Fig.3: 2007 SN-Technics i-boro

Fig.4: 2010: teXXmo tX-1000; CeBIT, Hanover [Source: dpa]

Fig.5: 2010, Brückner Callisto (teXXmo-based)

The challenge: software and data

So far, we looked at the hardware development as the main enabler for wearable AR. At the same time, Augmented Reality software evolved and is now running on Smartphones and Tablet PCs. There are a lot of consumer applications, e.g. used for mobile marketing and location-based information provision. Such applications have a broader market than industrial applications and thus, more potential users. At the same time, the requirements towards the exactness of AR overlay are higher in industrial settings. It is more difficult to have the AR system point to a specific screw of a car engine than to augment the direction of the nearest hotel or pop up an AR advertisement on top of a magazine. Stationary systems can use laser pointers to show welding points [1] in the range of millimeters. With HMDs not being firmly fixed to the user's head and the mobile systems not being able to provide enough performance, we might not be able to fulfill the expectations, which grew over time.

Once we know and accept the limits of wearable AR, we still need to set up the underlying data structure and keep this data up-to-date. If geometric and descriptive information shall be used for AR, this information needs to be generated, edited and mapped to an appropriate AR context. There are approaches to generate such data right from the development of products, such as vehicles, aircraft or buildings.

Expectations: R&D, marketing and reality

Important is to differentiate the expectations between the stakeholders in wearable AR systems. Marketing sets high expectations by implying that wearable AR systems are readily available and usable. For example, there are many videos, which show the use of an ideal system, raising the expectation of potential users that they can purchase and use such systems, even today [2][3][4]. The intention of this approach is twofold: painting the picture of an innovative company and trying to open up a market for such systems. While this will surely drive the awareness and demand of such systems, sometimes it raises the expectations higher than the state-of-the-art, affordable technology. Reality is driven by the actual users, who will only accept products, which facility their private or work life. In reality, we are further away from wearable AR systems than R&D and marketing imply. The following aspects are our lessens-learned, supported by some examples.

Lesson-learned: integration and usefulness

System integration: hands-free operation

One of Xybernaut's faults was that the system was marketed as hands-free computer, but hands-free user interfaces, such as speech recognition had to be developed by ISVs. At least the basic functionality to start, control or manage the system's OS must be provided as hands-free user interfaces [Fig. 1].

System integration: application software

With our system teXXmo ONE [Fig. 5], we designed hardware purposely for partners, who developed integrated software, which would make it a useful tool. Such specialized industrial software applications could have driven the market, but in the end, those partners could not successfully introduce their system. Ideal for wearable AR systems would be a kind of hardware and software ecosystem, such as today's smartphone with their corresponding application stores, might have helped back then.

Fig.6: 2012, Google Glass

Fig.7: 2013: Vuzix, M100

Fig.8: 2013: Motorola HC1

Usefulness: building tools
Successful wearable systems in industrial settings need to be useful tools, such as e.g. pick-by-voice systems. These show simple hands-free user interfaces, a completely closed, integrated hardware and software system, as well as seamless connectivity to the stationary infrastructure. The success of pick-by-voice currently drives approaches to use AR as the alternative hands-free user interface [Fig. 2].

Usefulness: marketing vs. reality
Adding wearability to Smartphones causes excitement and trouble. During the current marketing effort, Google Glass [Fig. 6] is often times reduced to a wearable camera, which raises privacy issues. The huge potential of a hands-free wearable device unfortunately is drawn out of focus.

Usefulness: reaching ROI
While Smartphones sell in millions, wearable AR systems are calculated in the hundreds to thousands. Thus, the unit price is much higher and it's more difficult to reach an ROI. For example, a system price of approximately €15.000,- for a tele maintenance wearable served a very small niche market [Fig. 3] and pricing of consumer products definitely set prices of industrial devices under pressure.

Usefulness: ease of implementation
Customers got used to accept that an implementation of larger-scale system need consulting and systems integration. With the emergence "an app for anything you need" there is no motivation for paying consulting fees; thus, Google's approach to use the Smartphone as the base – with the apps ecosystem already implemented. Alternatively, we could reduce functionality and improve the traditional concept. Motorola's HC1 [Fig. 8] e.g. goes back to the promises of Xybernaut, now without cables and with complete speech control for all functions. The system offers basic applications, such as document viewers and telephony, which offer enough support for some work processes, without further software development.

Conclusion: it takes time

Which conclusion do we draw from our lessons-learned? In comparison to the sentence in the introduction, we believe the time for wearables to broadly hit the market is reduced to "within the next 2-3 years". There is still a lot to do in terms of R&D and finding the right applications. Wearable AR might take the same road as RFID technology. It is around for many years. We saw RFID applications in many marketing stories. And although it seems to be much easier to stick RFID labels to products than setting up an AR infrastructure, RFID still is not as wide-spread as it could or should be. Who knows since how many years RFID researchers hear that breakthrough will come in 2-3 years?

References

[1] Extend3D Welding Example
http://www.extend3d.de/en/solutions/welding/

[2] KNAPP, Kisoft Vision
http://www.youtube.com/watch?v=BWY8uFlteIM

[3] Google Glass
http://www.youtube.com/watch?v=9c6W4CCU9M4

[4] SAP, Vuzix – AR Picking
http://www.youtube.com/watch?v=9Wv9k_ssLcI