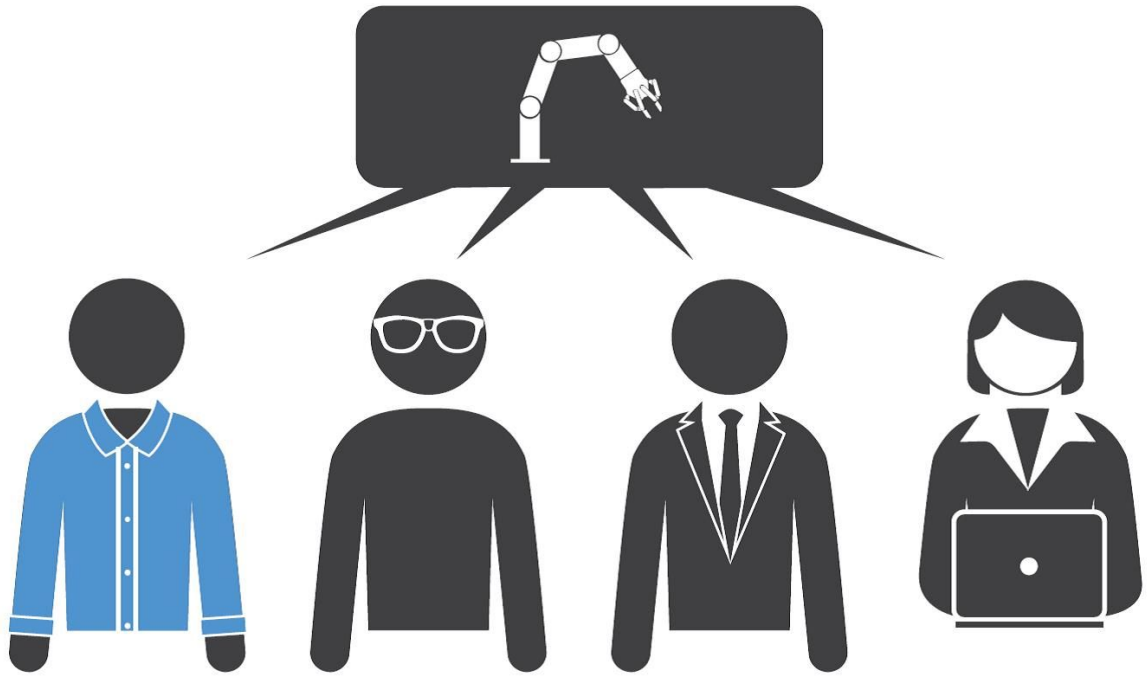
ROBOTIQ

ISO/TS 15066 Explained



The World's First Specifications of Safety

LEAN ROBOTICS

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Lean Robotics: Simplify Robot Cell Deployments

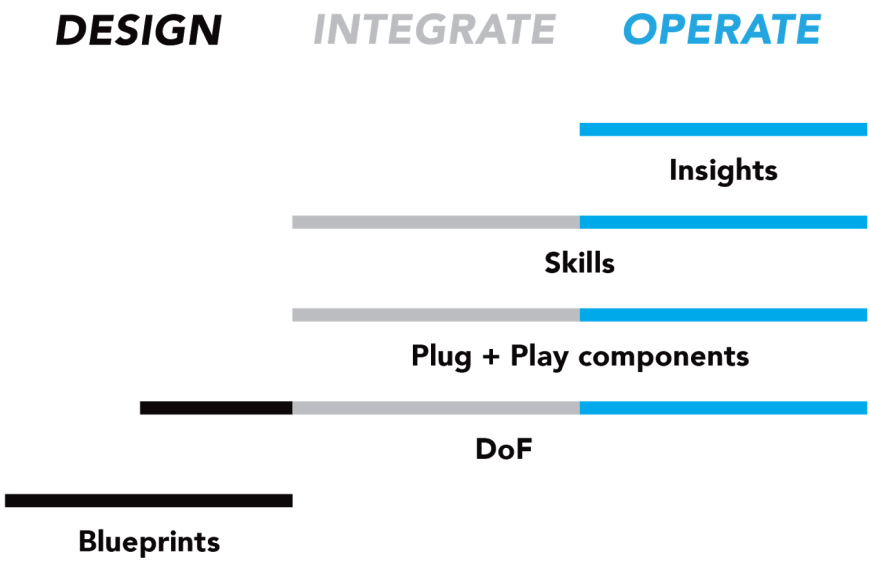
Whenever you ask if robots could work in your factory, the answer you receive is always a hesitant "It depends." It depends on your factory, your team, which robot you choose, what you want it to do... and a whole lot more.

If you're a first-time robot user, how can you get started? How do you get from your initial idea to a productive, working robot? And if you've already got a few robotic deployments under your belt, how can you scale up your robotics efforts throughout your factory—or across multiple factories?

The answers can be found in **lean robotics: a methodology for simplifying robotic cell deployments**.

Lean robotics is a systematic way to complete the robotic cell deployment cycle, from design to integration and operation. It will empower your team to deploy robots quicker and more efficiently than ever before.

Lean robotics divides robotic cell deployments into three phases: Design, Integrate and Operate.

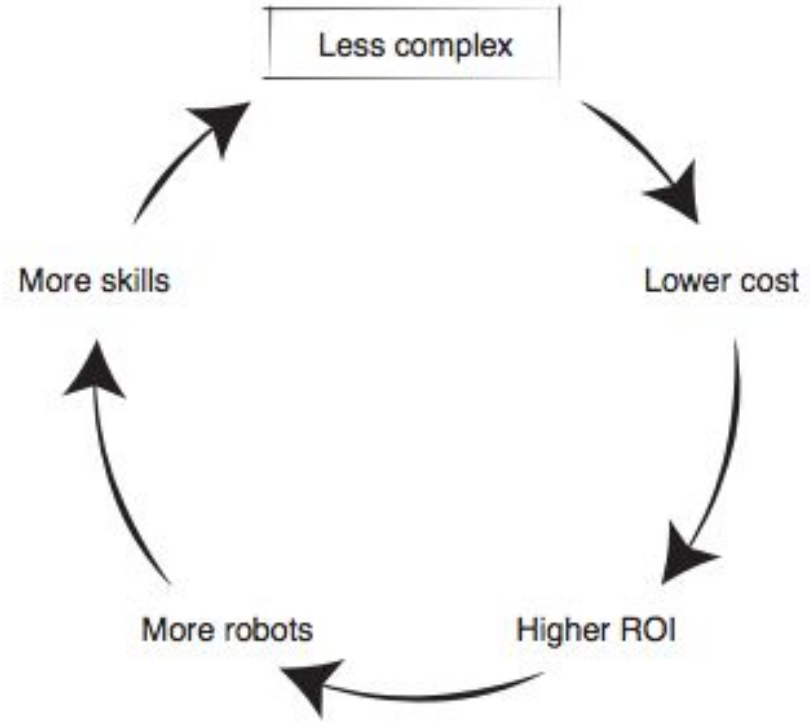


Robotiq's library of eBooks covers the different phases of the robot cell deployment to ensure that you have access to tips from robotics experts all along.

This Ebook Covers the Operate Phase

The operate phase represents the end goal of deployment: having a productive robotic cell that does its job properly on an ongoing basis.

When you're in the operate phase, your robotic cell is finally producing valuable parts for your company, and all your hard work will start to pay off. Since the operate phase is a continuous loop, there are many tips to optimize your robot cell and planning for the next one.



Introduction

ISO/TS 15066, the world's first specifications of safety requirements for collaborative robot applications, is here at last.

It's been a long journey for the ISO committee containing members from 24 participating countries, including representatives from leading collaborative robot manufacturers, who began work on ISO/TS 15066 back in 2010.

Designed to supplement the requirements and guidance on collaborative industrial robot operation provided in ISO 10218-1 and ISO 10218-2 (‘Safety Requirements for Industrial Robots’), ISO/TS 15066 specifies safety requirements for collaborative industrial robot systems and the work environment.

Specifically, ISO/TS 15066 provides comprehensive guidance for those conducting risk assessment of collaborative robot applications.

Crucial new information includes a chart developed by the University of Mainz, which provides a list of force and pressure levels to guide robot design. Additionally, for the first time, ISO/TS 15066 outlines maximum allowable power and speed limits for collaborative robots used in power and force limiting scenarios.

ISO/TS 15066 brings unprecedented clarity to collaborative robot system risk assessments. The document also deepens the level of observation that's required for a collaborative robot risk assessment, improving safety and encouraging safe, future innovation in the process.

As we shall see, the benefits of ISO/TS 15066 will extend from shop floor workers and production managers to application engineers and integrators.

To mark the release of ISO/TS 15066, Robotiq spoke with some of the experts on the ISO committee responsible for developing the technical specification. Leading figures in the world of robot safety, our sources have well over a century of robot safety expertise between them.

This eBook is intended as a companion guide to “How to conduct a risk assessment,” which provides detailed information on how to implement the guidelines contained in ISO/TS 15066.

With the help of ISO's experts, we hope to put ISO/TS 15066 in context, explain the difference between a standard and technical specifications, provide some real-world scenarios in which ISO/TS 15066 is relevant, and take a look at some of the benefits that ISO/TS 15066 is expected to bring to various stakeholders.

What's New in ISO/TS 15066?

In collaborative robotics, humans and robots can occupy an overlapping workspace. ISO/TS 15066 provides guidelines for the design and implementation of a collaborative workspace that controls risk.

One of the key ideas behind ISO/TS 15066 is that:

if contact between robots and humans is allowed,
and incidental contact does occur,
then that contact *shall not* result in pain or injury.

Toward that end, ISO/TS 15066 provides 'Pain Onset Level' data, Maximum Allowable Robot Power/Speed, design criteria, and a deeper explanation of collaboration techniques.

Crucially, for the first time, ISO/TS 15066 provides those performing risk assessments for collaborative robot applications with hard data and formulae to work with.

Pain Onset Level Data

Researchers at the University of Mainz, in Germany, conducted a pain onset study on behalf of the ISO committee. The study involved 100 subjects and was designed to establish force and pressure limits on 29 body areas.

As a result of the Mainz study, ISO/TS 15066 provides a list of maximum force and pressure levels for each part of the human body.

This data can be used to establish a set of force/pressure thresholds that the robot should not exceed, and is intended to guide robot design and integration.

Maximum Allowable Robot System Power/Speed

ISO/TS 15066 outlines recommended power and speed limits for collaborative robot systems intended for power and force limited operation. This section of the document provides the guidance required to determine the maximum allowable speed to set the robot at, such that the EOAT and part don't exceed the maximum for the robot system.

Design Criteria

ISO/TS 15066 describes the different design criteria that robot system and robot tool manufacturers should introduce into their designs. This section provides guidelines for manufacturers that had difficulty distinguishing between what was and what wasn't a collaborative robot system.

Collaboration Operation

Building on the information in ISO 10218, ISO/TS 15066 describes four main techniques for collaborative operation:

a) safety-rated monitored stop
b) hand-guiding
c) speed and separation monitoring
d) power and force limiting

Speed and separation monitoring receives particular focus. In such systems, a minimum protective distance between the robot system and the person is maintained to prevent contact.

When considering possible contact events between humans and robots, its important to keep in mind that that these can only take place in power and force limited applications. The other types of collaborative operation do not allow physical contact between the moving robot and their human coworkers. Consequently, such events do not need to be considered in risk assessments.

Who Needs to Read ISO/TS 15066?

ISO/TS 15066 is primarily aimed at robot suppliers, integrators, tooling manufacturers, production managers and application engineers. Shop floor workers will probably never need to read it.

A Note on Language

Key words to pay attention to when reading a standard or technical specification document are: “Shall”, “Should”, and “Can.”

The word “shall” is only used when a requirement exists and is being defined.

“Should” indicates a recommendation (also known as “informative guidance”), while “Can” is used as a statement of fact.

Whereas a requirement is normative and mandatory, a recommendation/informative guidance is voluntary.

Putting ISO/TS 15066 in Context

Where does ISO/TS 15066 fit into the world of ISO robotics standards and technical specifications?

ISO/TS 15066's Family Tree

ISO/TS 15066 builds on ISO 10218-1 and ISO 10218-2, which were published in 2011 and describe safety requirements for industrial robots.

Writing the sections on collaborative robotics for ISO 10218 was “almost like writing science fiction,” says Dave Smith, a robotics safety expert at Honda Canada Manufacturing, who served on the committees responsible for developing ISO 10218 and ISO/TS 15066.

“We were writing requirements for things that were coming, but we didn't know exactly what they would be. There were a lot of new products out there, particularly collaborative robots and power and force limited robots and we didn't know very much about those robots at that time,” says Smith.

Of course, the use of collaborative robotics has become much more widespread since ISO 10218 was released back in 2011. That growth is set to continue with the collaborative robotics sector expected to increase roughly tenfold between 2015 and 2020, reaching over US$1 billion from approximately US$95M in 2015, according to a 2015 study published by ABI Research.

Since 2011, a knowledge base around collaborative robot safety has been built, making it possible to create a set of technical specifications for collaborative robot applications.

“As collaborative robots became more prevalent, we needed to write these technical specifications. We needed to give more detail on ISO 10218's requirements, based on the experience we had all gathered since the first version came out,” explains Smith.

ISO/TS 15066 is expected to be added to ISO 10218 Part 1/2 where applicable, when the standard comes up for review in 2017.

When the Robotics Industry Association (RIA) first coined the term “collaborative robot” in 2003, they had very different robots in mind, says Jeff Fryman, a robot safety consultant, who served as Director of Standards Development at the RIA for 17 years.

“We were envisioning 'big, bad' six axis articulated robots. The concept of collaborative robot today is far different from our original vision. We did not envision the 'Foxconn' solution of a human-robot-human-robot working on the same line,” says Fryman. “ISO 10218-2 talks about the design of collaborative robot cells, but it doesn't have the detail. We hope to fill in that gap with ISO/TS 15066.”

Building on Standards

In essence, ISO/TS 15066 is designed to build on and supplement the limited requirements laid out in existing standards.

“ISO 10218 only describes the requirements in very general terms, whereas IS0/TS 15066 provides more guidance,” explains Lasse Kieffer, Global Compliance Officer at Universal Robots, who points out that ISO 10218 (Parts I and II) provides just a few pages of requirements for all four types of collaborative operation to which ISO/TS 15066 adds a wealth of new information.

ISO/TS 15066 answers questions that were left open by ISO 10218, particularly those around contact between human and robots, says Elena Dominguez, robot safety expert at Pilz.

“ISO 10218 listed some general safety requirements for collaborative robots, but it was difficult to know whether you were satisfying those requirements.”

For power and force limited operation, ISO 10218 requires that contact between human and robot be such that it “should not create an injury," without defining how much force is too much force, how those forces can be measured and what limits should be set.

“ISO 10218 said that you could implement a collaborative robot, but it did not provide enough engineering guidance to know when you were there. ISO/TS 15066 allows an engineer to be more precise in their design and then to legitimately claim that they have achieved the intent of ISO 10218.”

Standards vs. Technical Specifications

Note that ISO/TS 15066 is not a standard, it's a technical specification.

The difference is important. The ISO sometimes develops technical specifications prior to releasing final, formal standards.

This is a recognition of the fact that the state of the art is “in flux” and will be evolving over time, explains Björn Matthias, Senior Principal Scientist – Robotic Automation, at ABB.

“The technical specifications format is intended to record a snap shot of what the state of the art is here right now, and to make that available to the community to work with, knowing full well that there will be additions and changes in the future,” says Matthias.

Technical specifications like ISO/TS 15066 are intended to mature the material, says Fryman.

“Technical specifications are reserved for information that is ultimately intended to appear in an ISO standard, but is considered not fully developed and needs to be tested. A technical specification is what we really think the final standard will be, but you need to give us feedback.”

Universal Robots’ Kieffer sees technical specifications as documents that provide guidance for the industry to test.

“It's a way of trying out the requirements. If we were extremely certain about the content, then we could have made this a standard. But we chose not to,” says Kieffer.

Meanwhile, Roberta Nelson Shea, Convenor of the ISO Industrial Robot Safety Working Group (ISO/TC 299/WG 3) and global marketing manager for Rockwell Automation views a technical specification document as one that is “not quite ready” to lay out formal requirements.

“A technical specification document tells you that the technology needs a little more gel time and that the industry needs some experience with it in order to be able to make very definitive statements. At this point in time for collaborative robot applications, we are still learning.”

You may well be asking yourself “If ISO/TS 15066 isn't a full ISO standard yet, why do I need to pay attention to it?”

Firstly, it's never too early to get started on safety. Not only does ISO/TS 15066 build on the requirements in ISO 10218-1 and 10218-2, it constitutes best practice for the industry today.

Secondly, if you want to be able to legitimately claim that you have properly safeguarded your collaborative robot system and provided a safe work environment for workers, ISO/TS 15066 is the document to read.

“TS 15066 provides you with guidance so that you can say that you have properly safeguarded the robot system," explains Pilz's Dominguez. “You can say 'I have a safe system' if you follow the technical specifications. You can also confidently say 'I am implementing the robot system according to the best practice as industry sees it today.'"

Widespread Impact and Benefits

We asked ISO experts about the impact and benefits of ISO/TS 15066 and it turns out that there are impacts on and benefits for the robotics industry, end-user companies, integrators, production managers/application engineers, and factory workers.

Let's take a quick look at each group in turn.

Robotics Industry

Collaborative robotics are a “game-changer” says Rockwell's Roberta Nelson Shea and ISO/TS 15066 is an important part of this burgeoning segment of the robotics market.

“It has opened peoples’ eyes to the notion that they don't have to completely stop and remove power from equipment in order to say it's safe for people to have some degree of interaction with it. For full

automation, the game changer is that you can keep power on, but can safely control the situation, so that a person is not hurt."

The branch of the robotics industry that is using collaborative robotics, will have "great use" for ISO/TS 15066 because it contains a lot more description of what it means to have a collaborative application than previous documents, says ABB's Matthias. "There are some basic pointers in the common standards for industrial robots and industrial robot systems, but it's not sufficient to put in place a viable collaborative application, so this document fills that gap."

Factories Using Collaborative Robot Applications

Factory floor space has a higher value assigned to it than any equipment you could fill it with, says Roberta Nelson Shea, and collaborative robotics solutions take up considerably less space than traditional industrial robots.

"The costs of heating, plumbing, and maintaining that space, are higher than the value of the equipment you put in. So if we can decrease the floor space that's required, by safely implementing collaborative robotics we have the possibility of decreasing the cost to a user."

Not having to turn off the power to a robot in order to, for example, perform loading and unloading tasks, decreases the wear and tear on parts and components.

"Components such as contactors are expensive and they only have a certain number of actuations that they can withstand before they have to be replaced," says Shea.

"So, if we can safely control hazards, risks, and the like, without having to remove power, we prolong the life of these components. This also decreases the exposure of maintenance staff which in turn lowers exposure to hazards, which means less likelihood of any injury or accident."

The concept of human-robot system collaboration is designed to improve productivity and maintain worker safety, adds Fryman.

"This concept has been out there for several years now, little understood and loudly imitated with maybe very inappropriate solutions. Finally, we have a document that we can point to that says 'These are the limits that you can apply to your design'."

Integrators

ISO/TS 15066 eliminates a lot of guesswork by providing the information integrators need when performing a risk assessment on collaborative robot applications.

“It provides a lot of guidance that the integrator needs to think of when he's installing the robot,” says Universal Robots’ Kieffer. “If you are an integrator that is quite new in the field and you don't have that much experience, then ISO/TS 15066 is very good because it provides the input you need to do a good risk assessment.”

“The purpose of 15066 is to make the job of the integrator easier and if there is anything in it that they cannot use, then let us know about that,” adds Kieffer, who expects ISO/TS 15066 to be “a big help” to Universal Robot integrators.

ISO/TS 15066 will help Honda Canada's integrators better understand their requirements and obligations, says Smith.

“Now there are some good hard numbers that integrators can go by to make sure that we don't injure somebody. When people understand the specific guidance of the technical specifications, it's also going to be easier for us to show compliance to the ISO 10218 standard.”

Under Ontario law, there is a requirement for a pre-start health and safety review of robotics systems.

“We need an independent engineer to come in and to make sure that we've followed all the standards. ISO/TS 15066 is going to give them more information on how to apply those requirements properly,” adds Smith.

Production Managers and Automation Engineers

Production managers need to know that their people are working according to the state of the art, says ABB's Matthias.

“The production manager needs to care about ISO/TS 15066 because it will give him the confidence that he is using the present state of the art, best possible information available today.”

Automation engineers understand the application and its requirements, says Matthias. They also understand a bit about robotics and its capabilities and a bit about collaboration. But they may not have huge levels of experience in realizing collaborative applications.

“When the automation engineer builds collaborative applications, he will have the objective of using the best possible information. This objective is fulfilled by ISO/TS 15066 in the best possible way. The

benefit of ISO/TS 15066 for automation engineers is the specific guidance it provides on what to look out for when putting together collaborative applications."

Confidence is a theme running through our expert's responses to this question. Well executed risk assessments inspire confidence. Adoption of best practices inspire confidence. Providing a safe environment for workers inspires confidence.

But the benefits of ISO/TS 15066 go beyond generating feelings of confidence.

"It also mitigates risk if you follow the document and you are more certain that you do things right," says Kieffer. "There can also be benefits from stating that products comply with a safety document. Sometimes this has a commercial value or a value in terms of allowing you to show that you performed your risk assessment correctly."

ISO/TS 15066 provides production engineers with the information they need to understand all the capabilities and possibilities of collaborative robotics, says Smith.

"I think the more they understand about collaborative robots, the better. They understand automation and manufacturing, so once they understand these new tools and how to implement them, and all the different requirements, they can come up with a lot of different technical solutions."

Factory Floor Workers

Knowing that the specifications laid out in ISO/TS 15066 have been followed will generate confidence among factory workers, says ABB's Matthias.

"The factory worker can be confident that his colleagues responsible for creating the application (the production manager and the application engineer) have worked according to the best present knowledge of the state of the art. This should give him a degree of confidence in his workplace."

Fryman agrees.

"As a user, to know that there is a set of technical specifications that the integrator is designing to should give workers some comfort in the knowledge that someone is not just winging it and that the system has been designed within acceptable parameters," says Fryman.

"This should make factory workers more comfortable with the concept. The worker comes to work in the morning healthy, he's entitled to go home at night safely."

Factory floor workers will benefit from having collaborative applications properly defined with proper procedures, risk assessments, and warnings, says Pilz's Dominguez.

“Now there's guidance on how to permit the interaction with the person. So, if we have a job where someone has to work constantly with the robot and will occasionally be contacted --because humans are imprecise and they'll get in the way-- the standard gives guidance on how to adjust the parameters so that that periodic contact is not going to lead to injuries. It's going to provide them with a safer environment to work in next to these robots.”

Real World Scenarios

Scenario 1: Product Assembly, Power and Force Limited

Picture a sequential product assembly process that includes both humans and power and force limited collaborative robots, suggests ABB's Matthias.

Robots perform the simple steps where repeatability generates quality while human workers perform more complicated steps, particularly those that require highly dexterous manipulation.

When performing a risk assessment in a scenario like this, it's important to identify the interfaces between the human and robot workers.

“As it is being manufactured, the product passes over these interfaces. You have handover and you have assembly manipulation and these things are happening right next to human workers,” explains Matthias.

In this sample scenario, possible hazards occur at the interfaces; the area where workers reach into the robot's workspace for example. A different set of hazards arise when human workers accidentally bump into the robot.

“Mitigation of these hazards --and the way you can make the system harmless-- is by designing the robot's control system so that it enforces the maximum limits on mechanical loading of certain parts of the human body.”

If you follow the ISO/TS 15066 guidelines for power and force limited applications which specify maximum pressures and maximum forces, you will be able to realize this type of sequential assembly landscape in a safe way –and all without having to separate the robot off behind fixed guarding.

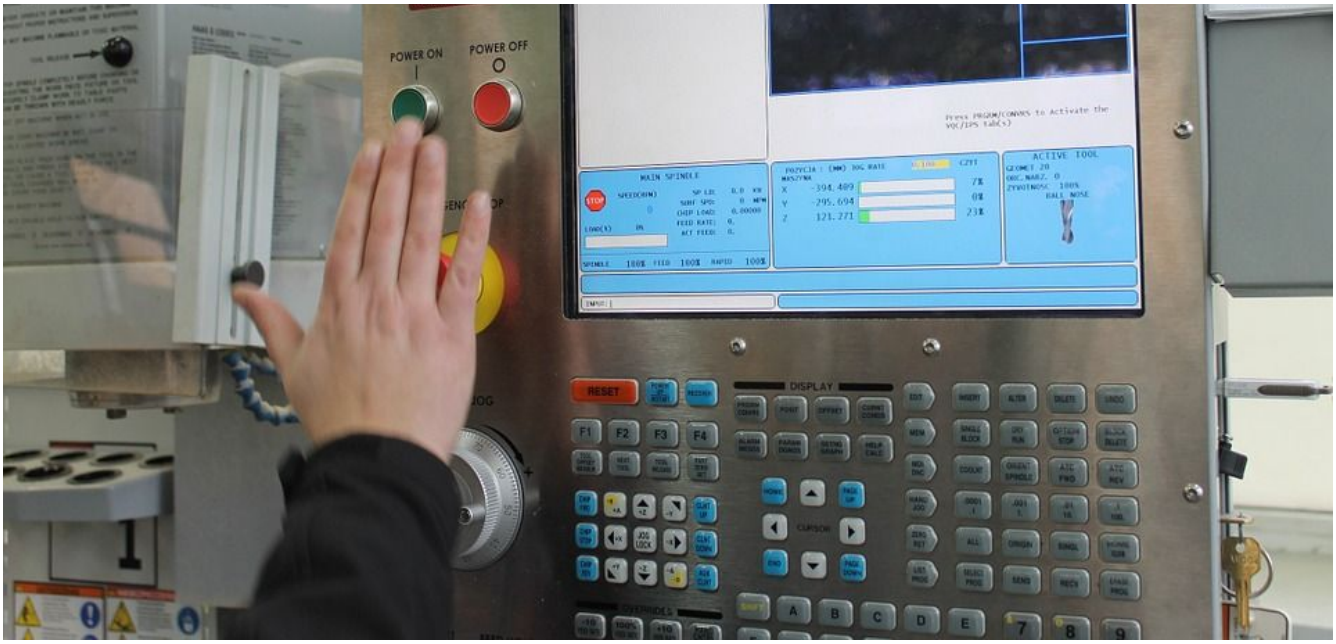
“That is the aspect which is very new in ISO/TS 15066.” adds Matthias. “This is also the aspect which addresses the need for higher flexibility and less use of floor space that today's manufacturers are looking for.”

Scenario 2: Packaging, Power and Force Limited

Picture a packaging application in which a robot picks parts from one bin, manipulates them, and packages them into another bin. In this scenario, the points of contact with human workers are limited to occasionally supplying one bin and occasionally removing the other. (Such a system might be set up by a company that wants to run a robot without a fence to test the technology, but that doesn't want a high frequency of exposure.)

“This scenario makes the overlap in time and space rather modest,” says Matthias. “Nevertheless, the same criteria apply, and if you have incidental contact, which can happen, then the pressure and force limit specifications provided in ISO/TS 15066 can help you to dimension this sort of application.”

Scenario 3: Manufacturing, Safety Rated Monitored Stop



Honda has used collaborative robots for safety rated monitored stop applications –applications that enable robots to be loaded by human workers without the servo needing to be shut off. (Note: Safety rated monitored stop applications can also be performed by regular, non-collaborative industrial robots.)

When they started implementing the system, says Honda's Smith, the first thing they showed their associates was the then draft of ISO/TS 15066.

“We showed them in the standard why these robots are different, because they are used to the robot being locked down during loading. We used ISO/TS 15066 to show our associates the requirements and all the different features that are keeping them safe. We will do the same with power and force limited applications,” says Smith.

Implementation of ISO/TS 15066 allows application engineers, integrators, and production managers to demonstrate the safety of the system to end-users, improving factory floor worker's confidence in the process.

Tips & Insights

We asked our experts to share their tips and insights for companies and individuals that are looking to perform a collaborative robot system safety assessment for the first time.

Do your Background Research

If you have never carried out a risk assessment before, begin with some basic background research, says Universal Robot's Kieffer.

“I would use ISO 12100 as a base document. At least look through it to get some basic ideas about how to perform a risk assessment. Then I would use the ISO 10218-2 standard and, finally, I would use ISO/TS 15066 to do a comprehensive and reasonable risk assessment,” advises Kieffer.

Seek advice from the experts
“My personal recommendation would be to seek advice from someone that has some degree of experience in this area,” says ABB'S Matthias.

“A number of companies have been involved in discussion in bringing forth ISO/TS 15066. And these are companies that have been front-runners in developing technologies suitable for such applications. If I were a customer wanting to realize an application in this way, I would seek their advice.”

Because collaborative applications are “not routine” even systems integrators that are expert at commissioning conventional robot systems might not have the necessary level of experience just yet to put in collaborative applications.

“Doubtless many of them will be seeking to do so and over time I think the number of possible partners that you could turn to will be increasing.”

Talk with Stakeholders

The first step in every risk assessment is getting the stakeholders together and talking about safety, says Honda Canada's Smith. It turns out that this first step is also one of the “biggest benefits” of performing a risk assessment.

“A lot of times people think risk assessment is a bunch of different, difficult steps you have to go through,” says Smith. “But really, it's just a bunch of people getting together to ask 'What do we want to do? What are the hazards going to be with that? What controls do we need to put in place to do that?' The risk assessment, the formal side of it, is about documenting those conversations and having a method to go through it.”

Long before a robot system is purchased, the automation engineer, the workers, and (particularly in the case of small companies) the owner need to talk with each other to understand what some of the risks might be, advises Smith.

“It's all about getting those stakeholders together and talking about it at the right time --before you buy the robot and before you try to implement the application. The risk assessment has to be done at the design stage or at the concept stage to be effective.”

Pilz's robot safety expert Dominguez, agrees.

“Seek support. Talk to third-party groups and integrators. Visit users who are using collaborative robot systems even if they're in a different industry. See what they did. Ask 'What did you learn?' and 'What mistakes did you make?',” says Dominguez, who recommends the RIA's annual safety conference as an excellent place “to go learn some basics and to network.”

Take an Application-Centered Approach

One of the most common misunderstandings around power and force limited collaborative robot systems is that some people assume that they can “tear down all the fences and everything is wonderful,” says Roberta Nelson Shea. This is a false assumption.

“The big thing that people have to be reminded of is that it's not about the robot, it's all about the application. I might have a power and force limited robot that can only exert x force and would not hurt

a person, but if that robot system is packing knives, it's not a suitable candidate for a collaborative application.”

Honda's Smith agrees about the importance of taking an application-centered approach when performing a risk assessment.

“It's about first understanding what your application is going to be and whether it is suitable before you even buy the robot. It's all going to come down to the application. You're going to need an experienced integrator or somebody who understands what you're trying to do and all the hazards associated with the application,” says Smith.

“You have to realize that even if it's a small, power and force limited robot with a low payload, that doesn't mean that it's risk-free. You have to understand what the application’s risks are going to be.”

“Don't be afraid, but also be careful. And understand that there are going to be more and more of these robot systems around. Make sure that your people understand what they are through ISO/TS 15066.”

Avoid Common Pitfalls

The two most common mistakes made during robotics-related risk assessments are oversimplifying and over-complicating the process, says Dominguez.

“I've seen risk assessments where they try to outline in detail every single piece of the application without simplifying and grouping and the analysis becomes so burdensome that you can't picture the basic requirements,” says Dominguez.

By the same token, risk assessments sometimes err on the side of oversimplifying the process.

“I've seen cases where a very simple approach has been taken, resulting in very brief risk assessments that don't address critical tasks and exposures,” says Dominguez.

“Sometimes you need more than that. An over-simplified risk assessment might miss those findings, might miss some hazardous situations that might occur, such as somebody putting themselves in a vulnerable position when unloading a reject bin based on where the bin is located.”

Adjust to Scale

Companies thinking about implementing collaborative robot solutions need to decide the degree to which they build up in-house expertise, says Dominguez.

Companies considering small collaborative robot solutions (1-2 robots) should get an experienced integrator to perform the risk assessment.

Meanwhile, big factories planning major installations of 10 or 20 collaborative robot systems should “empower people to learn.”

“Get some help in the beginning, but educate your people enough to do it on their own. If you do this, you'll be able to fine tune your applications better, because you'll have better control.”

Conclusion

While not normative in the way that ISO standards are, ISO/TS 15066 describes the state-of-the-art in collaborative robot safety.

Whether you are an integrator, a production manager, or an application engineer, the new technical specifications provide essential, data-driven information and guidance needed to evaluate and control risks, and support a risk assessment for collaborative robot systems and applications.

So, if you're wondering “When is a good time to get started with collaborative robot safety risk assessment?,” the answer is “Now.” The hard data and formulas in ISO/TS 15066 enable new levels of detail in cobot risk assessments. It also provides the data-driven safety guidance needed to evaluate and control risks.

For power and force limited operation, the document provides specific, objective data that can be used to create precise contact situation descriptions for your collaborative robot application. For speed and separation monitoring collaborative applications, ISO/TS 15066 describes the effects to consider when designing the robot system motion planning algorithm.

It also works very well as inspiration for risk assessments as it provides a good way for people to check whether they have forgotten to consider a potential hazard.

In a broader sense, ISO/TS 15066 is likely to inspire further advancements of protective device technology, better sensors, improved motion control and other innovations.

Finally, remember that ISO/TS 15066 is a work in progress. The ISO committee would love to receive feedback from those that have used the document. Please send your comments to: 15066@robotiq.com.

A Note of Gratitude to our Contributors

In the course of writing this ebook, we had a lot of help from experts on the subject matter: members from the ISO Committee who wrote ISO/TS 15066. We'd like to thank them for giving their time and expertise to ensure this ebook is accurate and helpful.

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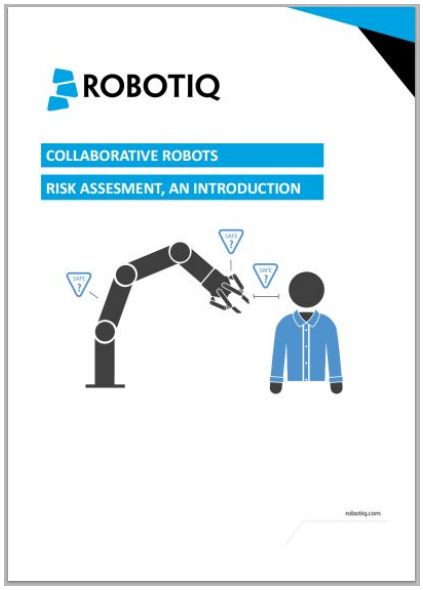
What's Next?

Now that you understand ISO/TS 15066 a little better, are you ready to move forward with collaborative robot safety? Here are some documents that will help.



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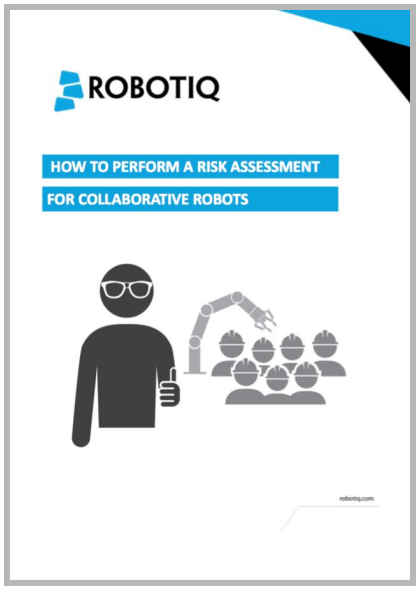
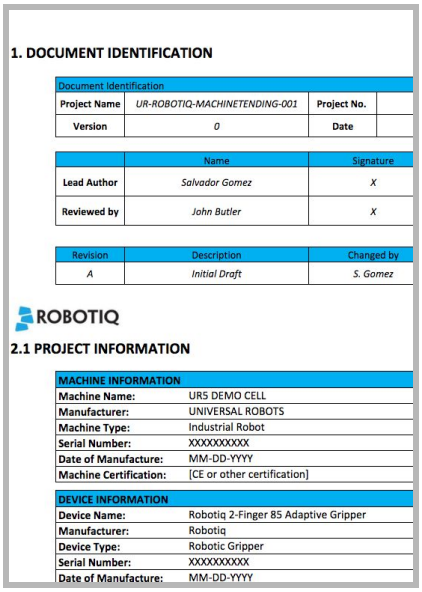


[How to Perform a Risk Assessment for Collaborative Robots]



1. DOCUMENT IDENTIFICATION

Document Identification			
Project Name	UR-ROBOTIQ-MACHINETENDING-001	Project No.	
Version	0	Date	

	Name	Signature
Lead Author	Salvador Gomez	X
Reviewed by	John Butler	X

Revision	Description	Changed by
A	Initial Draft	S. Gomez

ROBOTIQ

2.1 PROJECT INFORMATION

MACHINE INFORMATION	
Machine Name:	UR5 DEMO CELL
Manufacturer:	UNIVERSAL ROBOTS
Machine Type:	Industrial Robot
Serial Number:	XXXXXXXXX
Date of Manufacture:	MM-DD-YYYY
Machine Certification:	[CE or other certification]

DEVICE INFORMATION	
Device Name:	Robotiq 2-Finger 85 Adaptive Gripper
Manufacturer:	Robotiq
Device Type:	Robotic Gripper
Serial Number:	XXXXXXXXX
Date of Manufacture:	MM-DD-YYYY

[Risk Assessment Template]

About Robotiq

Robotiq exists to free human hands from tedious jobs. Our fast-growing company designs and manufactures advanced robot grippers and a force torque sensor. Robotiq is based in Quebec City, Canada. We work with a global network of highly capable local partners to solve flexible automation challenges in more than 30 countries.

Let's Keep in Touch

For any questions concerning robotic and automated handling or if you want to learn more about the

advantages of using flexible electric handling tools, contact us.

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