

THE ROYAL
SOCIETY
OF EDINBURGH



The Royal Academy
of Engineering

Joint Lecture
at
The Royal Society of Edinburgh

Wednesday 11 March 2009

*The i-LIMB Hand - Engineering
Innovation Drives Business Success*

TOUCH BIONICS™

Transforming the Everyday Lives
of Extraordinary People



The Royal Society of Edinburgh

The Royal Society of Edinburgh (RSE) is Scotland's National Academy of Science & Letters. It is an independent body with charitable status. The Society organises conferences and lectures for the specialist and for the general public. It provides a forum for informed debate on issues of national and international importance. Its multidisciplinary fellowship of men and women of international standing provides independent, expert advice to key decision-making bodies, including Government and Parliament.

The Society's Research Awards programme annually awards over £2 million to exceptionally talented young researchers to advance fundamental knowledge, and to develop potential entrepreneurs to commercialise their research and boost wealth-generation.



Among its many public benefit activities, the RSE is active in classrooms from the Borders to the Northern Isles, with a successful programme of lectures and hands-on workshops for primary and secondary school pupils.

The Royal Society of Edinburgh, working as part of the UK and within a global context, is committed to the future of Scotland's social, economic and cultural well-being.

The Royal Academy of Engineering

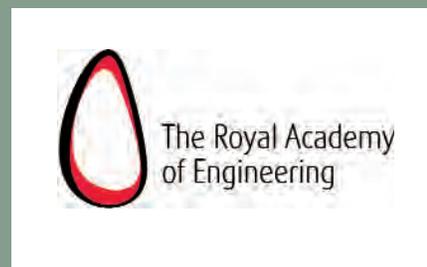
"As Britain's national academy for engineering, we bring together the country's most eminent engineers from all disciplines to promote excellence in the science, art and practice of engineering. Our strategic priorities are to enhance the UK's engineering capabilities; to celebrate excellence and inspire the next generation; and to lead debate by guiding informed thinking and influencing public policy."

Strategic Priorities

The Academy's work programmes are driven by three strategic priorities, each of which provides a key contribution to a strong and vibrant engineering sector and to the health and wealth of society.

Enhancing national capabilities

As a priority, we encourage, support and facilitate links between academia and industry. Through targeted national and international programmes, we enhance – and reflect abroad – the UK's performance in the application of science, technology transfer, and the promotion and exploitation of innovation. We support high quality engineering research, encourage an interdisciplinary ethos, facilitate international exchange and provide a means of determining and disseminating best practice. In particular, our activities focus on complex and multidisciplinary areas of rapid development.



Recognising excellence and inspiring the next generation

Excellence breeds excellence. We celebrate engineering excellence and use it to inspire, support and challenge tomorrow's engineering leaders. We focus our initiatives to develop excellence and through creative and collaborative activity, we demonstrate to the young, and those who influence them, the relevance of engineering to society.

Leading debate

Using the leadership and expertise of our Fellowship, we guide informed thinking; influence public policy making; provide a forum for the mutual exchange of ideas; and pursue effective engagement with society on matters within our competence. The Academy advocates progressive, forward-looking solutions based on impartial advice and quality foundations, and works to enhance appreciation of the positive role of engineering and its contribution to the economic strength of the nation.

The i-LIMB Hand – engineering innovation drives business success.

Lecture – Wednesday 11 March 2009 at 6 pm at the Royal Society of Edinburgh

They said it couldn't be done. For years, the prosthetics industry focused on delivering incremental improvements to a pincer-like hand design that was not a true reflection of a human hand. The concept of a hand with articulating fingers was considered too great an engineering challenge for prosthetic device companies. While the industry stood still, a small company from Scotland was tearing up the rule book and forging ahead with the development of the i-LIMB Hand, the world's first bionic hand. That company was Touch Bionics and this is their story

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This event is part of the National Science and Engineering Week (6 - 15 March 2009)

Photographs courtesy of © Touch Bionics

TOUCH BIONICS™

Transforming the Everyday Lives
of Extraordinary People



The history of Touch Bionics goes back to a programme of work conducted at the Princess Margaret Rose Hospital in Edinburgh from 1963, starting with comprehensive research into developing prosthetic solutions for children affected by Thalidomide.

In 1988, work began in earnest on electronic arms, including shoulders, wrists and hands. In 1993, a partial hand system received international publicity and in 1998, major international profile was achieved through the fitting of the world's first electrically powered shoulder.

In early 2003, the company was spun out from the National Health System, with significant shareholding held by Scottish Health Innovations Ltd., and became the first SHIL spin-out to receive significant funding. An initial SMART award from Scottish Enterprise got the company going, and it has now received investment funding from existing and new investors, including Archangel Informal Investments and the Scottish Co-investment Fund.

The company was initially called Touch EMAS, EMAS standing for Edinburgh Modular Arm System. In 2005 it was re-branded Touch Bionics to communicate the dynamism of the company's products and the future focus of its technology.

Touch Bionics is launching two key products, the i-LIMB Hand and ProDigits. The hand is the world's first commercially available multi-articulating bionic hand. It has five independently powered digits that open and close around objects. It supports amputees in going about their everyday lives. In medicine, bionics means the replacement or enhancement of organs or other body parts by mechanical means.

ProDigits, short for Prosthetic Digits, are the self-contained fingers that are individually powered and controlled to provide new fingers for partial hand patients. The i-LIMB Hand is effectively a chassis for five ProDigits. Individual ProDigits are used for patients who have lost part of their hand or a whole finger or fingers.

Welcome to the Bionic Generation

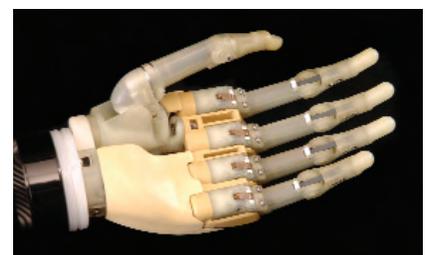
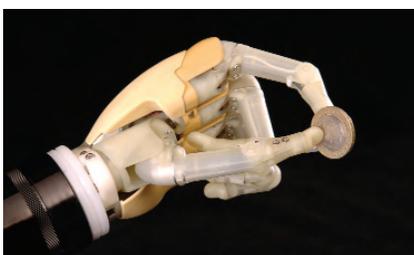
Touch Bionics is the UK-based award winning company focusing on the supply of electrically powered Upper Limb Prostheses (ULP).

The i-LIMB Hand

The hand is the world's first commercially available multi-articulating bionic hand. It has five independently powered digits that open and close around objects. It supports amputees in going about their everyday lives.

ProDigits - the Partial Hand Solution

ProDigits, short for Prosthetic Digits, are the self-contained fingers that are individually powered and controlled to provide new fingers for partial hand patients. The i-LIMB Hand is effectively a chassis for five ProDigits. Individual ProDigits are used for patients who have lost part of their hand and/or a whole finger or fingers.



Hugh Gill
Director of Technology and Operations, Touch Bionics



Since his engagement with Touch Bionics in 2007 Hugh's role has been to take the current iLimb into worldwide production and building an R&D team to develop Touch Bionics new product roadmap. Hugh is also responsible for production and supply chain.

Hugh has over 30 years experience in high technology companies in Product Design and Manufacturing.

He has been a Program Manager for Polaroid and was Technical and Operations Director for Wideblue. In this role he supported a significant amount of high growth companies taking their technology from concept into development, supply chain and manufacturing.

Hugh has a wide engineering background having developed products in the heavy machine tool industry, wind turbines, large scale tunneling machines, high speed document process machines, drug testing machines, cameras, printers and numerous other products. Hugh has two patents granted and three patents pending.

Phil Newman
Director of Marketing, Touch Bionics

Since his 2005 engagement with Touch Bionics Phil's role covers marketing, developing the market entry strategies and customer development programmes for the Company. Since market release in September 2007 the i-LIMB Hand has successfully been fitted to over 500 patients worldwide.

Phil has over 18 years of consulting in business development and marketing for international IT & Telecoms, Healthcare and Financial companies such as Boehringer Ingelheim, Cisco, Dresdner Kleinwort Wasserstein and Motorola whilst creating European market entry strategies for emerging technology businesses from Silicon Valley.

He has extensive experience of sales, marketing and business development in Europe and in the US - and is normally responsible for high-level customer engagements, new business strategy, channel development and sales performance.

During his career Phil has continually pursued entrepreneurial opportunities and sits on the boards of a number of early stage companies.



Product Background

Touch Bionics is a leading developer of advanced upper-limb prosthetics (ULP). One of the two products now commercially available from the company, the i-LIMB Hand, is a first-to-market prosthetic device with five individually powered digits.

The Touch Bionics i-LIMB Hand was developed using leading-edge mechanical engineering techniques and is manufactured using high-strength plastics. The result is a next-generation prosthetic device that is lightweight, robust and highly appealing to both patients and healthcare professionals.

The i-LIMB Hand is controlled by a unique, highly intuitive control system that uses a traditional two-input myoelectric (muscle signal) to open and close the hand's life-like fingers. Myoelectric controls utilize the electrical signal generated by the muscles in the remaining portion of the patient's limb. This signal is picked up by electrodes that sit on the surface of the skin. Existing users of basic myoelectric prosthetic hands are able to quickly adapt to the system and can master the device's new functionality within minutes. For new patients, the i-LIMB Hand offers a prosthetic solution that has never before been available.



Partial hand

In another industry first, the i-LIMB Hand's finger technology has been adapted for patients who have a partial hand, due either to congenitally missing fingers or fingers lost through an accident. Partial hand is an area of prosthetics that has been without suitable powered products in the past. ProDigits are another first from Touch Bionics. Not having fingers or a thumb to act in opposition to one another makes simple tasks such as holding a fork or a drink difficult and frustrating.

The modular nature of the ProDigit finger design and the individually-powered motor located within each digit means that a clinician can build replacement fingers to the correct anatomical length of the patient's remaining undamaged fingers. This new solution can help the many individuals who so far have had no effective options available to them.

Advanced controls

With the i-LIMB, Touch Bionics is utilising the myoelectric principles used in existing devices while taking advantage of the mechanical advance of five fully-articulating powered digits. The inclusion of a thumb that can, like the human thumb, be rotated into different positions enables important grip configurations, many of which have not been available to amputees before. The grasp of the hand is much more like that of a human hand with the articulating fingers able to close tightly around objects. Built-in detection tells each individual finger when it has sufficient grip on an object and, therefore, when to stop powering. Individual fingers lock into position until the patient triggers an open signal through a simple muscle flex.

Whereas previous myoelectric hands could only be opened and closed, the i-LIMB Hand offers numerous different grip patterns. These new grip options enhance dexterity and support almost all daily living activities, giving doctors, prosthetists and occupational therapists completely new options for enhanced patient rehabilitation and quality of life. For example, patients are now able to point the index finger to operate a PC keyboard, or to rotate the thumb to meet the side of the index finger to hold a plate or turn a key in a lock. None of these functions have been possible before.

The i-LIMB Hand is anatomically correct both when resting and in motion. This is a key innovation that has been very much appreciated by patients – many of whom simply wish to blend back into society without others noticing their amputation.

Advanced design

Touch Bionics is the first company to offer commercial availability of a true bionic upper-limb product. Both the i-LIMB Hand and ProDigits have been fitted to many different patients at a number of leading prosthetic and orthopedic clinics both in the US, the UK and in another 28 countries around the world.

The modular construction of the i-LIMB Hand means that each individually powered finger can be quickly removed by simply removing one screw. This means that a prosthetist can easily swap out fingers that require servicing and patients can return to their everyday lives after a short clinic visit. Traditional devices would have to be returned to the manufacturer, often leaving the patient without a hand for many weeks.



Controlling bionic devices

The i-LIMB Hand relies on some of the most advanced control software yet seen in the prosthetics industry. This software provides speed and grip-strength control to the device while patients generate signals to control the device in a way that does not differ from how traditional devices operated in the past. Two small metal electrode plates, which detect the minute electrical signals generated by the remaining muscles in the limb stump, are placed against the skin to pick up signals. Traditionally one electrode is placed on the top of the forearm and the other on the bottom.

Patients usually have a sensation that their hand still exists despite it being amputated, something often referred to as 'phantom' feelings. When encouraged to generate a strong signal, the patient is often asked to move and flex their missing hand to generate a strong control signal. Before too long, these reflexes become intuitive.

Feedback from early patient studies identified that software adjustments can allow patients to perform simple tasks and improve functionality. An example of this is thumb parking, instructing the thumb to close down against the side of the hand to allow a jacket to be put on. Another is a completely new grip function for prosthetic hands, the index point, whereby the hand grasps into a fist whilst leaving the index finger extended. Patients have found this very useful for operating computer keyboards, telephone dial pads, ATM cash machines and a host of other everyday requirements.



Advances in cosmesis

Cosmesis is the flexible skin covering that covers the i-LIMB Hand and ProDigits. By applying in-house expertise and partnering with companies that specialize in cosmesis, Touch Bionics has achieved major breakthroughs in the aesthetic appearance of its prosthetic products. The Touch Bionics products are the first prosthetic hands to imitate the true movement and life-like accuracy of a human hand. The challenge has been to find materials that can move and flex in the same way that human skin does.

This has been addressed in two ways, in order to support two distinct patient preferences.

Some patients, mainly military personnel, particularly love the robotic nature of the uncovered i-LIMB Hand and prefer not to wear it with a cosmesis glove. However, because of the need to provide a grip surface and to protect the hand from dust and water, Touch Bionics has developed the i-LIMB Skin. This is a thin layer of semi-transparent material that has been computer-modeled to accurately wrap to every contour of the hand.

Other patients wish their device to blend anatomically with the rest of their body, and have a life-like covering for the i-LIMB Hand and ProDigits. As these products are more anatomically correct than any currently on the market, which not only allows for increased functionality but also a vastly improved cosmetic appearance, the challenge has been to find a high-definition cosmesis of superior quality. Touch Bionics has launched with custom cosmesis products from two of its cosmesis partner companies.

CASE STUDY

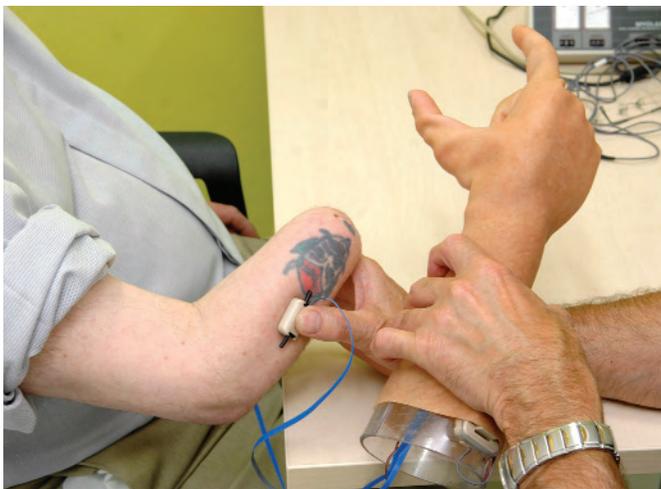
Name: Donald McKillop

Location: Kilmarnock, Scotland

Occupation: Retired welder

Clinic: Fitted by Touch Bionics

Product: i-LIMB Hand



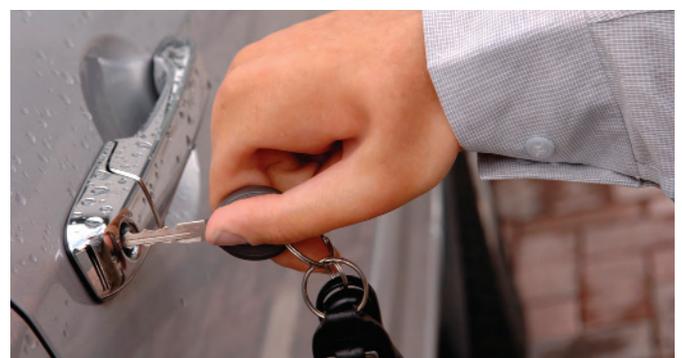
In 1977, Donald McKillop underwent an amputation of his right hand due to complications from an accident some nine years prior. After some basic rehabilitation, he was quickly fitted with a body-powered prosthesis so he could begin working again as a welder.

The initial prosthesis was a full-torso harness with a body-powered prosthesis incorporated into it. This solution was not well suited to physical work and so he was moved onto a self-suspending socket for his prosthesis, which worked better for him.

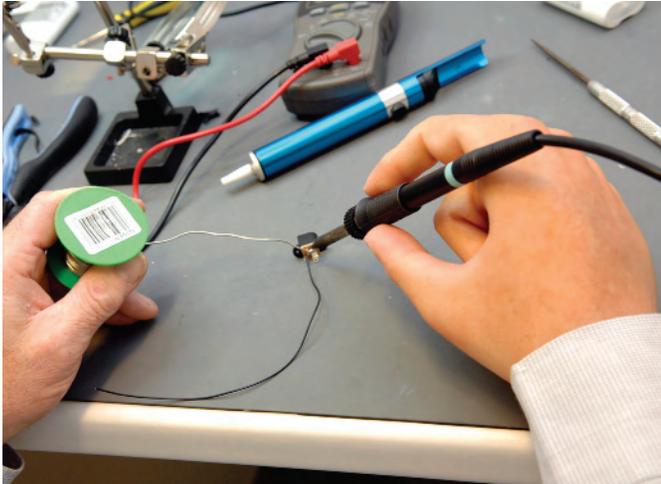
“You have to get on with your life, you can’t go on thinking that you’ll wake up the next morning and your hand has started to grow back,” said Mr McKillop. “I’m always a positive person, of course there are frustrations, but you can always find ways to do things.”



The developments in his life caused him to take an interest in the development of prosthesis and Mr McKillop became involved with The National Centre for Training and Education in Prosthetics and Orthotics at the University of Strathclyde. For the past 30 years, he has been a willing participant in the research activities of the Centre, and it was this connection that first brought him into contact with Touch Bionics.



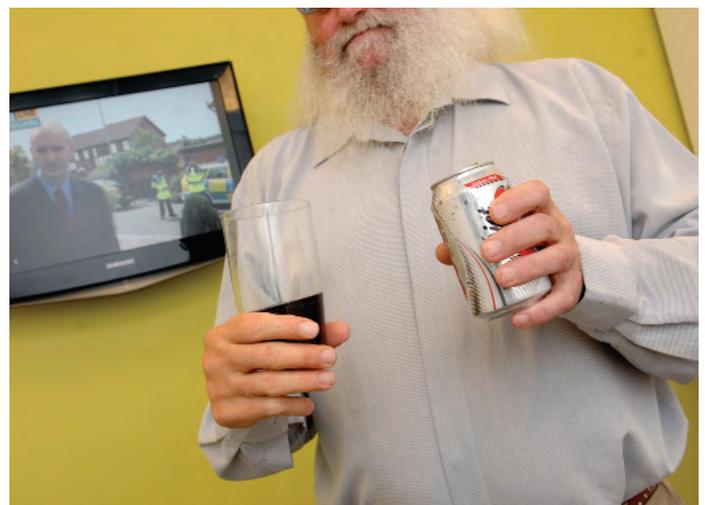
In 2006, Mr. McKillop was one of the first patients to be fitted with Touch Bionics' i-LIMB Hand. He immediately experienced the benefits.



"I was amazed by how quickly I could learn to do things with the i-LIMB Hand, even only an hour after being fitted with the hand and being talked through some basic exercises," said Mr. McKillop. "The most important thing is the movement of the fingers, that's what really makes the difference. It's truly incredible to see the fingers moving and gripping around objects that I haven't been able to pick up before. The hand does feel like a replacement for my missing hand and it is now very natural for me to pick up all sorts of objects. It makes everyday activities much easier."



Since being fitted with the i-LIMB Hand, Mr. McKillop is now able to do things for which previously he was restricted to using his remaining hand. A keen hobbyist, he was delighted to be able to hold a saw in the normal way for his woodworking projects and it is clear his everyday life has been markedly improved. Donald has been working in the garden with his new hand and is making great progress.



"I was in the kitchen doing cooking the other day and I was so much more confident in picking up pots and pans and using the cooker. As time goes by, I'll get even better at using the hand, but I'm really pleased with the progress I have made already," he said. "If you gave someone this hand for a month and then gave them back their old device, they would be very disappointed."

CASE STUDY

Name: Lindsay Block

Age: 26

Location: Oklahoma City, Oklahoma

Occupation: Marketing and PR Director for Limbs for Life.

Clinic: Fitted by Scott Sabolich Prosthetics and Research

Product: i-LIMB Hand



Lindsay Block has never known what it feels like to lose a hand. She was born missing the lower part of her left arm as the result of a birth defect.

"I never really knew any different," said Block. "In many ways, it has been a blessing as through my work in the industry, I have learned that the hardest part for amputees is learning to overcome the loss of something you once had. For me, that wasn't an issue I had to deal with."

She is well qualified to make such an observation. In 2004, Block joined the Limbs for Life Foundation as a marketing and PR director. Limbs for Life is a global nonprofit organization dedicated to providing prosthetic care for individuals who cannot otherwise

afford it and raising awareness of the challenges facing amputees.

Block is an experienced user of prosthetic products. "I've had a prosthesis since I was six months old," she said. "I was trained from a very early age, and learned to put on my arm the same way other kids learn to put on their shoes."

Up to the age of five, she wore a body-powered device that was strapped around her good arm with the gripping function operated by extending and retracting her arm. Then the first myoelectric hands appeared on the market and Block was fortunate to be part of the first trials for these revolutionary devices, which she has been using ever since.



Through her childhood and teen years, Block was provided her prostheses by Shriners Hospital, but has been in contact with Scott Sabolich Prosthetics & Research her whole life, visiting the clinic when any repairs were required. She established a firm bond with the clinic and has been attending more regularly since she turned 18.

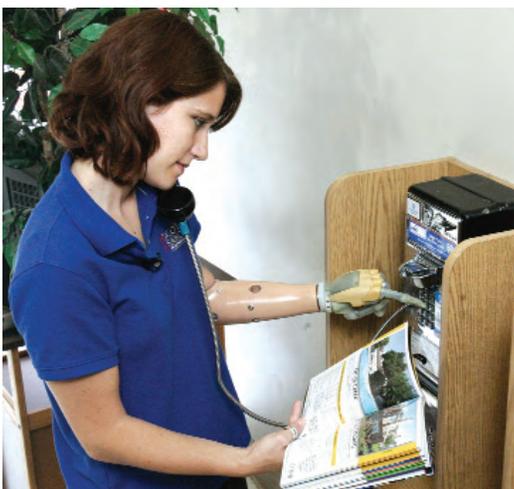
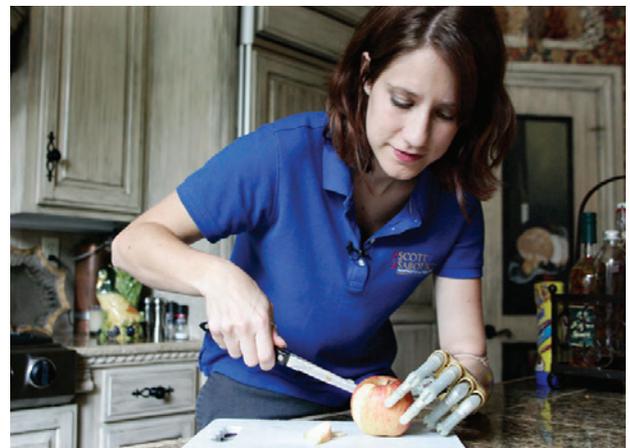
"They're like family to me," she said. "I even worked there for a while as an intern after college, before starting with Limbs for Life."

It was through her job with Limbs for Life and her close connection with Scott Sabolich that Block became one of the first patients to be fitted with the i-LIMB Hand. She was attending a fitting of one of the recipients of her program at Scott Sabolich and her eager participation in a discussion about new prosthetic technologies led to her eventual fitting with the new hand from Touch Bionics. She noticed an immediate difference.

"My previous myoelectric hand never really moved or looked like a real hand," she said. "When I'm wearing the i-LIMB Hand, I'm pretty sure that someone who doesn't know me wouldn't even guess that it wasn't my own hand."

Beyond the hand's natural appearance, she is also in awe of its advanced grip features.

"It's cool how it can adjust to whatever it is grabbing on to. With my previous hand, I would often have to move my entire arm to try and grab on to an object of a certain shape, and you often had to really think about the kind of shape that you are trying to hold, was it round or too flat or too wide, and so on. With this new hand, you don't have to strategize so much about what you do with it because you realize it's not limited and will adjust depending on what it's gripping on to."



Recent advances made in cosmesis, or coverings, for prosthetic hands were a welcome development.

"Within the last couple of years, the new cosmetic gloves that have now appeared are really amazing," she said. "I've really enjoyed being able to use the new kinds of gloves that help match my prosthesis to my right hand."



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