The Basics of Visualization

TM600








Perfection in Automation

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Prerequisites

Training modules:	Basic knowledge of computers
Software:	none
Hardware:	none

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1. INTRODUCTION

This training module "The Basics of Visualization" provides a brief look into the world of visualization. Recently, visualization has begun playing a much more significant role in the field of automation – from the switchboard to the industrial PC with touch screen.

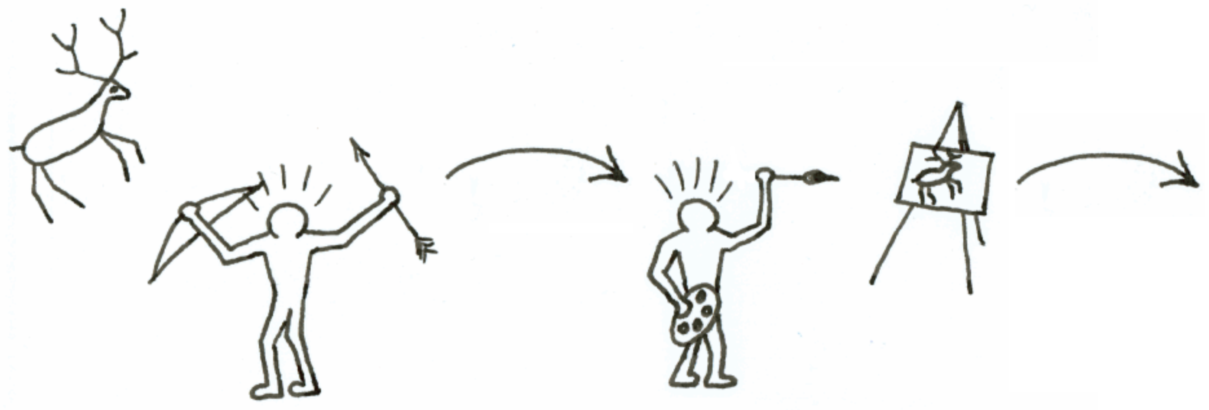

Fig. 1 The history of visualization

Images – no matter what form they're in – provide a way to display any process. They help the observer to quickly understand the situation being portrayed.

This was true for caveman paintings, for paintings made by famous artists – and is especially true for machine visualizations.

"A picture is worth a thousand words"

1.1 Objectives

The goal of this training module is to understand which aspects must be considered when designing a visualization application.

The course participant will be able to select the right visualization for his/her application.

The course participant learns how to accurately illustrate the processes necessary for the system in graphical or textual form by using visualization standards.

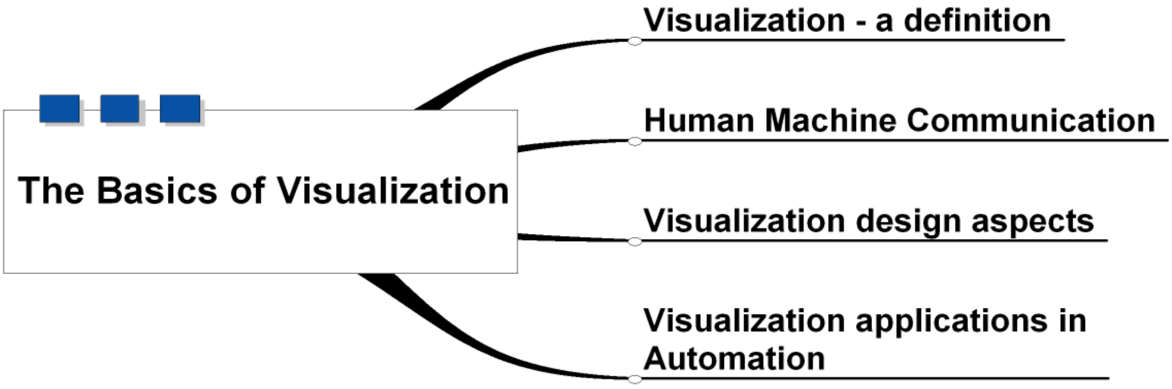

Fig. 2 Overview

2. VISUALIZATION – A DEFINITION

„A picture is worth a thousand words“

Since the dawn of man, visualization has played a central and significant role in the transfer and understanding of information. The reasons for this phenomenon can be found in the physiology of the human eye and the visual cortex to which it is connected.

From all of the human sense organs, the vision apparatus contains the highest bandwidth for absorbing information. This fact is supported by the common phrase "A picture is worth a thousand words".

Visualization (in the sense of information technology) is the precise transformation of data to a visual image to support the exploration, cognition and explanation of structures and processes.

Catch phrases such as "visual thinking", "visual communication", creativity via "visual brainstorming" or "virtual reality" and technical development are evidence of the increasing importance of visualization over the last few years.

The advantages of process visualization:

- Quick orientation thanks to self-documenting procedures
- Monitoring of procedures
- Optimum control of the system

This provides a basis for the process analysis of time, expenses, quality and value potential.

3. HUMAN MACHINE COMMUNICATION

„The focus is on the humans, not the machine“

This is an idea which includes all of the communication procedures involved when a person is operating a machine. Human-machine communication bridges the differences between human language and machine language.

This means the commands, which the operator enters, and the response, which he/she receives from the device.

In view of the numerous devices available on the market today, an important demand is to simplify human-machine communication in a way so that anyone can operate a device without error.

When creating a visualization application, the developer / designer should follow the goal of providing the operator with a tool that allows him/her to operate the machine intuitively.

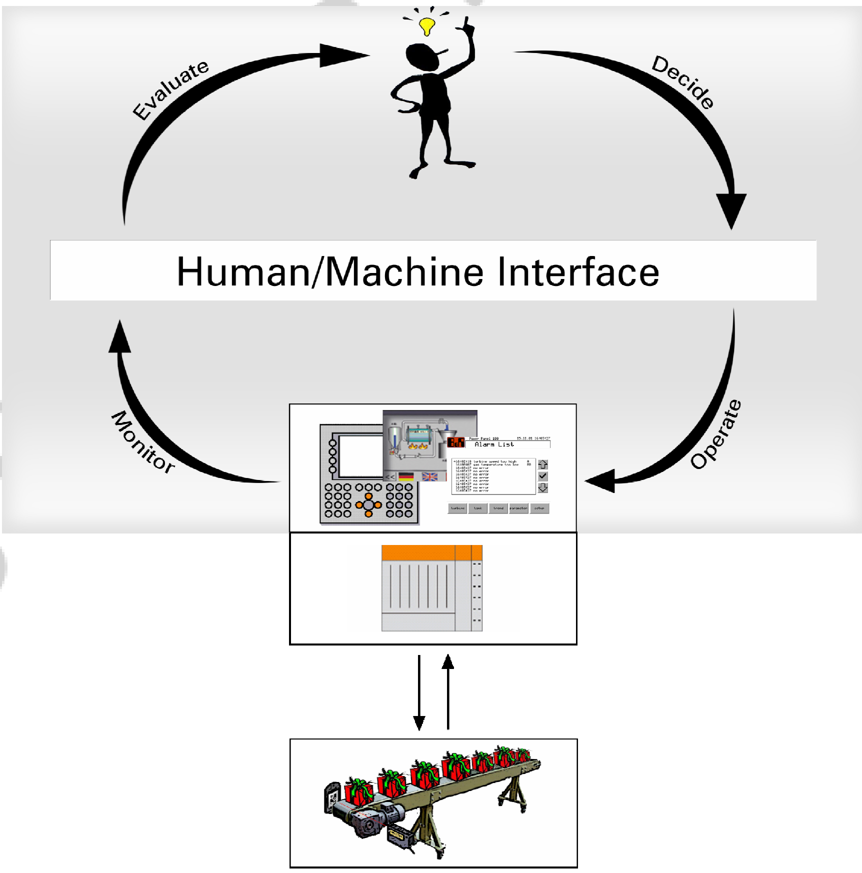

Fig. 3 Human/Machine communication

4. VISUALIZATION APPLICATIONS IN AUTOMATION

Visualization is becoming increasingly important in automation. In the early days, the user could only interact with a machine's process using conventional methods such as lights, level indicators, buttons and switches and monitoring the machine's status was only possible using analog gauges. In recent years, increasing demand has been placed on visualization with regard to functionality and ergonomics.

„Integrated visualization“

This is another result of the increased performance and sinking prices of the necessary hardware. Evidence of this trend can be seen in the recent shift from the "classic" remote visualization to an "integrated" visualization.

4.1 Development

4.1.1 From the switchboard to the touch screen visualization

In the beginning there were.....

Switchboards with process charts: These were inflexible and resulted in high production costs due to the extensive amount of manual handwork required.

Intelligent switchboards: were somewhat more flexible, but still expensive.

Fig. 4 Gauge

Line displays with buttons: These devices allowed considerably more flexibility.

Tube display with keyboard: This enabled goal-oriented tasks with a higher concentration of information, and later even a fully graphical display, but were however still prone to error.

In comparison, **industrial PCs** with flat-screen displays and matrix keyboards are more resistant and can also display Windows interfaces.

Industrial PCs / **panels** with touch screens and/or buttons are currently the state of technology and enable intuitive operation and monitoring of processes.

4.2 Demands on visualization

„Specifications are the foundation of every solution“

This section describes only the most important demands that are placed on a visualization application. When designing a concept, one should keep in mind that a list of requirements is created that identifies and prioritizes individual criteria. Once this specification has been established, it is possible to select the visualization hardware and the necessary tools.

The main part of a visualization application is **monitoring** and **operation**.

Monitoring can be performed in various ways. Processes are usually displayed in a process chart while status messages are often displayed in an alarm system or indicated via external status displays such as status lamps or key LEDs.

Machine and system status

- Process charts
- Displayed using key LEDs

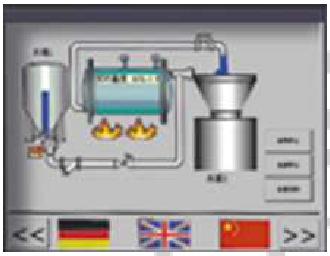

Fig. 5 Process chart

Messages and alarms

- Critical, targeted process monitoring

There are various guidelines regarding input for **operation**, which depend greatly on the profile of demands for the area of application.

Of course, it is also possible to combine various operating concepts such as touch and key operation.

Controlling the system

- Changing process data
- Sending commands to the process flow

Operating concepts

- Covered keys, short stroke keys
- Keyboards, buttons and switches
- Touch

Fig. 6 for every demand the appropriate solution

Diagnostics and service

- Analysis of problematic situations
- Support during problem correction

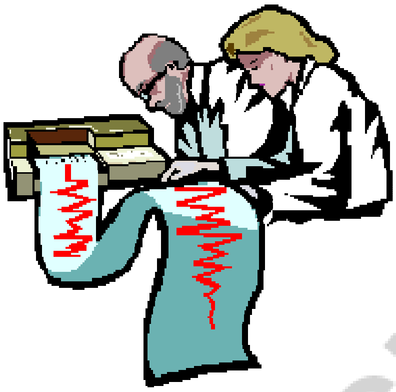

Fig. 7 Data analysis

The production data obtained during a process must be analyzed and further processed afterwards.

Data management

- Saving and loading process data
- Printing and archiving
- Storing data on the server

Machine setting specifications

- Physical or product-dependent limit values

Process data specifications

- Recipes

Fig. 8 Data management

4.3 Selection criteria

The visualization application which should be applied at the end of the process depends (among other things) on the following factors.

what the customer describes......

- Mechanics and ergonomics of the machine
- Type of system & machine ⇔ visualization concept
- What demands are going to be placed on the visualization? (image size, additional software components, networking, etc.)
- Which tool can be used by the developer? (Training) ⇔ correct hardware and software
- Development and runtime costs / licenses
- Training and support
- Implementation, maintenance and care for the system / software
- Possibility of future expansion (scalability of the hardware / software)

"The right solution for every application and demand"

Long-term availability of the hardware and software components and the ability to provide a complete solution are significant factors for product selection.

Classes of visualizations at B&R:

Visualization classes	Platform
Integrated visualization Visual Components	Automation Runtime
PVI-based visualization PviControl.Net, PviServices	Microsoft Windows Visual Studio.Net
OPC-based visualization (SCADA packet) Supervisory Control And Data Acquisition	Microsoft Windows
APROL control system	Linux

A hardware–software combination results from the profile of demands. Of course, this means that compromises regarding functionality and expansion possibilities might have to be reached for various reasons.

The selection profile could end up looking like this:

	Integrated Visualization	Own Development	3rd Party Systems (SCADA)
Time / Amt. of work	20%	100 %	Unknown
B&R support	100%	10%	5%
Training	Yes	No	No
Runtime costs	Low	Unknown	High
Standard components	100%	50%	Unknown
HW/SW availability	10 years	Unknown	Unknown
Range of functions	90%	100%	50%
Entire system	100%	50%	Unknown

You should be aware that there is no standard visualization which can meet all demands 100%. However, the difference between standard and requirement can usually be implemented with a little work on the application.

"Learn to know the limitations"

One often jumps to the conclusion that "there's something wrong with the product", because of a physical or product-related peculiarity. Attention must be given to this aspect when putting together the user profile.

Example: Touch screen

It is not possible to press several buttons on a touch system at the same time (has anyone ever tried this with a mouse?), because touch technology simply does not allow this. The x/y position determined is always returned.

4.4 Visualization concepts

There are different methods / solutions for a visualization application depending on the structure and the specifications of the machine. This ranges from a "classic" visualization (controller <=> visualization terminal) to networked and remote operation.

Local – machine-related operation

- Located right on a mechanical operating unit

Central operator station

- Grouping of multiple operating units
- Encompasses several machines

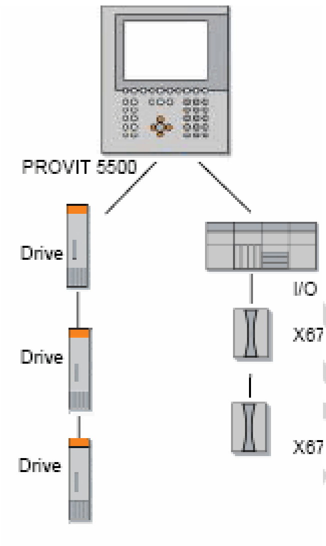

Fig. 9 Central operator station

Remote operation

- Targeted access via modem, intranet or internet
- SMS, FTP and WEB technology

Stand alone machines

- Closed machine units

Machines in a group – networked visualization

- Similar machines, work self-sufficiently but are networked

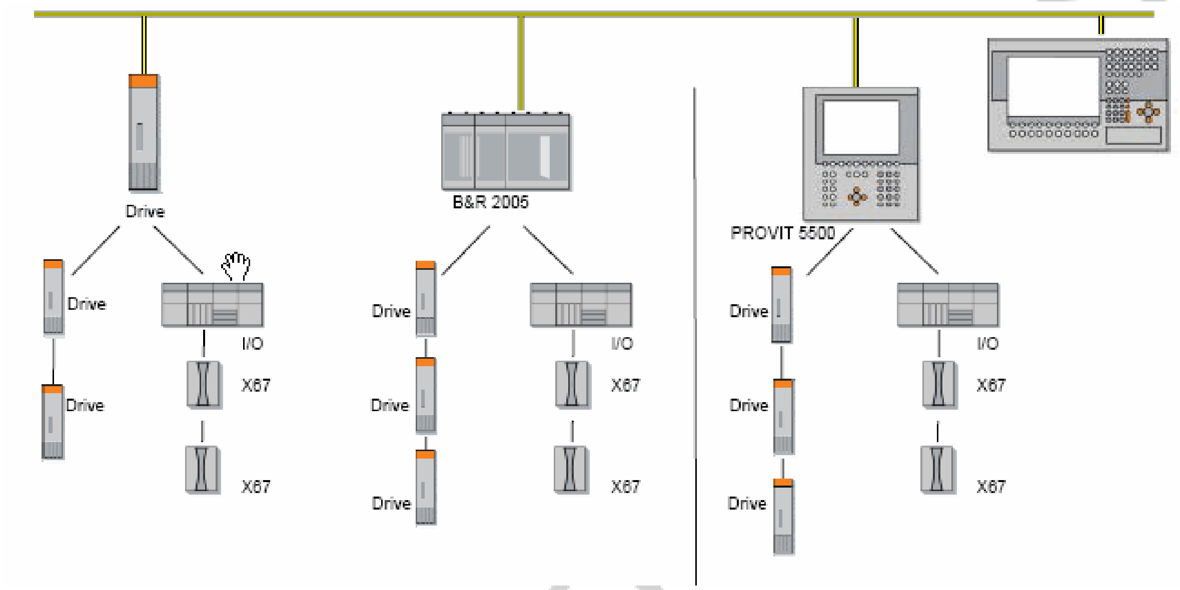

Fig. 10 networked operator stations with higher-level visualization

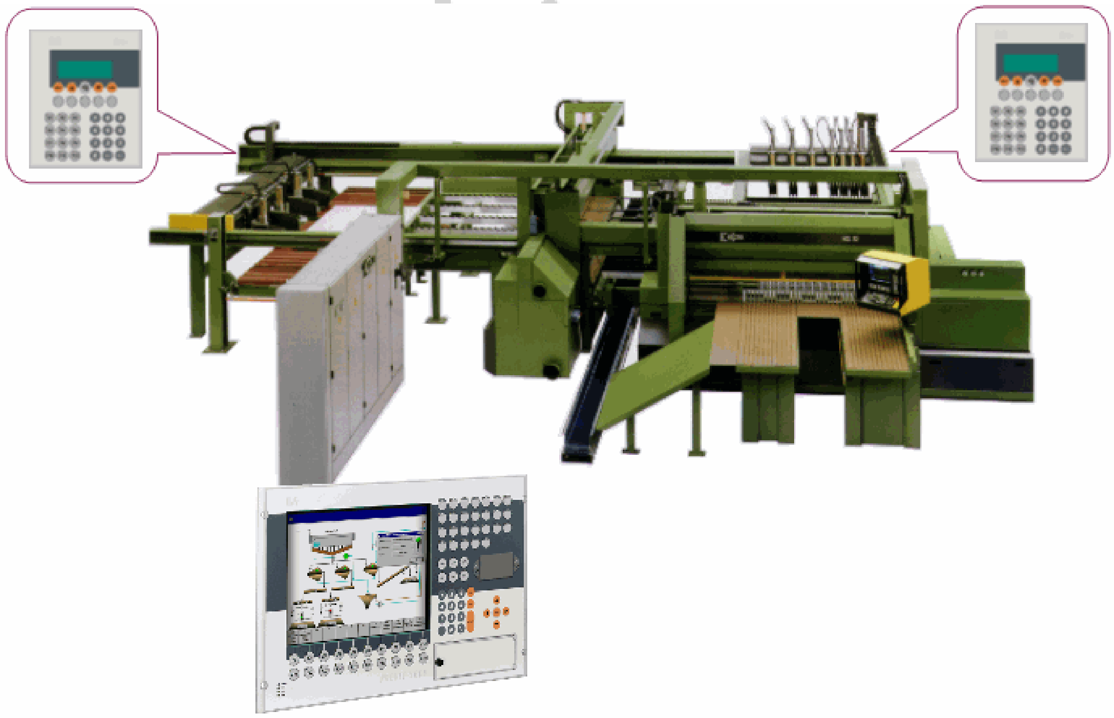

Fig. 11 Example of in/out feed conveyor with central operator station

5. VISUALIZATION DESIGN ASPECTS

Thanks to the use of the latest technology, the graphical display of processes allows an unprecedented bandwidth of information to be exchanged between machines and their operators.

This gives the developer more room for creativity when creating graphical interfaces.

However, because the demands regarding ergonomics (among other things) are a main focus, the artistic demands must be subjected to a few rules so that the operator can work with a system without any problems.

- Supplier and customer requirements
  Company CI (Cooperate Identity), standards and specifications

- System control

- Service & implementation
  Update, maintenance, error analysis

- Future expansions
  Hardware/software scaling

- Operating personnel training

"Unite the profile of demands with user friendliness"

The user – the person(s), operating the machine / system – must be the main consideration when creating a visualization application.

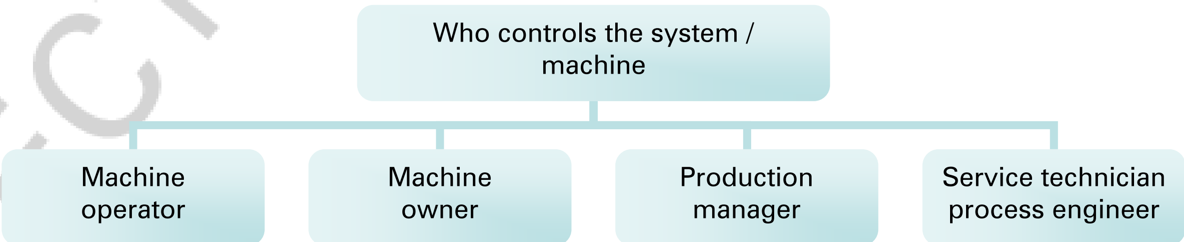

Fig. 12: Profile of demands

When taking a closer look at the tasks of the individual operator, demands such as those shown here below can be placed on the visualization:

The **machine operator** has mostly limited operating and monitoring rights on the system. This means that he/she cannot see all of the functions and cannot fully intervene with the process (e.g. to change parameters, etc). Furthermore, this can also mean that each action made by the operator is logged in order to analyze any problems that may arise at a later point in time.

Unlike the machine operator, the **machine owner** has advanced access to the system and can fully intervene in the process as well as change all relevant parameters.

The technician or **production manager** does not have to intervene in the process. They are only interested in the data at the end of the process. How much was produced? What amount of load was on the system? What problems occurred? Why did these problems occur?

The service technician / **process engineer** has all of the rights on the system regarding operation and service and can decisively intervene in the process. This person must able to oversee and control the machine from the implementation to the error analysis ⇔ problem detection ⇔ problem correction.

In addition to ergonomics, these guidelines must be taken into consideration when creating a visualization application:

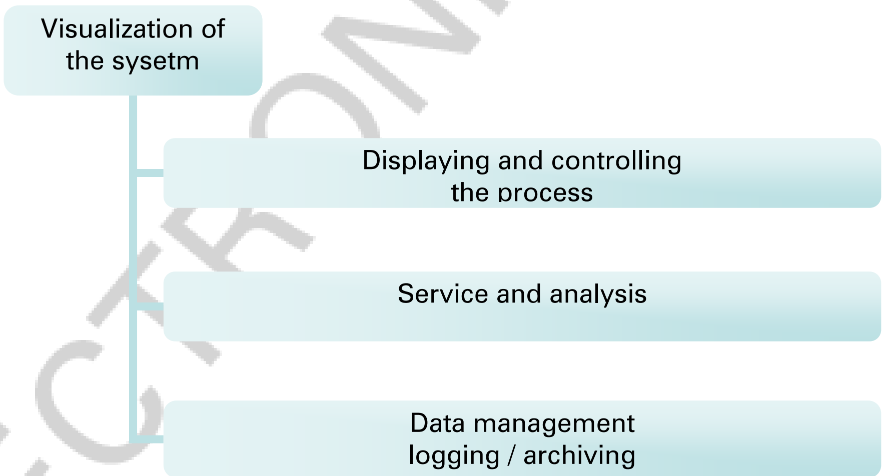

Fig. 13: Extended information

Human limitations

- The human eye does not register value changes faster than 200 ms (5 times per second).
- The human ear considers a delay of more than 30-60 ms between action (e.g. keystroke) and a resulting reaction as slow.

Process-representative display

- Textual display, when text is sufficient
- Graphics, when graphics are required
- Moderate use of dynamic objects
- Grouping of procedures
- User-friendly menus (page composition)

"Less is more"

User friendly

- Suitable, variable text size and graphical resolution
- Color design (determined by CI)
- Input support, operating safety
  Navigating the input fields, plausibility check, password protection
- User interface
  Keyboard input, touch screen, combination of both

Multiple operator stations in the system

- Uniform access methods
- Common network
- Different device types and designs combined

Main goal – complete operating philosophy

- Page branches are designed in a structured and logical manner
- Representation of colors (an input field display uses a different color than a process value display)
- Representation of graphics, icons, key labeling

Regarding data input, it should particularly be taken into consideration that the operator cannot always empty his hands before inputting data / operating and may even require gloves for his current task (larger operating field). Therefore, when planning the visualization for operation, the developer must base the design on the operator and not on his/her own environment.

6. SUMMARY

Nowadays, the design of elements in a visualization application such as the behavior of an entry or button is already determined by the software packets and cannot be influenced by the programmer of an application.

"Look and Feel"

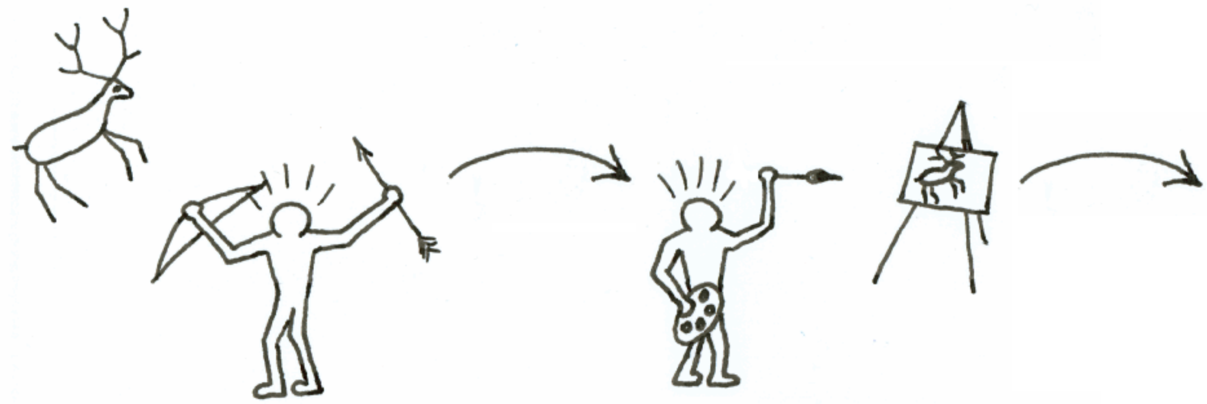

Fig. 14 The history of visualization

Not only the developer's creativity while designing the visualization, but also the user's needs should take center stage during development.

The quality of a system is often determined by the visualization. Who doesn't like working with a tool that that is tailored to their needs?

7. APPENDIX

7.1 Guidelines and standards

As a manufacturer of visualization devices, we cannot set the guidelines and standards for the creation and design of a visualization application, but we do have a few suggestions:

VDI/VDE guideline 3850, Part 1 "User-friendly design of useware for machines", May 2000, referenced from: Beuth Verlag GmbH

VDI/VDE guideline 3850, Part 2 "User-friendly design of useware for machines: Interaction devices for screens", November 2002, referenced from: Beuth Verlag GmbH

VDI/VDE guideline 3850, Part 3 "User-friendly design of useware for machines: Design of dialogues for touchscreens", April 2002, referenced from: Beuth Verlag GmbH

http://www.soft.uni-linz.ac.at/Teaching/Begleitmaterial/Vorlesungen/ - Human Machine Communication

Notes

Overview of training modules

TM200 – B&R Company Presentation **
TM201 – B&R Product Spectrum **
TM210 – The Basics of Automation Studio
TM211 – Automation Studio Online Communication
TM212 – Automation Target **
TM213 – Automation Runtime
TM220 – The Service Technician on the Job
TM223 – Automation Studio Diagnostics
TM230 – Structured Software Generation
TM240 – Ladder Diagram (LAD)
TM241 – Function Block Diagram (FBD)
TM246 – Structured Text (ST)
TM247 – Automation Basic (AB)
TM248 – ANSI C
TM250 – Memory Management and Data Storage
TM260 – Automation Studio Libraries I
TM261 – Closed Loop Control with LOOPCONR

TM400 – The Basics of Motion Control
TM410 – The Basics of ASiM
TM440 – ASiM Basic Functions
TM441 – ASiM Multi-Axis Functions
TM445 – ACOPOS ACP10 Software
TM450 – ACOPOS Control Concept and Adjustment
TM460 – Starting up Motors

TM500 – The Basics of Integrated Safety Technology
TM510 – ASiST SafeDESIGNER

TM600 – The Basics of Visualization
TM610 – The Basics of ASiV
TM630 – Visualization Programming Guide
TM640 – ASiV Alarm System
TM650 – ASiV Internationalization
TM660 – ASiV Remote
TM670 – ASiV Advanced

TM700 – Automation Net PVI
TM710 – PVI Communication
TM711 – PVI DLL Programming
TM712 – PVIServices
TM730 – PVI OPC

TM800 – APROL System Concept
TM810 – APROL Setup, Configuration and Recovery
TM811 – APROL Runtime System
TM812 – APROL Operator Management
TM813 – APROL XML Queries and Audit Trail
TM830 – APROL Project Engineering
TM840 – APROL Parameter Management and Recipes
TM850 – APROL Controller Configuration and INA
TM860 – APROL Library Engineering
TM865 – APROL Library Guide Book
TM870 – APROL Python Programming
TM890 – The Basics of LINUX

**) see Product Catalog

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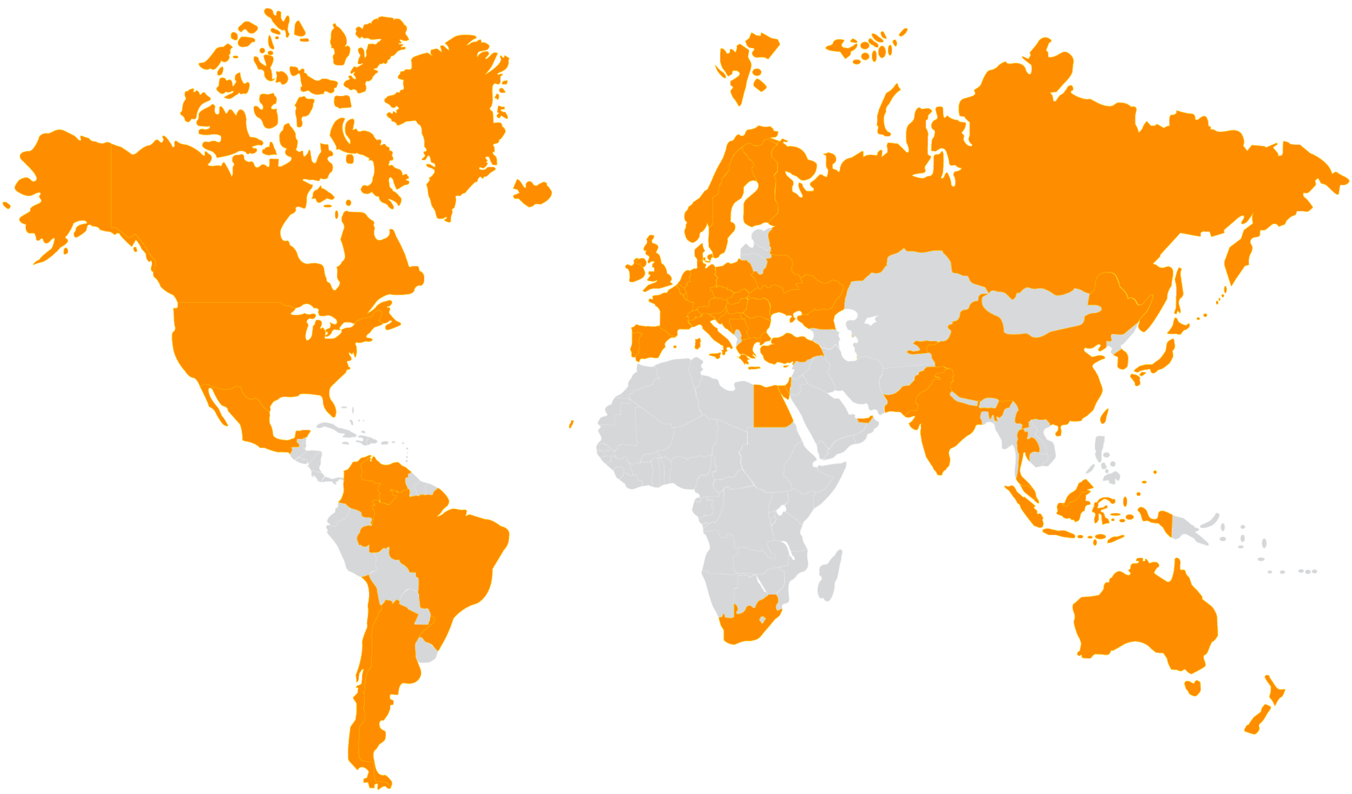

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