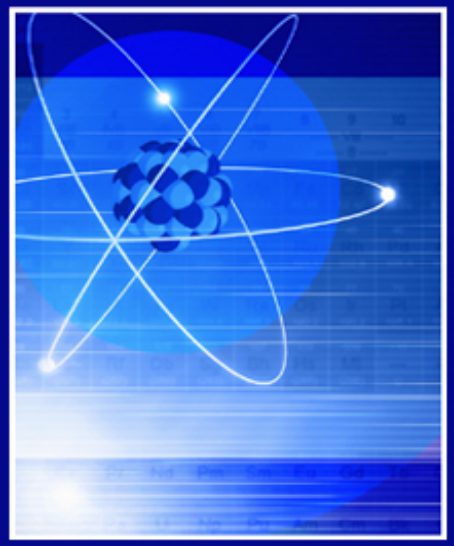


U.S. Technical Advisory Group to ISO/TC 229 *Nanotechnologies*

TAG Working Group 2

Angela R. Hight Walker
NIST
US TAG JWG2 Chair

The Queen of Carbon

The Alphabet Soup of Standardization

TAG
TC
SC
TWA41
TR
TS
IS
BDS
KCC

VAMAS
ISO
TC229
IEC
TC113
OECD
ASTM
E56
IEEE

ISO

VAMAS

IEC

ASTM INTERNATIONAL

NIST

Documentary Standards Tool Box

Different tools for different market needs:

- National participation models
  - Treaty organizations; ISO, IEC
  - Formality in process
  - One country, one vote
- Direct participation models
  - ASTM International, SAE, IEEE, etc.
  - Direct link between technical experts and SDOs
- Corporate participation models
  - Consortia and fora
  - Wide range of processes and procedures allows flexibility

ISO/TC 229 Nanotechnology

Secretariat: UK
Convener: UK

Participating countries:(P) **37**
Observer Countries: (O) 13

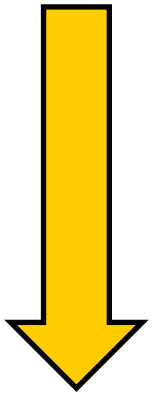
Total number of published ISO standards	52
Attendees at Plenary	**170**

Scope:
Standardization in the field of nanotechnologies that includes either or both of the following:

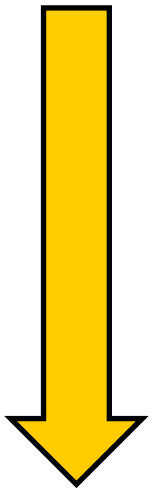
- Understanding and control of matter and processes at the nanoscale, typically, but not exclusively, below 100 nanometres in one or more dimensions where the onset of size-dependent phenomena usually enables novel applications,
- Utilizing the properties of nanoscale materials that differ from the properties of individual atoms, molecules, and bulk matter, to create improved materials, devices, and systems that exploit these new properties.

Specific tasks include developing standards for: terminology and nomenclature; metrology and instrumentation, including specifications for reference materials; test methodologies; modelling and simulations; and science-based health, safety, and environmental practices.

ISO Documentary Standard Types



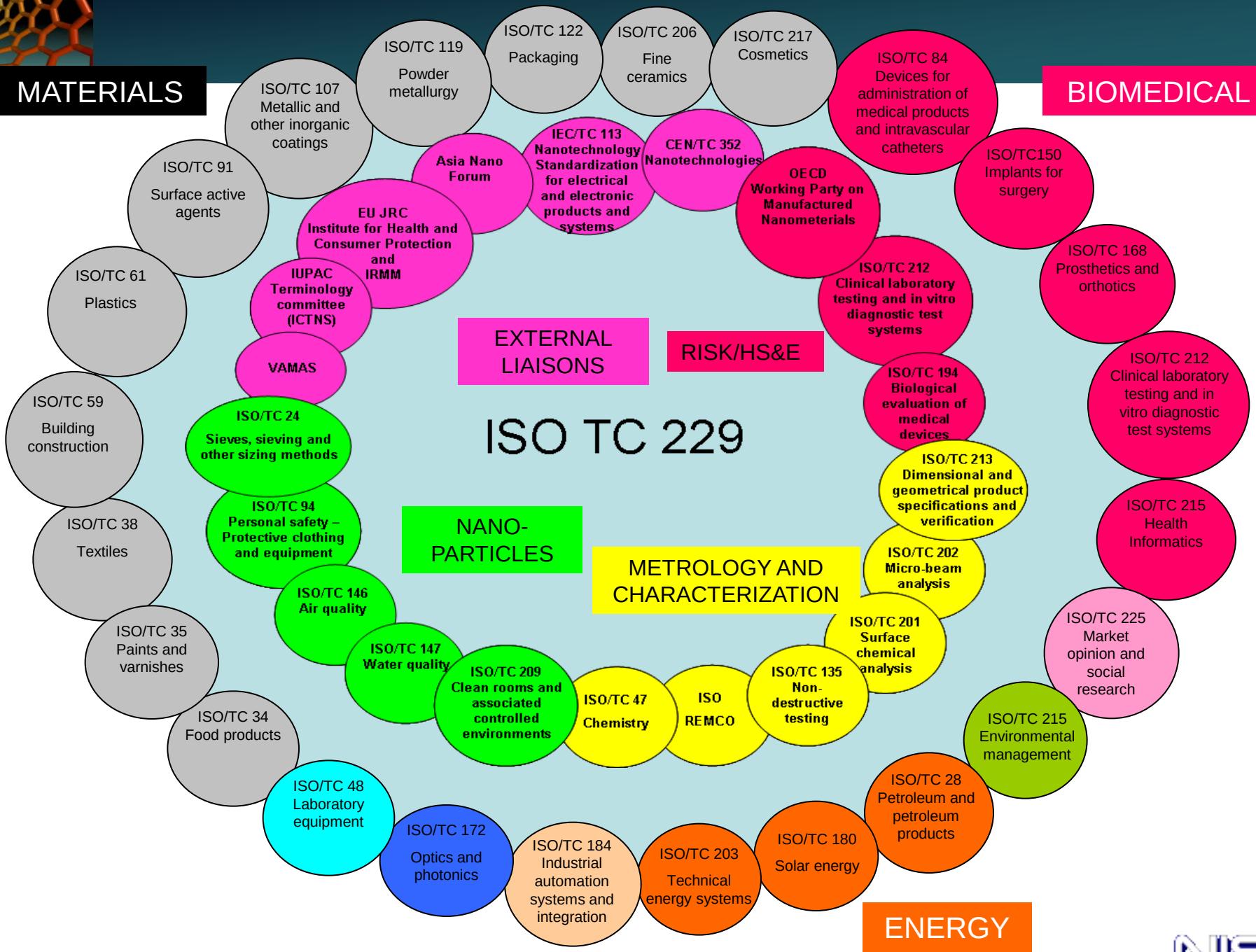
PAS Publicly Available Specification
TR Technical Report
TS Technical Specification
IS International Standard



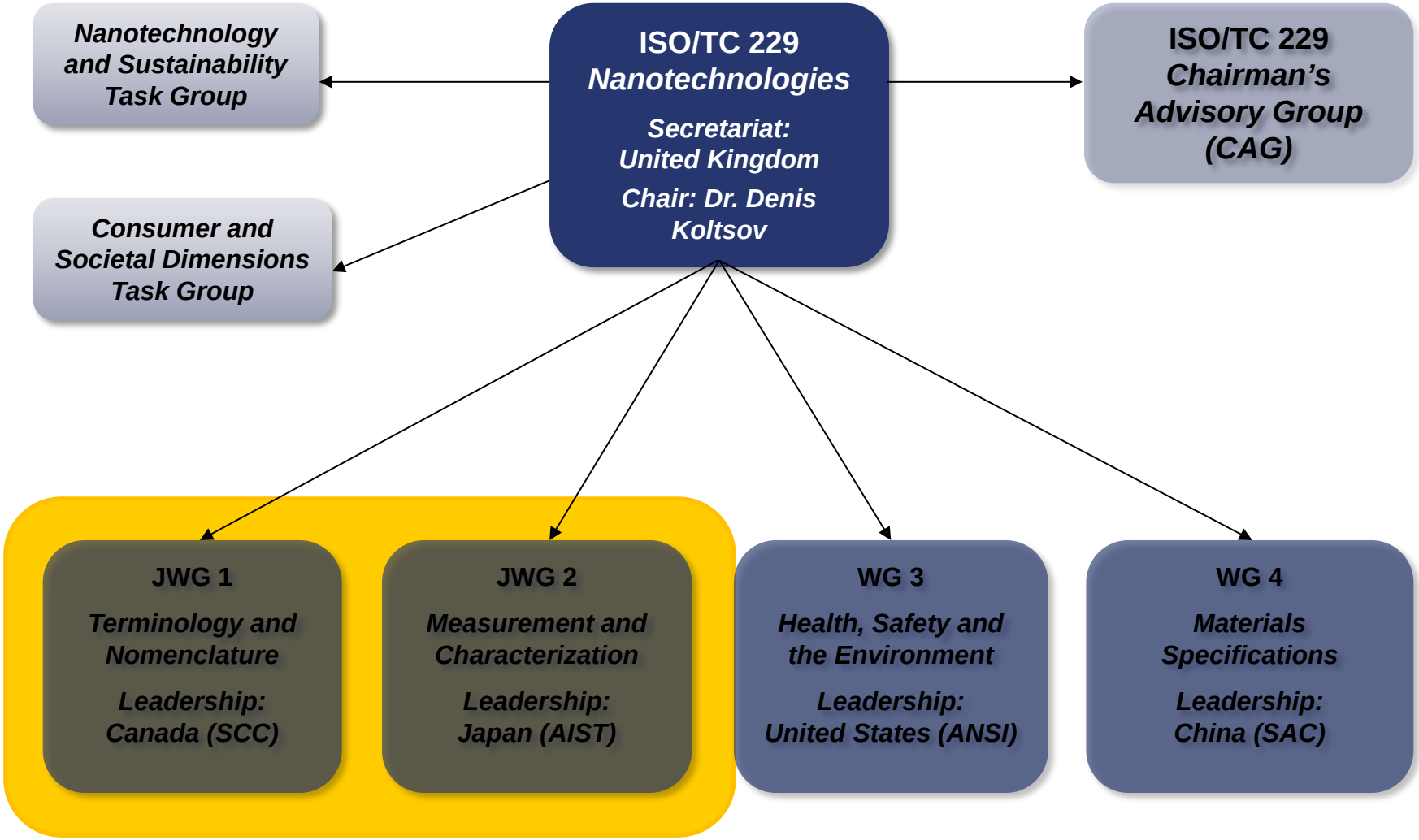
Agreement
PWI Preliminary Work Item
- Vote

WI Work Item
- Vote

Publish


MATERIALS
BIOMEDICAL
ENERGY
ISO TC 229
EXTERNAL LIAISONS
RISK/HS&E
NANO-PARTICLES
METROLOGY AND CHARACTERIZATION
ISO/TC 119 Powder metallurgy
ISO/TC 122 Packaging
ISO/TC 206 Fine ceramics
ISO/TC 217 Cosmetics
ISO/TC 107 Metallic and other inorganic coatings
ISO/TC 91 Surface active agents
ISO/TC 61 Plastics
ISO/TC 59 Building construction
ISO/TC 38 Textiles
ISO/TC 35 Paints and varnishes
ISO/TC 34 Food products
ISO/TC 48 Laboratory equipment
ISO/TC 172 Optics and photonics
ISO/TC 184 Industrial automation systems and integration
ISO/TC 203 Technical energy systems
ISO/TC 180 Solar energy
ISO/TC 28 Petroleum and petroleum products
ISO/TC 215 Environmental management
ISO/TC 225 Market opinion and social research
ISO/TC 215 Health Informatics
ISO/TC 212 Clinical laboratory testing and in vitro diagnostic test systems
ISO/TC 168 Prosthetics and orthotics
ISO/TC150 Implants for surgery
ISO/TC 84 Devices for administration of medical products and intravascular catheters
IEC/TC 113 Nanotechnology Standardization for electrical and electronic products and systems
CEN/TC 352 Nanotechnologies
OECD Working Party on Manufactured Nanometerials
ISO/TC 212 Clinical laboratory testing and in vitro diagnostic test systems
ISO/TC 194 Biological evaluation of medical devices
ISO/TC 213 Dimensional and geometrical product specifications and verification
ISO/TC 202 Micro-beam analysis
ISO/TC 201 Surface chemical analysis
ISO/TC 135 Non-destructive testing
ISO REMCO
ISO/TC 47 Chemistry
ISO/TC 209 Clean rooms and associated controlled environments
ISO/TC 147 Water quality
ISO/TC 146 Air quality
ISO/TC 94 Personal safety – Protective clothing and equipment
ISO/TC 24 Sieves, sieving and other sizing methods
VAMAS
IUPAC Terminology committee (ICTNS)
EU JRC Institute for Health and Consumer Protection and IRMM
Asia Nano Forum

ISO/TC 229 ORGANIZATION



WG= Working Group

JWG 1 *Terminology and Nomenclature*

Led by UK
1st graphene standard in TC 229

ISO/TC 229/SC N 1410

Date: 2016-07-22

ISO/DTS 80004-13

ISO/TC 229/SC /JWG 1

Secretariat: BSI

Technical Specification

Terms related to methods to produce graphene and related 2D materials

3.2.1
graphene
graphene layer
single-layer graphene
monolayer graphene
single layer of carbon atoms with each atom bound to three neighbours in a honeycomb structure
Note 1 to entry: It is an important building block of many carbon nano-objects.
Note 2 to entry: As graphene is a single layer, it is also sometimes called monolayer graphene or single-layer graphene and abbreviated as 1LG to distinguish it from bilayer graphene (2LG) and few-layered graphene (FLG).
Note 3 to entry: Graphene has edges and can have defects and grain boundaries where the bonding is disrupted.
[SOURCE: ISO/TS 80004-3:2010, 2.11, modified – Notes 2 and 3 added]

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Tech
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6 Matrix of properties and measurement techniques for graphene and related 2D materials

Table 1 — Matrix of properties and measurement techniques for graphene and related 2D materials

Properties \ Techniques		AFM	BET	EDS	EPMA	ESR (EPR)	Hall Bar	ICP-MS	LEEM	Optical Microscopy	Raman	SEM	SKPM	STM	TEM	TGA	UPS	UV-VIS-NIR Spectroscopy	XPS	Electrical Probing (4-point Probe)
Vertical Dimension	Number of Layers										○		○		○			○		
	Thickness	○							○						○					
	Stacking Angle													○	○					
Lateral Dimension	Flake Size	○								○		○			○					
	Domain (grain) Size									○	○			○	○			○		
	Surface Area		○																	
	Crystal Defect	○		○	○	○					○	○		○	○					
																		○		
Thermal Property	Thermal Conductivity										○									
																		○		
Electrical Property	Electrical Conductivity																			○
	Mobility						○													
	Work Function	○											○				○		○	

ISO/PWI 21356

Preliminary Work Item - Structural Characterisation of Graphene

CVD-grown Graphene
And Graphene Powders

Need to **validate** methods through VAMAS

Technical Working Area (TWA) 41

VAMAS

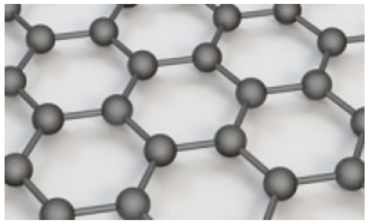
Led by UK and China
Plan to start early summer
Protocol based on NPL Good Practice Guide
Companies CAN participate!

Home > Technical Working Areas > Gr

- VAMAS home
- Formation & Objectives
- Structure
- Representatives
- Technical Working Areas
- Connections
- Members Area
- Contact us

TWA 41

Graphene and Related 2D Materials



Due to its many exceptional properties, graphene is predicted to impact many different industry application areas such as solar cells, biosensors, displays, composites, flexible electronics and energy storage. As industry uptake on this material increases, standardization will be increasingly required to enable commercialization. Particularly important for its uptake is the reliable, accurate and reproducible measure of the different properties of the material. This is because there are issues with both differing routes of production and batch-to-batch consistency.

The objective of this TWA will be to validate different methodologies of measurement for graphene and related 2D materials. Determining the uncertainties associated in measurement, sample preparation, and data analysis. Interlaboratory studies will be conducted and the results will form the basis for future standardisation.

Project Areas

Structural characterisation of CVD grown graphene:

1. Coverage on substrate, number of layers, level of disorder

Chemical composition of graphene flakes:

2. Elemental analysis and oxygen content
3. Measurement of the Metal impurities

10 Questions from the Metrology Check-List

Question 1: Has the system / body / substance that will be subjected to the measurement procedure, clearly been described, including its state?

Question 2: Is the definition of the system / body / substance not unnecessarily restrictive?

Question 3: Is the measurand clearly described?

Question 4: Has it been clearly indicated whether the measurand is operationally defined (or method-defined), or whether the measurand is an intrinsic, structurally defined property?

Question 5: Is the measurement unit defined? Are the tools required to obtain metrological traceability available?

Question 6: Has the method already been validated in one or more laboratories?

Question 7: Are any quality control tools available to enable the demonstration of a laboratory's proficiency with the test method?

Question 8: Have the results of measurements using the proposed method already been published in peer-reviewed journals by several laboratories?

Question 9: Is the instrumentation required to perform the test widely available?

Question 10: Does the document propose a measurement uncertainty budget?

How to know when ....

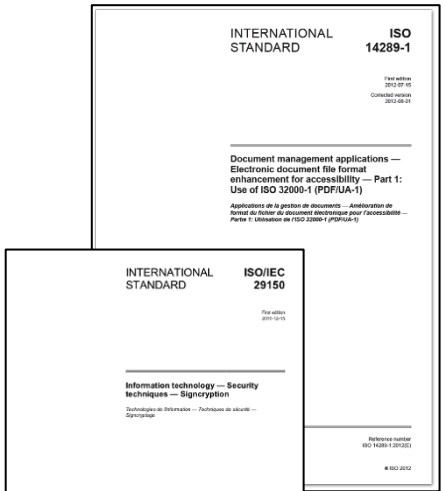
- ….the measurement science is ready to be standardized?

And more importantly

- ….standards are really needed?

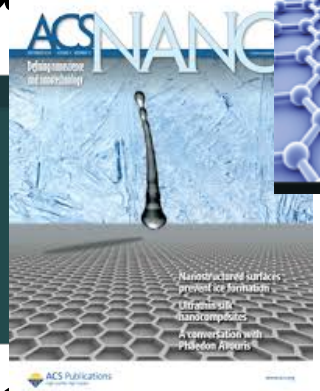
Standards are
for industry

The Metrological Approach at NIST



Physical Standards

Documentary Standards



Measurement Science

Take Away

Parti

stand

....be

only

people who contribute to it