Men of action and international cooperation (f.l.t.r.): Bob McCurrach (AIA), Christoph Zierl (MVTec), Tsuneo Sakuma (JIIA, Kirin Techno System), Mike Miethig (Teledyne Dalsa), Eric Gross (National Instruments), Chris Beynon (Active Silicon), Sadafumi Torii (JIIA, Hamamatsu Photonics), Sachio Kiura (JIIA, Symco), George Chamberlain (Pleora), Jochem Herrmann (EMVA, Adimec), Eric Carey (Teledyne Dalsa) and Thomas Luebkemeier (EMVA)

Standards Open up New Markets

International Cooperation Makes for Efficient Standard Setting: GenICam, GigE Vision, USB3 Vision, CoaXPress, Camera Link HS

Under the umbrella of the major machine vision standards associations, sometimes referred to as the G3, regular technical meetings take place at which numerous engineers put their heart and soul, as well as their valuable expertise, into advancing industrial standards in the field of Machine Vision. This crucial work makes implementation of camera solutions easier for manufacturers, integrators and end-users and it helps to reduce 'time-to-market'. A further consequence of this international cooperation is that it opens up new markets. inspect was allowed to listen in at the meetings and to talk to the experts.

This time the International Standards Meeting took place in a particularly charming, historical setting: the late-medieval Ballenhaus in the centre of the romantic old German town of Schongau. Members of the three international organizations AIA, JIIA (Japan Industrial Imaging Association) and the EMVA (European Machine Vision Association), meet two to four times a year, always at a different location around the globe, to advance the standardization of industrial and non-industrial image processing. The member companies take it in turns to host the meetings.
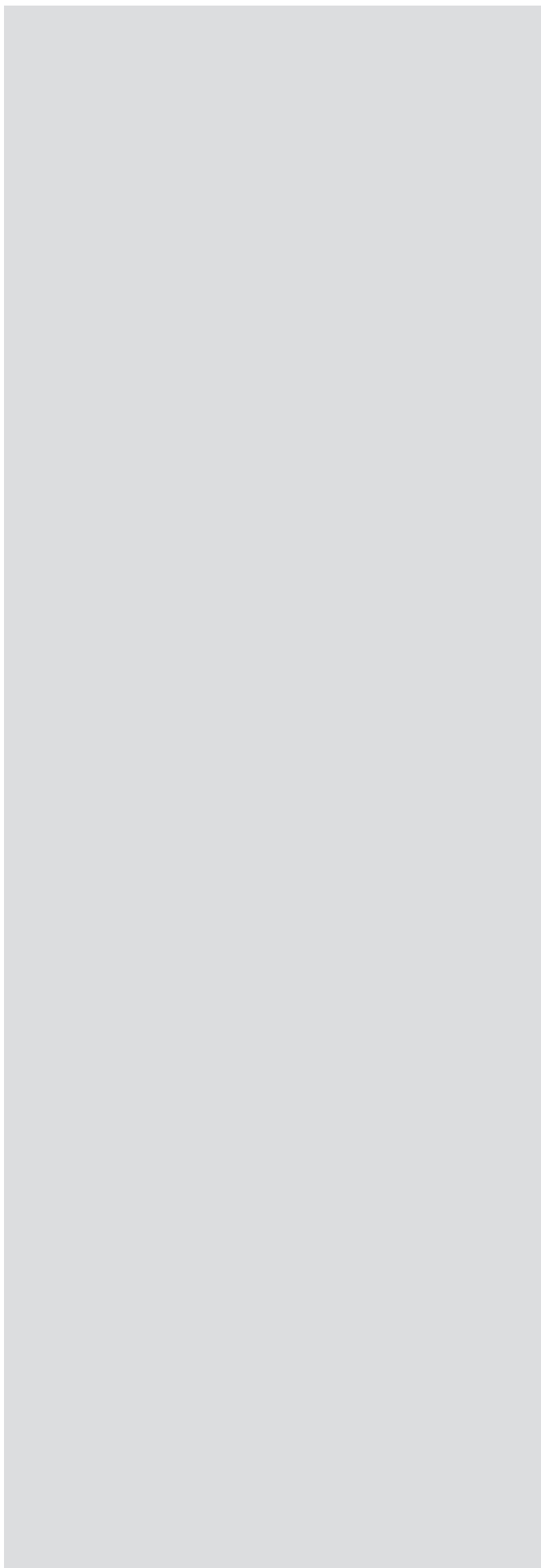
George Chamberlain: "Standards enable manufacturers to save system costs and to accelerate the 'time-to-market' of their products."

Jochem Herrmann, George Chamberlain, Bob McCurrach (f.l.t.r.): "These standards live a long time, and that is why the effects extend even longer."

Every Standard Has Its Niche

The thicket of interface standards will be thinned out a bit. The standard experts expect, at least, that the use of the traditional Camera Link interface will decline over the next few years. And we can expect Firewire to be increasingly replaced by USB3 Vision. GigE Vision, USB3 Vision, CoaXPress and Camera Link HS complement each other very well and each one will find its own niche. But, ultimately, it will be the market and the users that will decide.

USB3 Vision Is Pushing onto the Market

The young communication interface standard USB3 Vision, Release 1.0, was published in January 2013. This Vision standard guarantees software compatibility as well as flexibility in the choice of camera. "We are reaching a status of maturity and can see that a large number of products are pushing onto the market. We expect it to be adopted by the market very quickly. USB3 Vision can offer a lot of advantages in comparison to Firewire. The pure physical layer alone is no reason to prefer Firewire. USB 3 Vision will be used in situations which require broad bandwidth together with low-cost cameras. USB3 Vision cameras are easy to install, Plug&Play, with only one inexpensive cable. In circumstances in which it is a question of capturing images and no additional I/Os are needed, USB3 Vision solutions are well suited. If longer cable lengths are required it is hardly any problem to transfer quickly to GigE Vision owing to their very similar specifications and consistent use of GenICam. GigE Vision and USB3 Vision complement each other very well and will co-exist happily," says Eric Gross, Senior Vision Software Engineer at National Instruments and Technical Head of the USB3 Vision group.

10 GigE Vision, Still Only Modest Enthusiasm

"Since the first release in 2006, the market share of GigE Vision cameras has grown steadily and, according to AIA's "2013 Machine Vision Camera Study", now accounts for 50% of cameras now sold worldwide. Yet the acceptance of its faster speed, 10 Gigabit/sec., has developed extremely slowly. There are a few products on the market, but not many, because the costs are still high. Unfortunately, as well as being fairly power-hungry, 10 GigE Vision also needs a larger amount of space than its one Gigabit counterpart. At present the design of the 10 GigE Vision interface does not lend itself to miniaturization which would make it suitable for installation in very small cameras. As 10 GigE becomes more commonplace, power consumption and space requirements will continue to drop and

Mike Miethig: "It will be the market that decides how well Camera Link HS is accepted as a standard."

Christoph Zierl: "Cameras will become ever more complex and will have more functions."

Eric Gross: "Camera manufacturers can now differentiate themselves from their competitors much better – and can penetrate into very specialized markets."

there will gradually be an increased demand," according to Eric Carey, Director of R&D at Teledyne Dalsa.

CoaXPress Goes for Speed

CoaXPress has been in existence for about two-and-a-half years and is conceived for high-end cameras. "In February 2013, Version 1.1 was published and it accommodated the high-speed uplink and new connector options. Frame grabber and camera manufacturers are now in the process of implementing Version 1.1 of the communication standard. We are currently investigating what we should add to it in Release 1.2 or 2.0. The key factor is speed. We want to ensure that in future the fastest cameras on the market will continue to be able to operate with CoaXPress and, by evaluating feedback from users, we intend to achieve this. As part of this we are planning to support 10 Gigabit and 12.5 Gigabit cable speeds, and we are also discussing whether the standard should be extended to enable it to support multiple frame grabbers installed in one application for operation with very fast cameras. But the whole multi-frame-grabber system should also be very easy for a user to deal with using GenICam, too, and that means we still have a lot of work to do," reports Chris Beynon, Chief Technology Officer at Active Silicon and Technical Head of the CoaXPress standard.

Camera Link HS with 10 Gigabit in the Starting Blocks

Camera Link HS (CLHS) is a communication interface between cameras and frame grabber and is directed at more or less the same field of application as CoaXPress. "Both standards were developed independently of each other. Teledyne Dalsa developed HS-Link, a proprietary Dalsa protocol needed

for our high-end line scan cameras. When we suggested developing a standard on this basis, we found out about the attempts to standardize CoaXPress. Dalsa needed the trigger capability and reliability of the HSLINK/CLHS protocol for cameras with 200 kHz line frequency which CoaXPress didn't offer. Also Camera Link HS not only provides a checksum, but a re-send mechanism which is integrated in the hardware, i.e. implemented in FPGA, and thus does not need any external memory in the camera. Camera Link HS is able to spread the data from one source to a number of frame grabbers operating in parallel and to synchronize them. To achieve this, a lot of firms worked together to design an IP core, available from the AIA, which permits customers to develop their own cameras and frame grabbers. We considered these capabilities to be very important for our customers. Camera Link HS is designed to use proven off-the-shelf components leveraged from the telecom industry such as 10 GigE hardware. We add a protocol which fulfills the specific requirements of Machine Vision. CLHS Revision 1.0 is 10 Gigabit-approved and CLHS will continue to leverage the advances of telecom technology for Machine Vision. We want to ensure that Camera Link HS will be available for at least 20 years. Although there are hardly any products on the market at the moment, except for a 4.8 Gbyte/sec camera from PCO with an associated Dual 10 Gbps fiber-optic frame grabber from SISO and Teledyne Dalsa is currently developing a camera/frame grabber using the 2.1 Gbyte/sec. copper-cable connection, it will be the market that decides how well Camera Link HS is accepted as a standard," says Mike Miethig, Technical Manager for Digital Imaging at Teledyne Dalsa.

"Although this time, as a firm with 10 employees, we are the smallest host company, we have organized the biggest meeting so far with 73 participants and more than 30 companies," jokes Werner Feith, CEO of Sensor to Image in Schongau.

G3 came into existence back in 2009 to jointly promote vision standards, to make their development economical and to achieve maximum dissemination and application of them", explains Werner Feith. "With the Future Standards Forum, the latest initiative of G3, we want to plan ahead and avoid a situation in the future in which we have competing standards," agrees Jochem Herrmann, the EMVA's Director responsible for Standards. "But it is also important that sensible standards with regard to quality and quantity should be developed," adds Werner Feith.

G3 Puts Its Faith in Synergies

The members of the G3 are currently focusing their attention on different standards: the software interface standard GenICam (Generic Interface for Cameras) and the EMVA 1288 Standard for the characterization of digital camera systems are under the supervision of the EMVA. The AIA is mainly responsible for communication interfaces such as Camera Link (CL), Camera Link HS (CLHS), Gigabit Ethernet Vision (GigE Vision) and USB3 Vision (U3V). The JIIA is in charge of CoaXPress (CXP) as well as an optical standard and a lighting standard. "Until quite recently," explains Jochem Herrmann, "Vision standards were initiated by relatively small groups. Today a lot more companies are involved; we are like a big family and we really cooperate with each other, which means that, across the organizations, we make use of each other's technical solutions, knowledge and experience. Establishing standards is a very cost-intensive activity and G3 ensures that we work efficiently and effectively and we make real progress."

The G3 has confidence in the synergy effects because Vision standards are very important worldwide. They make it a great deal easier for users, integrators or OEMs to incorporate cameras or frame grabbers in their applications and to reduce costs related to hardware and software. Among other things, the aim of the G3 is also to update Vision standards constantly, to develop them further and to achieve worldwide deployment by explaining the sense and the benefits of having standards in image processing. "Indeed, the G3 will grow even more, there will be G4, G5 or G6 and cooperation with countries such as China, Korea, India and in South America for example, Brazil," says Sachio Kiura, Chairman of JIIA. Negotiations are already underway with Korea and China. "Worldwide co-operation on the subject of standards has advantages not only for the users but also for our members. It gives

Eric Carey: "In the field of intelligent traffic-management systems, mainly analogue cameras were dominant, but that has now changed because of the GigE Vision interface which permits long cable lengths and because of the GenICam interface, which makes implementation easy."

Sachio Kiura: "The American and European markets have adopted digital technology very quickly."

99 We expect the USB3 Vision to be adopted very quickly by the market."

Tsuneo Sakuma: "What we want to prevent above all with FSF is that too many standards come onto the market."

Chris Beynon: "We want to ensure that in future the fastest cameras on the market will continue to be able to operate with CoaXPress and, by evaluating feedback from users, we intend to achieve this."

Jochem Herrmann: "With G3, the international cooperation between the individual organizations, we want to avoid a situation in the future in which we have competing standards."

Bob McCurrach: "Help users and system integrators to find the optimal standard for their applications - and make it tangible to people outside our industry what the benefits of standardization and image processing are."

Plugfest: High-Tech Meets the Middle-Ages

In the medieval rooms of the Ballenhaus in Schongau it was not all theoretical discussion, there was some hands-on testing, too. "Our PlugFest has grown up alongside our two standards GigE Vision and GenICam. Today it is part and parcel of our International Vision Standard meetings," says Bob McCurrach, Director of Standards Development for AIA.

Here the manufacturers of cameras, frame grabbers and software tools come along and connect a device from manufacturer A with a device from manufacturer B and add the software of manufacturer C (Plug&Play) and test whether the products comply with the standards and are compatible. "When you put them all together you discover deficiencies, which is not necessarily so possible in the firm's own laboratories," explains Bob McCurrach. "The good thing about it," according to George Chamberlain, President of Pleora Technologies, "is that here technical knowledge is exchanged and discussed too, which really helps us to make progress." The most frequent faults, the experts say, arise as a result of the misinterpretation of standards. "That is what is always so significant about this standard work. We are still discussing formulations, e.g. of GigE Vision, to make sure that the requirements are understandable for everyone," explains Werner Feith, CEO of Sensor to Image. "In our experience standardized devices such as cameras work in 90% of cases; earlier, when there was no standardization, the rate used to be about 2%," remembers Werner Feith, and he continues: "If the inter-operability between devices does not work, we have the moral duty to find out the cause of the error, and at the next PlugFest to prove that it works. This is of benefit for the customers, the manufacturers and the industry, and every year we gradually become more Plug&Play."

> 99 **The most frequent errors at the plugfest result from the misinterpretation of standards.**"

system manufacturers access to completely new markets," explains Jochem Herrmann. "The integration of components from a wide range of manufacturers is much easier if we have strong standards. What is more, standards enable manufacturers to save system costs and to accelerate the 'time-to-market' of their products," adds George Chamberlain, Managing Director of Pleora Technologies and member of the AIA Board.

Common Goal: to Capture New Fields of Application

Since the G3 has existed, the organizations have also presented themselves jointly at international trade fairs. "Some of the goals we are working towards are to help users and system integrators to find the optimal standard for their applications and to make the benefits of standardization and image processing tangible to people outside our
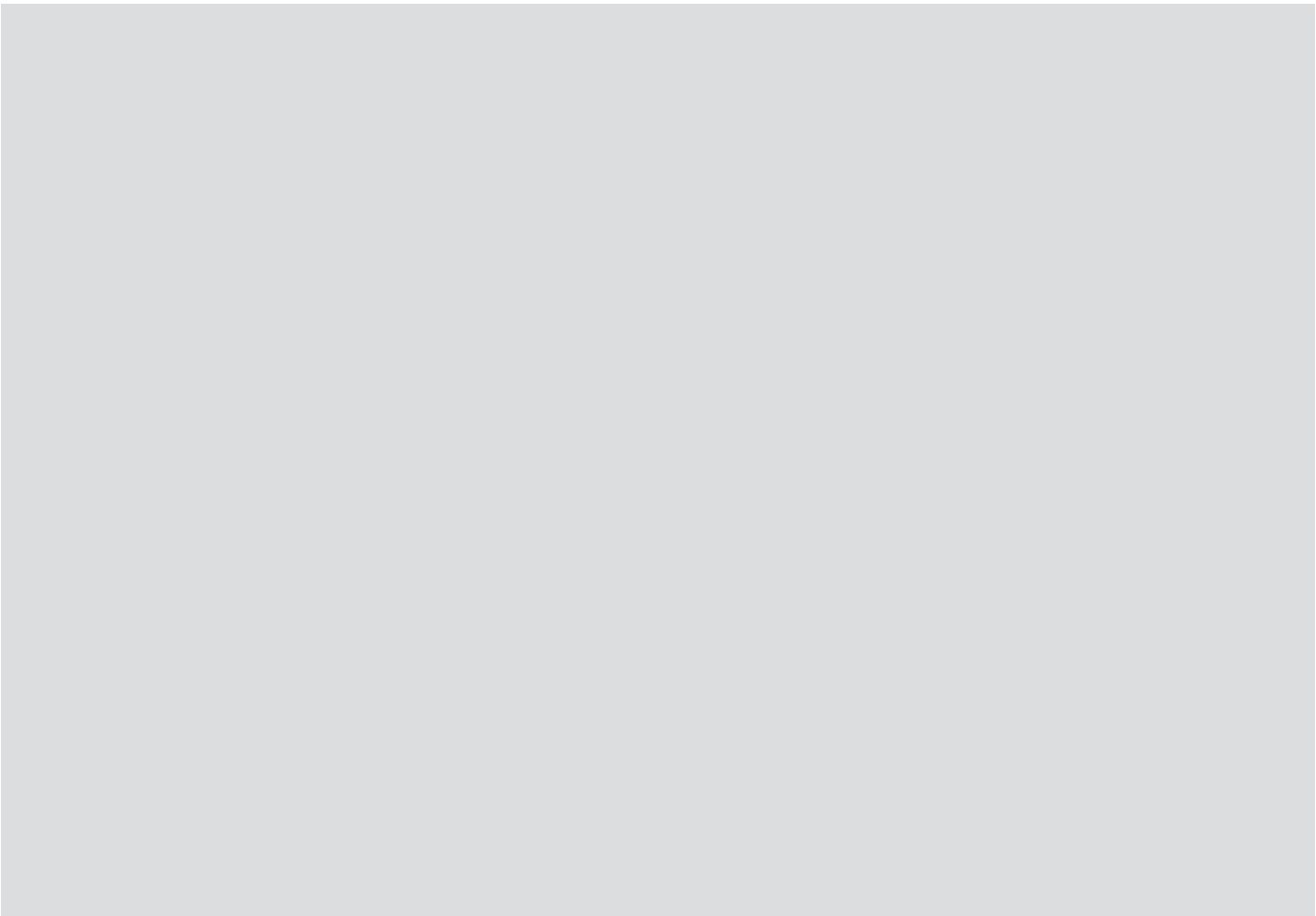

Discussing the benefits of standardization (f.l.t.r.): Mike Miethig (Teledyne Dalsa), Eric Gross (National Instruments) and Eric Carey (Teledyne Dalsa)

Testing, trying, speaking with each other:
Plugfest during International Standards Meeting Schongau

Plugfest participants with inspect:
Pascal Pellet (e2v) and Jean-Philippe Arnaud (Active Silicon)

Plugfest participants from Matrix Vision

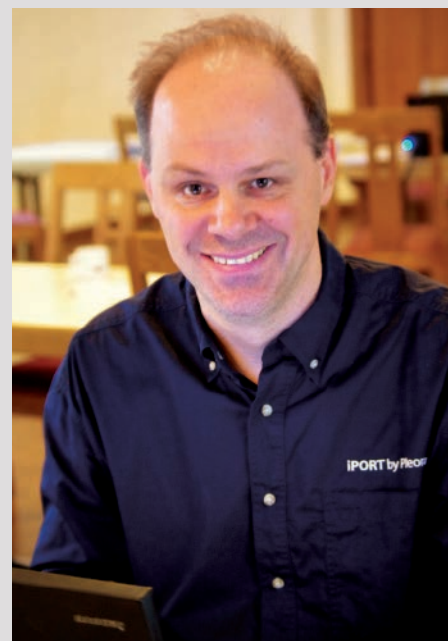Thomas Luebkemeier, EMVA General Manager and inspect, leading magazine for machine vision

Plugfest participants discussing during a break

„ The Future Standards Forum steers the evolution of standards for tomorrow.“

Christoph Zierl, Chris Beynon, Mike Miethig (f.l.t.r.): "A standard is never completely finished."

Plugfest participant from Pleora

Thies Moeller, Technical Architect at Basler, "Experts from competing companies...

...working shoulder to shoulder with each other," Max Larin, CEO of Ximea

industry," explains Bob McCurrach, Director of Standards Development for AIA. To this end, the G3 has for the first time composed a brochure which was introduced at the SPS/IPC/Drives Exhibition in Nürnberg. It gives a good overview, compares standards with each other, explains their benefits and thus assists the user to make the right choice. "The brochure is a great help, too, for example for customers who want to change from analogue to digital cameras," Bob McCurrach adds. From his experience, Sachio Kiura observes that "the American and European markets have adopted digital technology very quickly. The change is moving more slowly in Asia, but now a lot of companies are also converting from analogue to digital because we have these standards. They are of great benefit to our customers."

These international meetings are something unique because experts from different companies and different nations whose products compete on the market are here working shoulder to shoulder with each other. "When we come together at the International Standards Meetings," explains Bob McCurrach, "the main focus is on communication and exchange with each other, whether in the consultation bodies or in the technical committees. Here communication is the key component." "These international meetings reduce misunderstandings and help the entire industry to achieve higher quality Vision standards," stresses George Chamberlain. "We all have a

Plugfest participants from MVTec

and GigE Vision has been in practical operation for seven years now, and both of them are still widely used. "In the FSF we want to converge ideas, feedback from users and market observations so that later, on the basis of this information, new and even better standards can be developed," summarizes Werner Feith. "And what we want to prevent above all with the FSF," agree Tsuneo Sakuma and Sadafumi Torii, both Vice-Chairman of JIIA, "is that too many standards come onto the market and that there are parallel developments. By preventing this we make life easier for the users."

GenICam: Camera Describes Itself

At the International Standards Meeting in Schongau the spotlight was on GenICam because all the hardware interface standards supported by the G3, e.g. GigE Vision, USB3 Vision, CoaXPress, Camera Link and Camera Link HS, which control communication between camera and host, make use of the same software interface standard. GenICam enables a flexible description of all the camera's features, in the form of an XML file usually stored in the camera's firmware. A generic software can read this file and use these features to adjust parameters such as the analogue gain factor in the camera. In this way it is very easy to call up whichever camera function you want and have access to parameters. And if end-users decide to replace cameras already installed in the field with models by other manufacturers, this is no longer a problem because GenICam is used. The new cameras can be put into service and configured with very little effort. Christoph Zierl, Director of Product Management at MVTec Software, states that "the idea behind GenICam was a camera which describes itself. You ask the camera when it opens up: what are your features? Then the application learns what the current features are. This has been common practice in software development for many years now, I know, but we have adapted it for Machine Vision and the customers really appreciate it." "There is no need to have a user manual anymore," adds Eric Carey, Director of R&D at Teledyne Dalsa, "the XML file is loaded and it contains all the information needed to configure the camera."

GenICam originated seven years ago in conjunction with GigE Vision and you might think that standardization should now have been completed. "A standard is never completely finished," says Christoph Zierl, "because, as a result of developments in the field, there are always new challenges, and adaptations have to be made." One good example of this, according to the experts, is the coordination of the special features of the recently approved USB3 Vision standard or the integration of 3D-cameras and -sensors.

common goal," argues Bob McCurrach, "to introduce image processing into areas which have not been penetrated before but in which this technology can provide great advantages and innovative solutions." In George Chamberlain's view this could include above all segments of non-industrial application such as medicine, traffic, agriculture, solar- or wind-power generation and many more.

Future Standard Forum

For about a year now G3 has also set its sights on the future, and explicitly for this purpose founded the Future Standard Forum (FSF). "In the past we concentrated above all on existing standards, but there was no planning of new ones for the future," says Jochem Herrmann. Now, with the FSF, we also look into the future to determine in which direction developments must go in order to fulfill the long-term needs of the

users of Machine Vision. What will be important in the future? How can we develop our standards to offer higher speeds, how can we reduce the costs for applications that only need moderate speeds? Which existing standards in the consumer industry, or from quite different branches of industry, could be useful? These are the kinds of questions that the FSF has to answer. So far there are two working groups within the FSF: one is responsible for digital interfaces and the other for extending the lighting standards. "The FSF Committee is currently working on an audit of where we stand at the moment. The next step will be to draw up a roadmap which should stretch five to 19 years into the future," says Jochem Herrmann. "Standards live a long time," adds George Chamberlain, "and that is why the effects extend even longer, perhaps about 20 years into the future, or further." Indeed, Camera Link has already been in existence for 13 years

Plugfest participants from Basler

At present, there are six GenICam modules which enable cooperation with the hardware standards: GenApi (camera configuration), SFNC (Standard Feature Naming Convention), GenTL (Generic Transport Layer), CLProtocol (explicitly for Camera Link), GenCP (Generic Control Protocol) as well as GenTL SFNC (recommends feature names and types for GenTL). In addition, the GenICam standard group has provided a reference implementation for GenApi. Werner Feith has many years' experience with the standards as his company develops and supplies the interface technology for a variety of different camera and frame grabber manufacturers: "When I visit a customer the first thing I have to do is to make it clear to him which of the six modules he needs. I think in the GenICam group we have more work to do here to achieve greater transparency."

Specify Conformity

One important issue for the members at the International Standards Meeting was to push forward GenICam Release 3.0. In Christoph Zierl's view: "Cameras will become ever more complex and will have more functions. Consequently, the storage needed for the XML file increases, as does the storage needed in the PC, and the time-lag from opening the camera until all the features are ready for the application increases, too. In particular customers using cameras in deep embedded systems would highly appreciate faster loading times and a smaller footprint of the reference implementation. The committee has responded to these requests and created a prototype for a new major release 3.0 which is up to five times faster than the upcoming version 2.4 and uses up to ten times less RAM at run-time. The new version is expected to hit the market mid-2014." "Another issue is the Transport Layer standard GenTL. We are striving to achieve 'plug & play', as is already common in the consumer market, in the Machine Vision sector, too. Application software should cooperate in a simple and generic way with a variety of different devices such as cameras (GigE Vision, USB3 Vision) or frame grabbers (Camera Link, CoaXPress, Camera Link HS) from different manufacturers, in the same way for instance that a scanner does when connected up to a PC. GenTL works and is also being increasingly used. So far, however, we have not developed official procedures to specify and validate conformity so that a product is authorized to carry the GenICam-GenTL logo. We need to work on this in the coming months," explains Christoph Zierl.

GenICam Goes 3D

The trend to 3D image processing is obvious. The standard-makers have recognized this and a few months ago launched a working group to investigate the requirements 3D

During Standards Committee Meeting: "Our plugfest has grown up alongside our two standards GigE Vision and GenICam."

camera manufacturers have vis-à-vis GenICam. "Initial results were presented here and the good thing about it was that all the major 3D camera manufacturers were present," said Christoph Zierl. "It is a sign of the resounding success of GenICam," stated Chris Beynon, Chief Technology Officer at Active Silicon, "that all the 3D camera manufacturers and distributors want to be involved in GenICam. They have recognized that the standard holds a lot of advantages for them." According to the experts, before 3D can be incorporated into GenICam, they have to investigate how suitable pixel formats are to be defined in 3D images. Explaining the next objective, Christoph Zierl declared that "in the course of next year we plan to integrate new pixel formats and special 3D features into the standard."

More Innovative and Quicker-to-Market

"The most impressive thing about GenICam for me is that the standard allows individual camera manufacturers to make their own specific innovations, e.g. integration of new functions which other manufacturers have not even thought of, and that these are able to work in a simple and uniform way with a third-party software. In the past everything was much more complicated and more difficult to apply. Camera manufacturers can now differentiate themselves from their competitors much better with special features and can penetrate into very specialized markets," stated Eric Gross, Senior Vision Software Engineer at National Instruments. This was confirmed by Christoph Zierl, who

added: "And they can get to market much faster with their new features. This is what is happening at the moment in the Machine Vision market and it is spreading to other markets, too."

AIA's global „2013 Machine Vision Camera Study" study revealed that e.g. GigE Vision cameras, which include the GenICam Interface, already account for a 50 % share of newly purchased industrial cameras. Over recent years, this combination has also conquered new markets. Giving an example, Eric Carey pointed out that, "in the field of intelligent traffic-management systems (ITS), mainly analogue cameras were dominant until up to ten years ago, but that has now changed because of the GigE Vision interface which permits long cable lengths and because of the GenICam interface, which makes implementation easy." "The modern hardware interface standards are based on GenICam and we are very satisfied with the current roll out," summarized Thomas Lübkemeier, General Manager of EMVA.