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WEARABLE ELECTRONICS & BIG DATA = HIGH VOLUME, HIGH MIX SMT!

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ABSTRACT
With all the excitement around IoT (Internet of Things), big data and cognitive computing the impact of wearable electronics on the manufacturing environment frequently gets lost in the noise. However, the capability and capacity to serve the needs driven by these trends falls on the shoulders of the electronics industry and in particular SMT assembly. This paper explores the seemingly conflicting requirements of achieving low cost while meeting the high volume, high mix product requirements of this brave new world of electronics systems.

Software tools applied to the world of integrated circuits, e.g. field programmable gate arrays, soft radios, etc. provide the flexibility demanded in the design of smart phones, embedded controllers, and specialty sensors. Drawing on these experiences SMT assemblers can serve the burgeoning world of wearable electronics and tailor individual products to specific applications and environments using rapid change approaches driven by quantitative and qualitative analysis of large data sets that define the market expectations. The authors delve into specific tools being developed in Japan, Germany and the USA that facilitate these approaches while outlining specific changes demanded of the supply chain in order to meet the high mix needs of customers at low cost.

INTRODUCTION
The era of wearable electronics began quietly more than a decade ago with the advent of pedometers to passively monitor walking activity levels and rapidly progressed to today's more sophisticated systems that monitor heart rates, blood pressure and even such things as sweat composition, glucose levels and other body parameters. Even more capable systems incorporate blood sugar sensors & insulin pumps, digitalis injectors or defibrillator activation for smart fabric vests. Only the imagination constrains the potential for wearable devices, particularly in the era of the internet of things where these devices produce incredible databases of information (big data) and interact with cognitive computing systems to improve the quality of life for everyone. And smart textiles continue to expand the possibilities.

Figure 1. Medtronic wearable blood sugar sensor/insulin pump

Similar to many areas today driven by big data analysis, wearable electronics offers the potential to collect huge levels of anonymous data that can be analyzed to define specific solutions to many challenges in the areas of health, workplace safety and simple comfort. However once achieved the implementation of these solutions creates rigorous demands on manufacturing infrastructure with respect to cost management, turn time and inventory management as examples.

Manufacturing Challenges & Solutions
Traditional manufacturing philosophy views markets from one of two perspectives; low volume/high mix or high volume/low mix. Low volume/high mix products generally drive higher costs, longer lead times and higher inventory (primarily of components and subsystems). On the other hand, high volume/low mix products generally result in lower costs, shorter lead times and reduced inventory (of components and subsystems). Of course, these generalities do not apply universally but rather indicate the usual expectations.

As wearable electronics produces increasing volumes of usable, anonymous data for analysis; this analysis results in an ever expanding array of product variations in the manufacturing environment. Consider Pavloc, a device

Figure 2. Pavloc habit forming wearable

for stimulating desired habits for a user. This type of device must eventually interact with a variety of sensor options related to personal behavior/habit (e.g. dietary plans, alcohol consumption, drug use, etc.) in order to create a significant market.

To find examples of solutions to the high volume/high mix manufacturing challenge consider the mobile telephone market. In the late 1990s and early 2000s Nokia and Ericsson pursued a distinct modular approach to the varied demands of the rapidly expanding global marketplace for mobile phones. By designing a set of common motherboards for a small number of hand phone lines and using a selection of common modules for such functions as the radio, personal information management, GPS, power, internet/WiFi, voice recognition, etc. While each handset in a particular series contained the same motherboard, not all handsets contained all the available modular functions. This created the ability to adjust the relative volumes of each handset produced to the actual market demand on a relatively continuous basis.

An additional benefit of a modular approach to high volume/high mix results from the ability to upgrade the performance and/or capability of each module separately and on different schedules without redesigning the entire system. For example die shrinks, memory expansion and speed enhancements incorporated into specific modules without changing the footprint of the module itself provide an upgrade or cost reduction path at the system level without redesign of any other components.

Modularization further contributes simplified manufacturing logistics through reduced parts count at the assembly stage, reducing inventory management concerns and enhancing yield and yield management since modules come to the manufacturing floor fully tested, and when required, burned in.

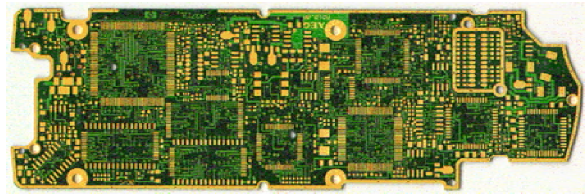

Figure 3. Modularized handset motherboard

Modularization of Wearable Electronics

Like cancer treatments tailored to the genetics of both the tumor and the patient for maximization of effect, wearable electronics will expand greatly with the ability to tailor functionality to the needs and expectations of the customer. Perhaps the simplest initial solution results from modularization of the sensor functions incorporated into such systems. Examples include not only sensors, but also functions already well known such as data storage, management and transmission, security/anonymity controls, GPS, energy harvesting/power management and even drug or treatment provision. While many of these modules remain in their infancy or even simply as preliminary concepts the opportunities abound.

This modularization produces the adaptability demanded by the marketplace, yet reduces the manufacturing challenges described previously through a similar impact to that on the handsets of the last decade. The trade off, of course, remains miniaturization versus flexibility and cost. However as sensor technology continues to progress and our ability to carefully analyze the data collected through these systems manufacturers can rapidly deploy performance and miniaturization solutions in the required modules.

Thus the immediate solutions to our wearable electronics, high volume/high mix production challenge lies in already known techniques from the world of mobile telephony! And as smart fabrics continue to develop and penetrate the wearable electronics market new solutions will present themselves that further enhance the ability to proliferate these systems to the betterment of many lives throughout the world.

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