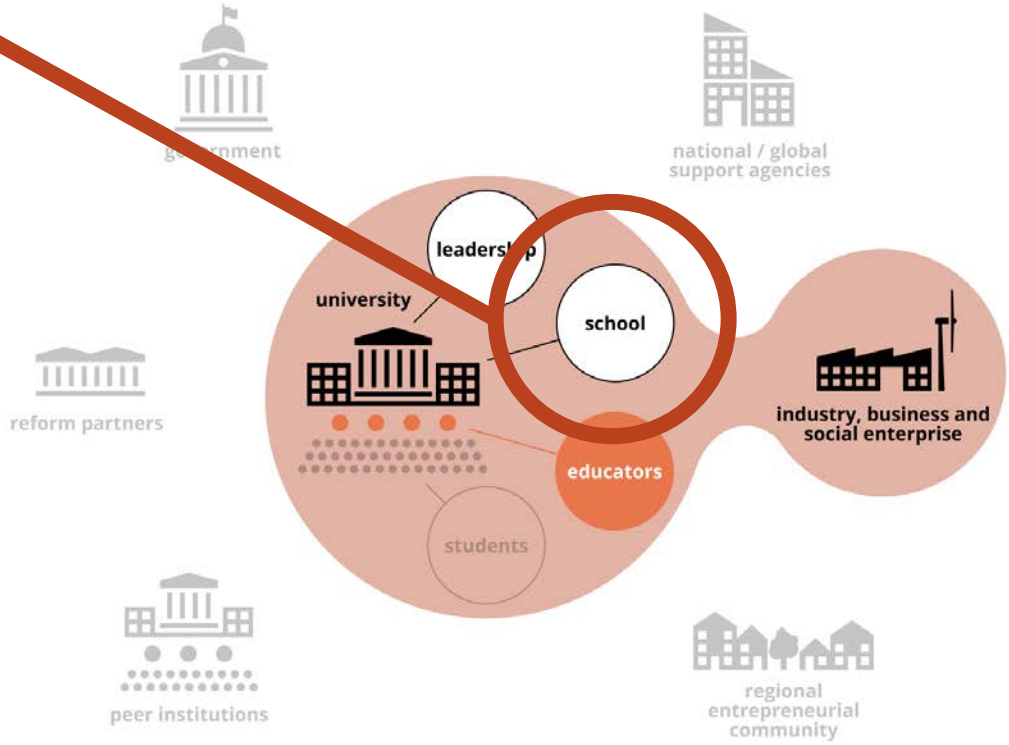
Where the invited guests fit in as agents of change

UCL
UK

John Mitchell

Associate Dean Education,
UCL Engineering

John has led a root-and-branch reform to the curriculum across the school of engineering at UCL that allows students to apply their engineering learning through intensive, authentic and cross-disciplinary industrial and societal challenges



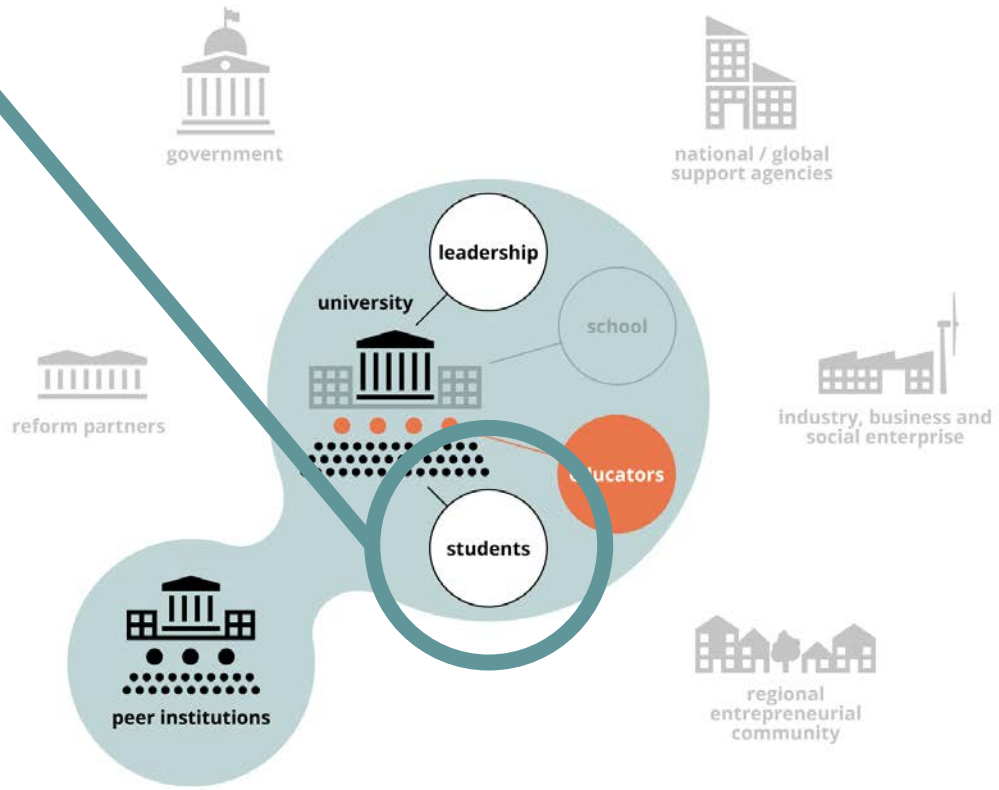
Where the invited guests fit in as agents of change

TUD
NL

Eva Smeets

Masters student,
TU Delft

Eva was the team leader of the Eco-Runner team at TU Delft – a highly innovative and creative team that is entirely student-run – and is also a student representative on the TU Delft's Board of Studies



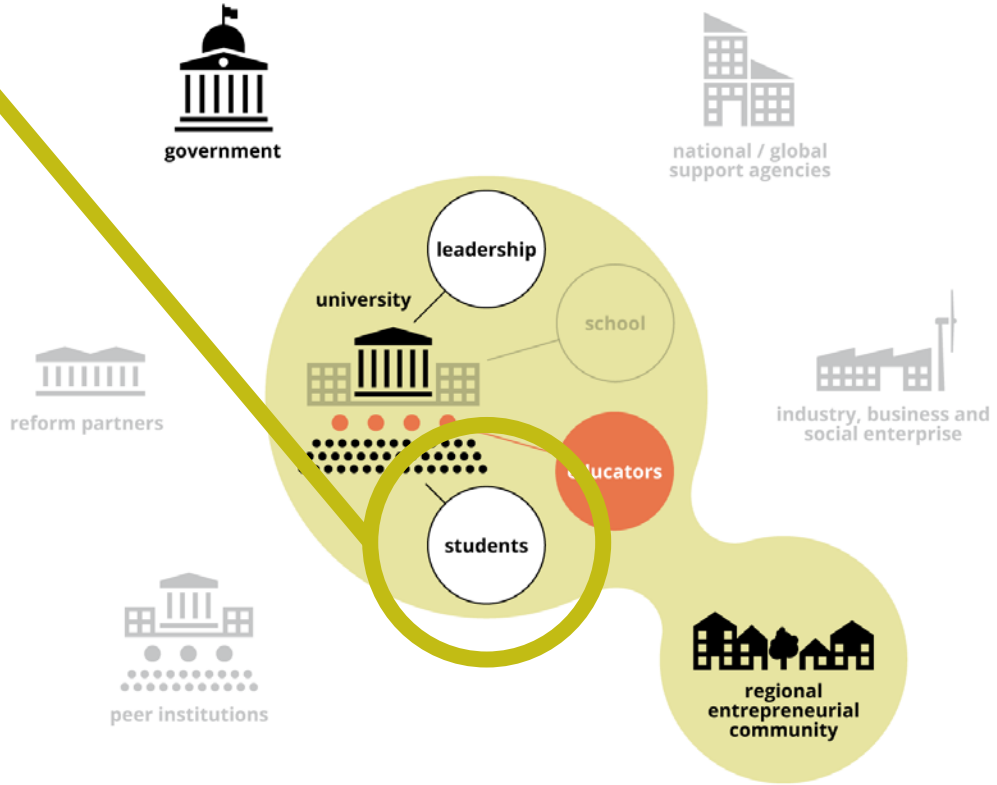
Where the invited guests fit in as agents of change

DTU
DK

Anne Sofie Larsen

Masters student, DTU

As an engineering student at both Aalborg and DTU, Anne Sofie has engaged in a range of appointments, internships, courses and experiences – from within and beyond the curriculum – focusing on the development of entrepreneurship and innovation capabilities

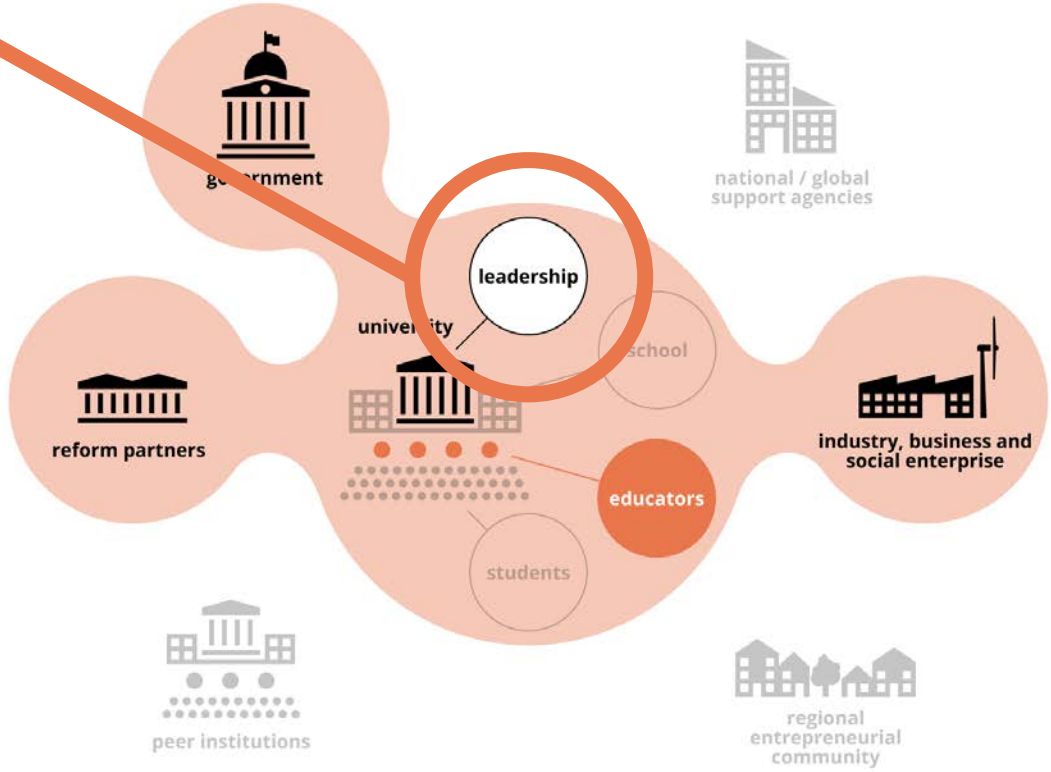


Where the invited guests fit in as agents of change

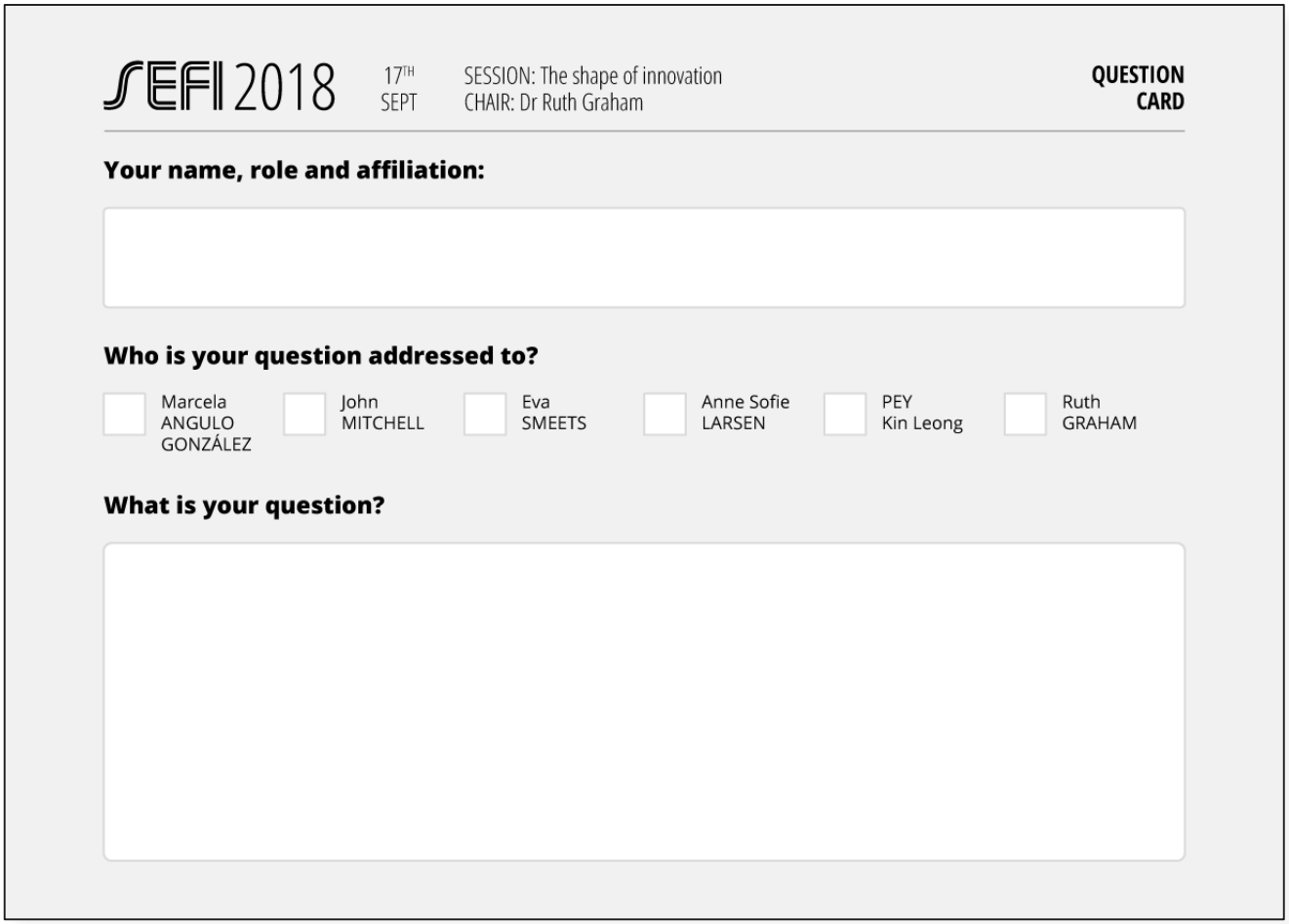
SUTD
SG

Pey Kin Leong
Associate Provost Education, Singapore University of Technology and Design

Kin Leong has overseen and guided the development and delivery of a new student-centred engineering curriculum at SUTD that emphasises hands-on exploration, innovation and entrepreneurship



Your questions to the panel



SEFI 2018 17TH SEPT

SESSION: The shape of innovation
CHAIR: Dr Ruth Graham

QUESTION CARD

Your name, role and affiliation:

Who is your question addressed to?

- ☐ Marcela ANGULO GONZÁLEZ
- ☐ John MITCHELL
- ☐ Eva SMEETS
- ☐ Anne Sofie LARSEN
- ☐ PEY Kin Leong
- ☐ Ruth GRAHAM

What is your question?

Please leave your cards in the drop-buckets on your way to the coffee break

Thank you