

SCIENCE



About the writers

Professor Low Teck Seng (far left) is chief executive of the National Research Foundation Singapore, Professor Tan Chorh Chuan (centre) is

president of the National University of Singapore, and Professor Bertil Andersson is president of Nanyang Technological University.

ScienceTalk

Oasis for world's top R&D brains showing results

Create to feature joint projects by renowned institutions and local unis to mark 10th year

Low Teck Seng, Tan Chorh Chuan and Bertil Andersson

Perched along a major expressway in the western part of our sunny island is a campus recognised internationally – where researchers from top universities work with local scientists to develop technology that will improve lives and lead to new enterprises.

The concept for a campus to attract highly regarded research institutions from all over the world to Singapore was conceived more than 10 years ago by former president Tony Tan Keng Yam, who was then chairman of the National Research Foundation (NRF). He had envisioned this strategic move to position Singapore as a global research hub.

That is how the Campus for Research Excellence and Technological Enterprise (or Create) was born. Next month, Create, situated in the National University of Singapore (NUS) University Town, will commemorate its 10th anniversary by

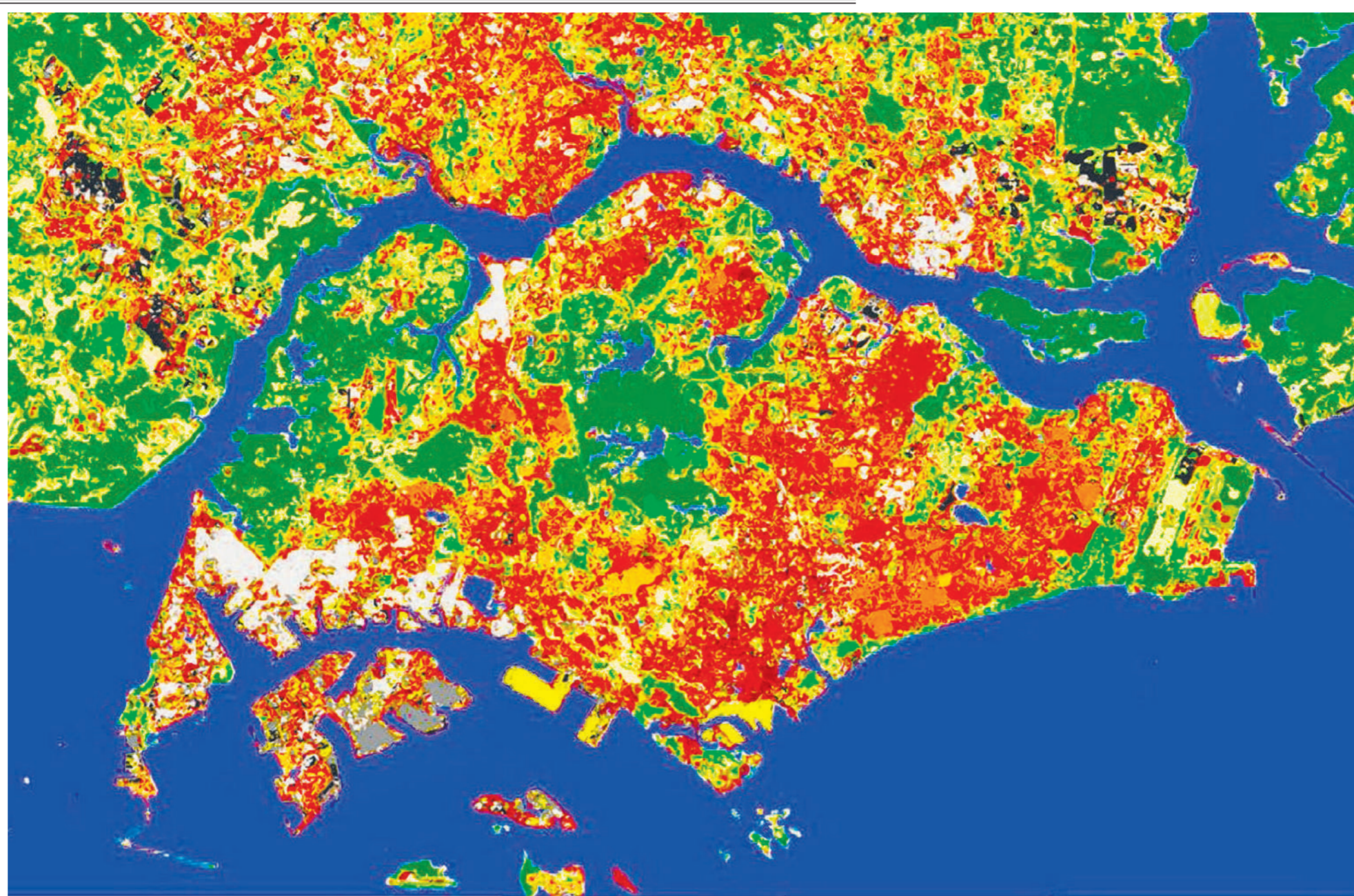
showcasing research which has brought practical benefits to Singapore.

The NRF established Create in partnership with a few stringently selected, highly regarded overseas research institutions so that their top researchers would come to Singapore to work closely with local researchers from local universities in areas of strategic interest to the Republic. The research students trained in these collaborations are primarily from local universities. The knowledge acquired from these collaborations would allow the country to grow new industries or solve significant challenges of relevance to Singapore's development and progress. Create has achieved some early successes.

CHOOSING THE RIGHT RESEARCH AREAS

Research topics are identified and proposals jointly crafted to ensure that these topics are strategically relevant to Singapore – either in catalysing economic growth or meeting national challenges – likely to make a significant impact not only in Singapore but also globally, and grounded on excellent science.

Today, researchers from seven overseas partner universities – Massachusetts Institute of Technol-



A map depicting the climate zones of Singapore provides a research framework for urban heat island studies under the Cooling Singapore project, one of Create's collaborations on cross-disciplinary research topics important to Singapore and the region.

PHOTO: MUHAMMAD OMER MUGHAL, COOLING SINGAPORE PROJECT

ogy (MIT), Swiss Federal Institute of Technology Zurich (ETH Zurich), University of California Berkeley (UC Berkeley), Cambridge University, Technical University of Munich (TUM), Hebrew University of Jerusalem (HUJ) and Shanghai Jiao Tong University – are co-located in Create with researchers from NUS, Nanyang Technological

University (NTU), Singapore Management University (SMU) and Singapore University of Technology and Design (SUTD) working on 14 interdisciplinary programmes.

These research programmes encompass more than 50 collaborative projects where overseas partner institutions work closely with local institutions and government

agencies to develop new capabilities in the four key technology domains: advanced manufacturing and engineering, health and biomedical sciences, services and digital economy, and urban solutions and sustainability.

ATALENT OASIS

In the face of intense global competition, Create provides a powerful platform that helps attract top-notch talent from leading overseas research institutions. The Create research system comprises more than 1,110 people from over 40 countries, including more than 200 tenured professors from world-renowned universities. By aggregating talent and supporting

collaboration between local and overseas researchers, we diversify our talent pool and deepen local capacity to undertake cutting-edge research to meet Singapore's challenges. For instance, Professor Peh Li Shuan, a Singaporean and professor at MIT, studied low-energy electronics as part of MIT's partnership in Create. She has since joined the Department of Computer Science in NUS as a tenured professor to lead systems research, and is working in Singapore full-time.

The campus provides a vibrant environment for training undergraduate and graduate students. Over the past decade, more than 550 PhD students have been trained at Create, and there are currently 280 PhD, 13 master's and 20 undergraduate students conducting research there.

Create also provides a unique platform for researchers to collaborate on cross-disciplinary research topics important to Singapore and the region. Dubbed "intra-Create" collaborations, researchers pool their collective capabilities for greater synergy.

One example is the "Cooling Singapore" project, where researchers from ETH Zurich, MIT, TUM and NUS work together to develop a road map to reduce Singapore's urban heat island effect. The team will identify key areas of research and develop tools to assess the effects of a range of mitigation measures.

"This is a matter of importance not just for Singapore but for large cities, and Singapore could be the first city in the world to come up with a coherent strategy for tackling what is a very general problem," said Professor Peter Edwards from the Singapore-ETH Centre, one of the lead principal investigators for the project.

RETURNS ON INVESTMENT

Ensuring returns on investments is one of the biggest challenges in research endeavours worldwide. While there is no guarantee discoveries can be commercialised, Create entities have turned in a good scorecard: They have filed more than 400 patents, 280 invention disclosures and generated 15 spin-off companies since its inception.

Researchers work closely with companies to ensure successful translation of science into industry-ready technologies. Smart's Low Energy Electronics Systems programme, for one, works with industry partners such as GlobalFoundries to build new integrated circuits for the semiconductor industry. Similarly, the Berkeley Education Alliance for Research in Singapore has research projects on printable solar cells with Greatcell Solar and REC Solar, an installer of commercial solar electric systems.

In addition, Create's overseas partner universities are connected to key innovation nodes around the world, including Silicon Valley, Boston and Tel Aviv. Create has been tapping their experience in innovation and commercialisation to inject stronger entrepreneurial culture into the Singapore ecosystem.

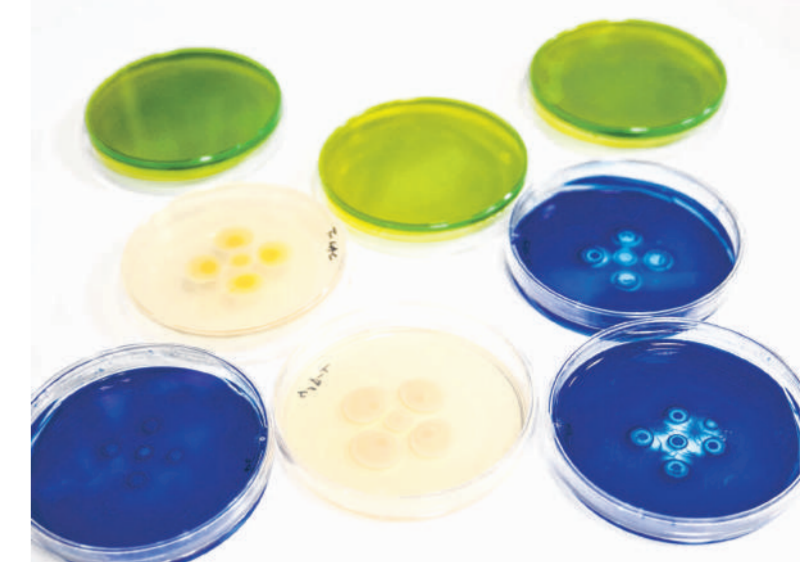
SINGAPORE'S GROWTH TRAJECTORY

Research and development will continue to drive Singapore's economy, create high-value jobs for Singaporeans, and produce solutions for our national challenges.

Currently, our research-intensive universities, Agency for Science, Technology and Research institutes, academic medical centres, and Create form the four pillars that drive Singapore's vibrant research landscape.

Create will continue to play an important role in enhancing Singapore's competitive advantage in R&D. It will position Singapore as a global hub where talent gathers to conduct high-impact research activities – significant in impact, and built on excellent science.

Beautiful Science



Superbugs cultivated in a laboratory. A team led by researchers from the Spanish National Research Council (CSIC) has made an important breakthrough in the battle against superbugs and their resistance to multiple drugs, the council said. The scientists have designed molecules that can break the cellular mechanisms which result in these bacteria becoming unaffected by conventional antibiotics. In recent decades, drug-resistant bacteria, such as Staphylococcus aureus (MRSA) and Clostridium difficile, have become a global health threat, while superbug strains of infections such as tuberculosis and gonorrhoea are now untreatable. PHOTO: ANDRES DIAZ/CSIC COMMUNICATION

How do parked cars get so hot?

Q&A

Q When I park my car in direct sunlight with the windows closed, the temperature inside climbs above the ambient temperature. Why is that?

A The process that puts children and pets in danger in a closed car on a hot day is at work: the greenhouse effect.

Light energy, in the form of short, visible wavelengths, passes easily through glass into the closed vehicle. Some of the

energy is reflected right back out, again in visible wavelengths. But some of it is absorbed by objects and surfaces inside, and then reradiated in longer wavelengths in the invisible infrared range – that is, heat.

The heat is effectively trapped by automobile glass, which is not so permeable to longer wavelengths. The air inside the car is also trapped.

Temperatures can rise quickly in a closed, sunlit car. One study, done at warmer temperatures, found typical increases of 11.1 deg C above the ambient temperature in just 10 minutes, and 18.2 deg C in 20 minutes. NTfMES

400

Number of patents Create entities have filed.

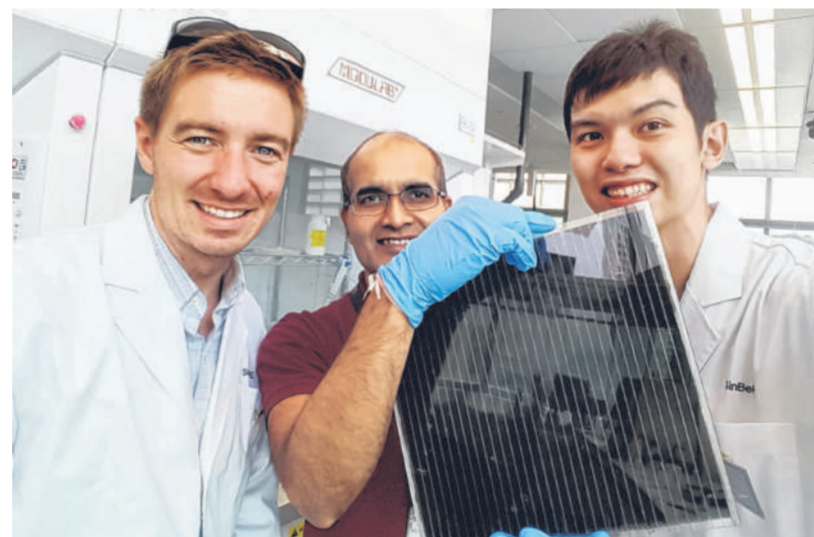
280

Number of invention disclosures they have filed.

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(From left) Dr Frederick Carl Prehn Jr, Dr Anish Priyadarshi and Mr Lew Jia Haur, researchers from the Singapore-Berkeley Research Initiative for Sustainable Energy with a printed perovskite panel. PHOTO: BEARS, NTU

Promising technologies and innovative spin-offs

Sustainability

Researchers from the Berkeley Education Alliance for Research in Singapore (Bears) and Nanyang Technological University (NTU) are looking at a fascinating new material known as perovskite, which can capture and convert more light energy into electricity than traditional silicon solar cells. This presents an opportunity for Singapore to develop expertise that may create new industries based on a solar energy value chain. If this is deployed on our island, it will also reduce Singapore's reliance on conventional energy sources. Likewise, as the Energy Market Authority pilots renewable energy sources on its micro-grid test beds, it is working with Bears to develop a sensor system capable of online, real-time monitoring of the micro-grid's performance.

Urban planning

The Singapore-ETH Centre and the Singapore Land Authority have recently embarked on a "Digital Underground: Guidelines for 3D Mapping of Utility Networks" project to develop a road map for mapping existing and future utility networks in Singapore. The road map will lead to

guidelines on how to acquire data of existing as well as new networks, and how to maintain permanent digital records of underground infrastructure. These records will eventually be integrated into the Virtual Singapore platform, for decision-making by government agencies and businesses.

Smart Nation

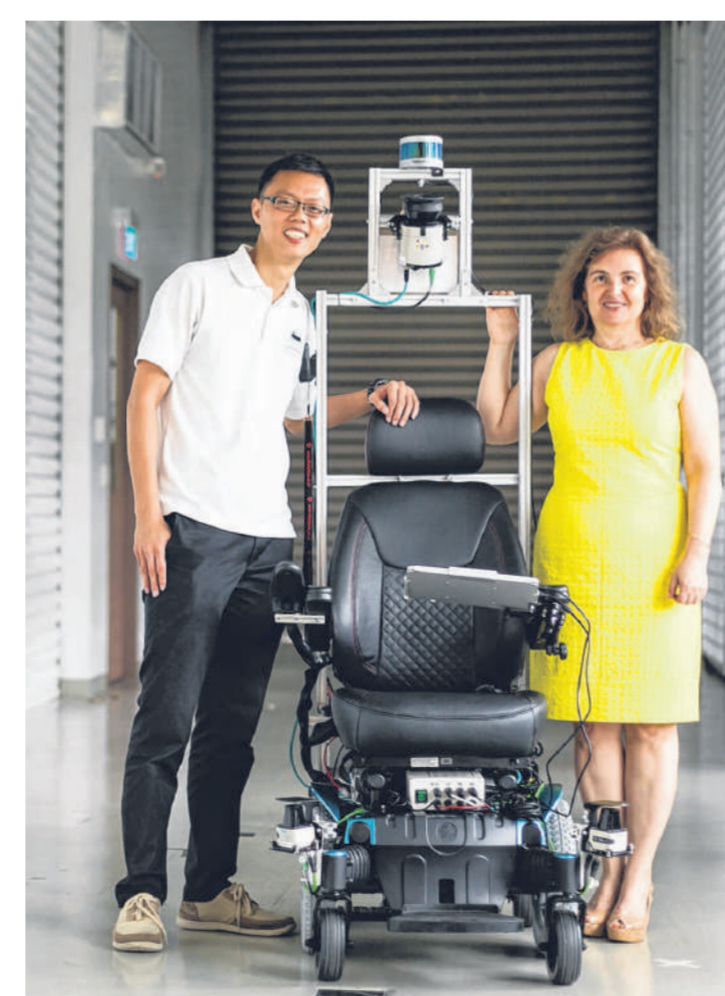
SELF-DRIVING WHEELCHAIR
Researchers from the Singapore-MIT Alliance for Research and Technology (Smart) Future Urban Mobility team and National University of Singapore (NUS) introduced Singapore's first self-driving wheelchair that was piloted at Changi General Hospital last year. Studies show that nurses spend a significant amount of time looking for wheelchairs for their patients. A self-driving wheelchair will free up the nurses for other tasks, while giving patients autonomy in movement.

ROBOTIC AUTOMATION OF THE CARGO-HANDLING PROCESS

The Technical University of Munich Create is working with the Civil Aviation Authority of Singapore on robotic automation of the cargo-handling process at Changi



The Technical University of Munich Create is working with the Civil Aviation Authority of Singapore to implement the world's first AI-powered robotic system which automates the build-up and breakdown of aviation cargo pallets. PHOTO: TECHNICAL UNIVERSITY OF MUNICH CREATE



Dr Eng You Hong and Professor Daniela Rus from the Smart Future Urban Mobility team with the self-driving wheelchair that can manoeuvre through tight spaces autonomously. PHOTO: SINGAPORE-MIT ALLIANCE FOR RESEARCH AND TECHNOLOGY

Airport. The goal is to incorporate technology into ground-handling operations to alleviate the manpower crunch in a traditionally labour-intensive sector.

Spin-offs
RAPID-CHARGING BATTERIES
Quickcharge – from the Singapore-Hebrew University of Jerusalem Al-

liance for Research and Enterprise (Share) Nanomaterials for Energy and Water Management (NEW) programme – has developed technologies for rapid-charging batteries. It was acquired by Ultracharge last year.

WIRELESS SENSOR NETWORKS
Visenti, a spin-off from a Smart col-

laboration, developed wireless sensor networks that allow the remote detection of leaks and pipe bursts in urban water distribution systems. National water agency PUB has deployed this technology in Singapore and its intellectual property rights are licensed to 10 countries around the world.

ADVANCED FORM OF LIQUID BIOPSY

Clearbridge Biomedics is using an advanced form of liquid biopsy that is paving the way for the next generation of non-invasive cancer diagnosis. This technology is licensed from NUS and Smart. An estimated one in three individuals is expected to be diagnosed with cancer in his or her lifetime.

STRESS-FREE DIAGNOSTICS KIT

NTU-affiliated biotech start-up Biosensorix is creating a thumb-size device that provides stress-free diagnostics for various viruses. The kit can determine if someone has been infected with viruses such as dengue or Zika, and how serious it is.

CARBON-FIBRE AEROGEL

Ecworth Tech, another NTU-affiliated company, is using patented carbon-fibre aerogel (CFA) technology to reduce the environmental impact of contaminated wastewater, by removing organic contaminants and turning waste into value-added products. CFA is poised to transform the food recycling industry as it can efficiently separate grease and oils from food sludge, and use it for applications such as biofuels.

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