Nanotechnology: A universe in Construction
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Nanotechnology: A universe in Construction

Motif and Script
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Dear readers, the Construction Industry historically presents a number of challenges to the health and safety of workers and their workplaces. One of the examples is the construction of major buildings in the early twentieth century, when weren’t sought security conditions.

Look! In this photo, the workers are taking a break in a highly dangerous situation. The use of a steel beam for a nap shows that there was no concern with the social areas where workers could stay during their rest time.

The lack of equipment for collective and individual protection stood out in a time marked by the absence of safety measures in the workplace!
Fortunately, since these photos were taken, a lot has changed for the better. These advances have resulted from the mobilization of workers... 

... from the performance of governmental technical institutions, such as Fundacentro, from the supervisory bodies, from construction workers Union...

Mr. Adams, in your homebuilder, no worker wears a hard hat! There aren’t any available! Only the one you’re wearing!

The hard hats are in the laundry, you know?

With the passing of time and the raised awareness of employers themselves...

Now, my homebuilder no longer gets fined! Here, we have a system of risk management!

There are a number of measures and safety equipment that should be adopted in a working site. Collective protection equipment, such as guard rails and trays... 

... and personal protective equipment such as hard hats, safety belt, safety glasses and gloves.

With protective equipment and the program Conditions and Working Environment in the Construction Industry, PCMAT, work is safer! And if the hard hat goes with the uniform, you even look fashionable!

But even today, the Construction Industry still concentrates a large number of accidents. This reinforces the need for workers to participate in the Internal Commissions for Accident Prevention!

Workers in construction sites need to talk with their employers and seek better working conditions!
Back to the New Universe Carrier, where our heroes are enjoying their coffee... Mr. Anthony, what are you reading?

Man, an article about the struggle of workers in construction sites for health and safety in their workplace! Really good!

Mr. Anthony, what are you reading?

Wow, Mr. Anthony. You are really studious! I didn't know you were into building too!

Actually I got interested recently because of our next job, which is to deliver a lot of materials in construction sites.

That will be great, for sure! I'm already tired of just talking about nanotech, "nano this," "nano that."

Well, We'll deliver many materials. Pipes, wires, tiles... But a lot of nanocement too! And we'll talk a lot about nanotechnology in this story!

Okay, guys! The truck is already loaded! Time is up!

There we go... At least I'll learn what this so-called nanocement is.

As usual, she doesn't let us stay a minute longer! Humpf!
“Nanotech” is the study and manipulation of matter with at least one dimension sized from 1 to 100 nanometers for scientific and/or industrial purposes. And one nanometer equals one meter divided by one billion.

At the nano level, the properties of materials can change. Thus, what is stable at a higher reactive size can become reactive at the nanoscale. Insulating materials can become conductive. What is opaque becomes transparent and secure materials can become toxic!

We need to draw close attention to this unpredictability of materials at the nano scale. How to determine accurately whether a certain element is safe, at the nanoscale? Should’t we find out more about the risks of nanoparticles and nanomaterials to human health?
Because of that, there are several concerns about the industrial applications of nanotechnology.

Nano goods are being made available to consumers even though we have no information about their risks to health.

Also, those people manufacturing these products may be at risk if studies on nanotech danger are not carried out.

Not to mention the risks to the environment and the danger of contamination.

It’s always the same thing: Gabriel asks what nanotech is and you are so pessimistic!

And the worst part is that the writer always places me between them both... Come on, Ms. Sandra... The boy needs to have a critical view of new technologies!

But you need to bow down to the great possibilities offered by nanotech! Like this wonderful nanocement we are carrying!

Listen, according to the Union course on new technologies... Nanocement? This one I’ve never heard of!

Ms. Sandra: I also read a lot about it and know what nanocement is! You can leave this explanation to me, Mr. Driver!

Look, guys, cement is a thin and gray powder, that, when in touch with water, it forms a mass. As it dries, this mass becomes a hard and tough material. That’s why it’s used in buildings!
Cement is the main element used in the Construction Industry. It is a ceramic material and limestone is the main raw material used in its manufacture. In its composition, there may also be small amounts of clay and iron ore.

Nanocement has an important difference in relation to common cement: it contains carbon nanotubes!

Do you remember we talked about nanotubes in our first issue? They are cylindrical structures formed by carbon atoms. Their diameter ranges between 1 and 20 nanometers and their length can be up to 18,000 nanometers! Although they are up to 100,000 times thinner than a thread of human hair, nanotubes are extremely resistant!

Nanotubes are object of studies for medical use, conductive and semiconductive materials, computer chips and many new materials just like the nanocement in this story! This cement is much tougher due to nanotubes in its composition, which makes it rather advantageous as construction material!
You rocked, huh, Ms. Sandra!

I was also impressed...

Ah, I got tired of falling behind in our discussions! I researched on the internet, read several books, magazines... I did my homework!

Mr. Anthony... I'm afraid Sandra will hamper!

And now, Mr. Driver, what do you want to talk about?

Since you have teased us, ma'am, I will talk more about nanotechnology and the nanocement we are carrying!

You are such a know-it-all...

I don't know everything, Ms. Sandra... But I can talk about nanotechnology and nanocement! By the way, I bet that the truck will disappear again in the frame below!

Nanocement has many advantages compared to ordinary cement, as you can see here in this ad!

- Less porous!
- Resistance up to 3 times higher than the ordinary materials!
- Greater mechanical strength and bending resistance!
With greater bending resistance, nanocement can wear more than ordinary cement before breaking or cracking! In some cases, we can even dispense with the use of hardware in concrete!

Isn’t it amazing?

Besides, considering its greatly reduced porosity, nanocement can be used in underwater works!

Now, guys, let’s talk a little bit about theory. Is nanocement a nanomaterial?

For example: depending on the definition, we can call nanomaterial any particle, substance or material that has been engineered to have one or more dimensions in the nanoscale.

Following this definition, we could also say, that carbon nanotube is a nanomaterial. In this case, since it results from the combination of ordinary cement with nanotubes, nanocement can be considered a nanocomposite material.

See, the definition of “nanomaterial” can vary a great deal. Scientists, government agencies and research institutions haven’t come to an agreement on that yet.
But these theoretical issues are not the focus of our story! The most important thing is to know that nanocement is a material that results from the use of nanotechnology and, although it offers many advantages, it should be well studied before ending up in the market!

Beautiful explanation, Mr. Anthony... At least you were a little less pessimistic this time...

Well, Mr. Anthony! You just said that nanocement only has advantages!

Nanocement can revolutionize the construction industry. But I still think that caution is essential! For example, does nanocement offer any new risk to people's health?

Here comes the fear of new technologies again!

But he's right, Ms. Sandra! A new product needs to be tested before it hits the market!

And here's more: the workers who will handle these new materials need to be more alert! When we don't know the risks, we have to be cautious!

But what can workers do, Mr. Anthony?

They can turn to their Union, look for the Internal Commission for Accident Prevention of the company they work for, contact the governmental supervision bodies. They have many options!

Look! We've just arrived to the site where we have to deliver. Let's leave the Unionist talk for later!

Here we are... Hardly did we have time to listen to some folk music.

An important reminder, friends! This story shows drawings of nanoparticles, molecules and atoms. However, none of them is visible to the naked eye and can only be detected by high-resolution electron microscopes! These drawings are only representations, so that you may understand our explanations!
Some time later, at the construction site...

Ms. Sandra: Guys, as we did in our last delivery, we're going on a tour at our customers' workplace! These are Ernest and Vladimir! They work for the Spike Homebuilder!

Hello everyone, I'm Ernesto! I'm the foreman who coordinates the work on this site!

And I'm Vladimir! I work as a safety technician and I'll accompany you on your visit! Feel free to ask if you have questions!

Hello, friends!

I'm Sandra, the delivery supervisor of New Universe Carrier! This is Anthony, our driver! And that is Gabriel, who works as Delivery Assistant!

I see you're all wearing hard hats, earmuffs and boots!

These three items are "personal protective equipment", also known as PPE!

So let's start our visit! Wow, what a big building! It doesn't even fit into the page!

Hard hats help to protect the workers against possible injury from falling materials or impacts! The rubber boots are important if they have to go through flooded areas! And the earmuffs attenuate the noise, protecting them from hearing loss.

Oops!
Sills and guard rails where there is risk of falls.

Protection against electric shock.

Protective trays to prevent accidents caused by falling materials.

Well-built suspended scaffolds, with steel cables in good condition and well fixed.

The collective protection devices ensure safety to all workers at a working site and prevent accidents from occurring! Here are some examples:

See, guys? With these PPEs, we are perfectly safe!

In fact, Ms. Sandra, this is a common mistake by people who know little about Construction Industry and its security measures!

In fact, the PPEs are just complementary safety items!

The collective protection equipment, CPE, is even more important than the PPE!

Wow! How interesting! And what are the differences between PPEs and CPEs, guys?

I know the answer to that question... But I’ll leave it to our new friends!

Humpf! CPE, PPE... Even I get confused with this bunch of acronyms!

The collective protection devices ensure safety to all workers at a working site and prevent accidents from occurring! Here are some examples:
As its name suggests, the personal protective equipment protects each worker individually! PPEs provide protection when there is risk of injury during the execution of the work or prevent the worker from getting hurt when an accident occurs!

- **hard hat**
- **safety glasses**
- **for situations in which the worker is exposed to high noise levels**
- **various types of gloves**
- **welder mask**

Homebuilders are required to provide all protective equipment necessary for the safety of workers in their workplaces!

Workers, claim your right!

Security

After a long walk and a lot of sighseeing...

Now, I'm starving!

Guys, I love this policy of integration between employees of different companies. But who should we honor such a long ride to?

Long and thorough! You explained the construction security in every detail!

See... As a foreman and member of the Internal Commissions for Accident Prevention here at the Spike Homebuilder, I think the issue of safety in the workplace is very important!

And I think the same applies to me, since I'm a safety technician!

Besides, we got interested in two more things!

First, the load of nanocement you brought! We're always concerned with the new materials, their characteristics and their handling by workers!
We have already read the two other issues of the "Nanotechnology Comics" series and we realized that you understand all about the subject!

And we think we could talk about health, safety and nanocement! How about that?

Wow! Now I'm famous!

Guys! Why didn't you say that before? It's just what we're always talking about! We love Nanotechnology!

I do love nanotechnology. Tell me another one... anything a bit more modern than a jukebox will get you moaning...

Good! Look... We are very concerned with this nanocement thing!

From what we've researched, there aren't enough studies on the toxicity of nanoparticles and nanomaterials, are there? Maybe it's dangerous to use a product without precise data about its possible health risks to people!

You must be in Anthony's team! Risk, danger of contamination... See, you have collective protection equipments, personal protective equipments and a lot of security measures! What harm can a mere building material cause?

This is very serious, Ms. Sandra. Talk a little bit about silicosis, guys! This is a good example of the risks involving building materials!

That's it, Anthony! Think about the dust! It seems harmless, right? A sneeze here, a cough there... What is the danger?

There are many! And one of the most important is the silicosis!
Silicosis is a disease caused by silica and is characterized by inflammation and scarring in the form of nodular lesions in the lungs. In practice, this impairs the organ and breathing gets harder and harder. It is a chronic disease with no cure.

In its most common variant, silica is a natural compound present in quartz! Silica is present in many materials used in construction, such as sand, gravel and granite!

The problem is the dust eliminated by these materials in many common processes in construction: excavation, the cutting of stones, especially granite, sanding floors...

- Whenever possible, silica must be removed or replaced!
- Dry cutting processes must be replaced by wet ones.
- Local exhaust ventilation and physical barriers between workers and sources of dust must also be used!
- When collective protection is not possible, companies must provide respiratory protection, such as the semifacial respirator with a mechanical filter!

Okay! Dust is hazardous, silica is toxic and silicosis can be fatal! But what does that have to do with nanocement and nanotechnology?

Chill out, Ms. Sandra! No need to get angry! We know that nanocement promises wonders!

And we know that the list of revolutionary materials produced with the aid of nanotechnology is quite large!
It is possible to manufacture pipes and fittings from PVC nanocomposites! There are also frames with nanoceramic coating. . . And nanopaintings: dark paints that keep the cold walls and white paints that are able to absorb heat!

But even with many potential advantages, these new materials have a fundamental problem, which is common to all products involving nanotechnology...

I get it... but what is the relationship between silicosis, nanocement and the risks of nanotechnology?

This cement has an additional risk, which is related to carbon nanotubes!

That's it! It also reinforces the need for labeling nanoworked products already available in the market!

Humph! I bet the advantages of nanocement outweigh any possible risk!

There are some studies showing that some carbon nanotubes may be carcinogenic. These studies indicate that some types of nanotubes can cause breathing problems and lung cancer if inhaled!
Ms. Sandra, the ethics in the production process is not as simple as a mere calculation of costs and benefits!

Tolerating a single worker victim of contamination or occupational diseases is unacceptable!

We can not compromise people’s lives because of indiscretions in the production process. Ethics is related to precaution and to studies of the risks and impacts on the health and safety of workers and people in general. We’ve already had too many bad examples...

Let’s see the guys’ lunch...

Cool! I’m Starving!

What a cool room for lunch, Ernest!

Yeah, Anthony. A room like this in the Construction Industry is rare! Construction workers still have a lot to fight for...

I hate minced meat...

Enjoy your meal, Ms. Sandra!

Well... But it is important to have a cool room for meals and rest...

With workers well organized, we’ll get there!

See that building, man? I helped to raise. It was a time of distress. It was four rides. Two to go, two to get back.
REFERENCES


This comic book was born out of the Project “Impacts of nanotechnology upon the health of workers and the environment”, which began in 2007 at Fundacentro. This project is coordinated by Arline Sydneia Abel Arcuri and is developed in partnership with Renanosoma (Research Network in Nanotechnology, Society and Environment), IIEP (Exchange, Information, Studies and Research), Diesat (Inter-Union Department of Studies and Research on Health and Work Environments), Dieese (Inter-Union Department of Statistics and Socioeconomic Studies), Osasco Steelworkers Union, ABC Chemical Workers Union, the Social Observatory Institute, ENSP/Fiocruz (National School of Public Health/Oswaldo Cruz Foundation), SRTE/SP (Regional Superintendency of Labour and Employment - São Paulo/Brazil) and it has Leila Nadim Zidan as collaborator.

This text was developed by Antonio Gracias Vieira Filho, who prepared the motif and the script from discussions and proposals of the Project “Impacts of nanotechnology upon the health of workers and the environment” team.

The following technicians contributed to the comics: Luis Renato Balbão Andrade; Mey Rose de Mello Pereira Rink; Maria de Fátima Torres Faria Viegas; Maria Gricia de Lourdes Grossi; Valéria Ramos Soares Pinto, José Tarcisio P. Buschinelli and Arline Sydneia Abel Arcuri, from FUNDACENTRO; Ana Yara Paulino and Thomaz Ferreira Jensen, from DIEESE; Daniele Correia, Eduardo Bonfim da Silva, Gilberto Almazani, Maíra Andrade, Pérsio Dutra and Wilson Cesar Ribeiro Campo, from DIESAT; William Waissmann, from Fiocruz/Cesteh;
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Leila Nadim Zidan, as collaborator.

The motif also had the collaboration of the editorial board of Fundacentro and the following colleagues of the Engineering Program of Safety in Construction Industry (Proesic), developed by Fundacentro: Francisco de Almeida Gusmão; Jose Helio Lopes Batista and Maria Christina Felix.

The initial idea to use a transportation company for all comic books was developed by Alexandre Custodio Pinto and the characters of the carrier were created by João Antonio Garcia, the Jão Garcia.

Other texts on the subject can be found at:
http://nano.fundacentro.gov.br/
http://nano.iiep.org.br/node/
http://iiep.org.br/blog/nanotecnologia/
http://nanotecnologiadoavesso.org/
http://www.nanosaude.fiocruz.br/new/index.php
http://jusnano.blogspot.com.br/

Short glossary (dictionary of terms) of nanotechnology can be found at:
http://nano.iiep.org.br/sites/default/files/Glossario_nano.pdf
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