

# LAI SMART BED

*Tuscany Region  
Production Activities Directorate  
Business Support Policies Sector*

*POR-FESR 2014-2020*

*PROJECT LEADER: MATERASSIFICIO  
MONTALESE S.P.A.*

*PROJECT: LAID - SMART BED*



Regione Toscana





Fondo europeo di sviluppo regionale (Fesr)

Le ali alle tue idee

What is Por Fesr 2014-2020?

To contribute to the implementation of the European Union strategy for smart, sustainable and inclusive growth and to promote economic, social and territorial cohesion. This is the strategic objective of the **Regional Operational Programme (ROP)** of the European Regional Development Fund (ERDF) 2014-2020 of Tuscany.

The project is based on **three strategic choices**:

- priority role of research, development, innovation and competitiveness in the economic system, with particular attention to the manufacturing dimension on one hand and to link between tourism, cities and major museum attractions on the other;
- synergy between increased business competitiveness and environmental sustainability, as a guide for development and production;
- enhancement of the social dimension for local interventions, focusing on services to people and on functional recovery of buildings aimed at the inclusion of vulnerable groups.

Therefore, in order to score more significant impacts, the programme allocates the majority of its resources to support the entrepreneurial system and also concentrates resources on interventions to develop social, service and environmental quality in the territories.



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*The **L A I D** project:  
Linking Automation to  
artificial Intelligence to  
reveal sleep Dysfunctions*

# PARTNERS

- *Materassificio Montalese S.p.A.*
- *BP Engineering S.r.l.*
- *EB Neuro S.p.A.*
- *UniPi*
- *IFC-CNR*



# THE INDUSTRIAL COMPONENTS



Materassificio Montalese is constantly engaged in the study and development of new methods and materials that, in addition to transferring the best of technological evolution to the mattresses, also aims at exploiting all the benefits of BIO products. To ensure sleep in complete harmony with nature is the goal.



EBNeuro is currently engaged in a development plan that aims at designing and integrating new generation wireless systems and accessories devoted to the Neurology and Polisonography sectors in which EBN is already present and market leader.



BP Engineering offers integrated engineering design services. In the Process Automation sector, Bp Engineering is able to offer a complete engineering activity that ranges from feasibility studies to the realization of industrial "turn the key" products in sectors, where pre-designing and precise process control is required. Providing building plans for the industrialization of products and / or processes, developing systems with high energy efficiency is what BP technicians achieve to meet the increasingly stringent needs of customers.

# THE UNIVERSITY AND THE SUPERVISED RESEARCH ORGANISATION



The Department of Surgical, Medical, Molecular Pathology and the Critical Area includes BD courses in Psychology, single-cycle courses in Dentistry and Dental Prosthetics and BD courses qualifying to the practice of various professions in biomedical oriented areas of technical-assistance, technical-diagnostic and rehabilitation. It also offers various postgraduate courses such as master's degrees and specialisation schools, as well as Ph.D, programmes



The activities of the Institute of Clinical Physiology of CNR can be well defined as the synergy of four main areas of interest:

- Preclinical biology and disease mechanisms
- Clinical physiology and health risk factors
- Biotechnology, bioengineering and modelling
- Epidemiology and health promotion

# MATERASSIFICIO MONTALESE, AT GLANCE...

<https://www.youtube.com/watch?v=lsXvBXGs2WA>



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# QUALIFIED CONSULTANTS



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DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



In the project LAID-SMART BED, UniFi will develop:

1. a dedicated software for the central unit that collects data from all the users, and from various types of beds, providing real time aggregated data to the users and also to remote researchers, through a WEB interface.
2. a mobile application (iOS and Android), able to collect data from the mattress/cushion (through a BT interface, for example) so that a data history can be built and transmitted both to the user and, in the presence of an internet connection, to a central unit that is to be developed within this project.

In the project LAID-SMART BED, Centro E. Piaggio takes responsibility:

1. to develop, together with Materassificio Montalese, a production process automation solution based on advanced mechanical technologies
2. to develop, together with Materassificio Montalese, non-destructive testing techniques on final product using technologies that pertain to the field of ICT&Photonics.



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# QUALIFIED CONSULTANTS



Thanks to the skills and qualified professionals, an organizational structure has been developed that guarantees the market an updated, complete and specialized offer of products. With a consolidated turnover of 154 million Euros in 2013, a team of 800 people and over 15,000 customers, VAR GROUP is the leader in Italy in the marketing of IT solutions and services for businesses. In the project LAID-SMART BED will develop the product and process tracking solution through the use of TAG-RFID technologies.



In the LAID-SMART BED project they will support Materassificio Montalese from a technical and IT point of view in order to guarantee full integration of the data resulting from the process innovations (pushed automation of the production process, automatic quality control, production tracking system) within the IT platform and the management ERP present in the company.



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# QUALIFIED CONSULTANTS



The services offered relate to the field of consulting, such as:

- Legal: Legal defense and consulting on trademarks, patents, copyrights, unfair competition, privacy and domain recovery.
- Patents: Patent filing in Italy and abroad, novelty searches, technical appraisals, counterfeit valuations.
- Trademarks, design & copyright Registration and supervision of trademarks, designs and copyrighted works, software protection.
- Consulting: Tax and administrative consultancy on trademarks and patents. Due diligence, extraordinary transactions.

In the project LAID-SMART BED will provide legal advice on trademarks and patents resulting from the project.

Biotech was founded in 2007 with the aim of improving the quality of life of people with severe motor deficits through the design and manufacture of technologically advanced equipment. The centrality of the patient, his health, his well-being, his independence in daily activities, are the focus of Biotech's research activities. In the LAID-SMART project, BED will provide technical consulting for the development of special sensors and the SMART BED power supply system.



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# PROJECT SUMMARY

Insomnia, which in the clinical sense means "individual experience of inadequate or insufficient sleep", is among the most common light-distress conditions of the industrialized world. Just as daytime experiences have a profound influence on sleep, determining in part its continuity, depth and refreshment capacities, so sleep also influences the quality of day-time activities. It is a single cycle, in which awake life and sleeping are interdependent elements. Indeed, insomnia is correlated with high rates of absenteeism from work, with problems of concentration, with the reduction of performance capabilities, and even further downstream, with the number of accidents both at work and on the road. It emerges from the literature that insomniacs have more frequent medical problems, use healthcare facilities about twice as often as non insomniacs, and have a much higher drug use.



Among the medical problems related with insomnia, the best known are: type 2 diabetes, various acute and chronic heart diseases, high blood pressure, dyslipidaemia, and more generally premature aging. It is assumed that, in the presence of chronic insomnia, the probability of death from myocardial infarction or neoplastic pathology increases. Persistent insomnia increases the vulnerability to affective psychopathology (Humor or Anxiety Disorder) whose incidence, in this case, is more than double that of the general population. The project aims to develop intelligent mattresses that can identify insomnia early enough, thereby reducing its socio-economic cost and increasing individual well-being.



The project consists in the R&D of an innovative mattress for the general population with sensors to detect the physiological parameters during sleep, necessary for quantitative measurement of its quality. In addition, the mattress will be equipped with a dedicated sensor able to evaluate the quality of the mattress, from production to final use.

The project involves the development of an application on smartphones for the analysis of data from the mattress. The smart bed will be the ICT platform for web-based sleep hygiene programs. The "smart bed" can collect and provide data to users and should be potentially usable for research. The data collected by the "smart bed" sensors, once suitably aggregated, will be accessible to users and to research/clinical personnel, once the necessary privacy consents are obtained.

Among the physiological indexes, not associated with the electrical activity of the brain, that contribute to the evaluation of sleep quality, we have kinematic (attigraphy) and autonomic measurements. So far no devices exist on the market that evaluate sleep quality by integrating all such indices. UniPi has developed methods to integrate sleep parameters that constitute the basis of a global index of sleep quality.

Preliminary to the development of the mattress is the optimization of the algorithm of integration of sleep parameters as a function of the sensor of the "smart bed". The entire "smart bed" system (sensors, analysis and application algorithms) will be validated using gold standards for the assessment of sleep quality (polysomnography, sleep diaries and psychometric tests) on both healthy subjects and patients with sleep disorders.

The project will therefore cover R&D and deployment of:

- an intelligent sensorized mattress
- specific sensor technology in the mattress for sleep evaluation
- a sleep quality analysis dedicated software
- cloud application that collects and makes user data available for search (on-demand)
- traceability system and product/process monitoring of the mattress from the factory



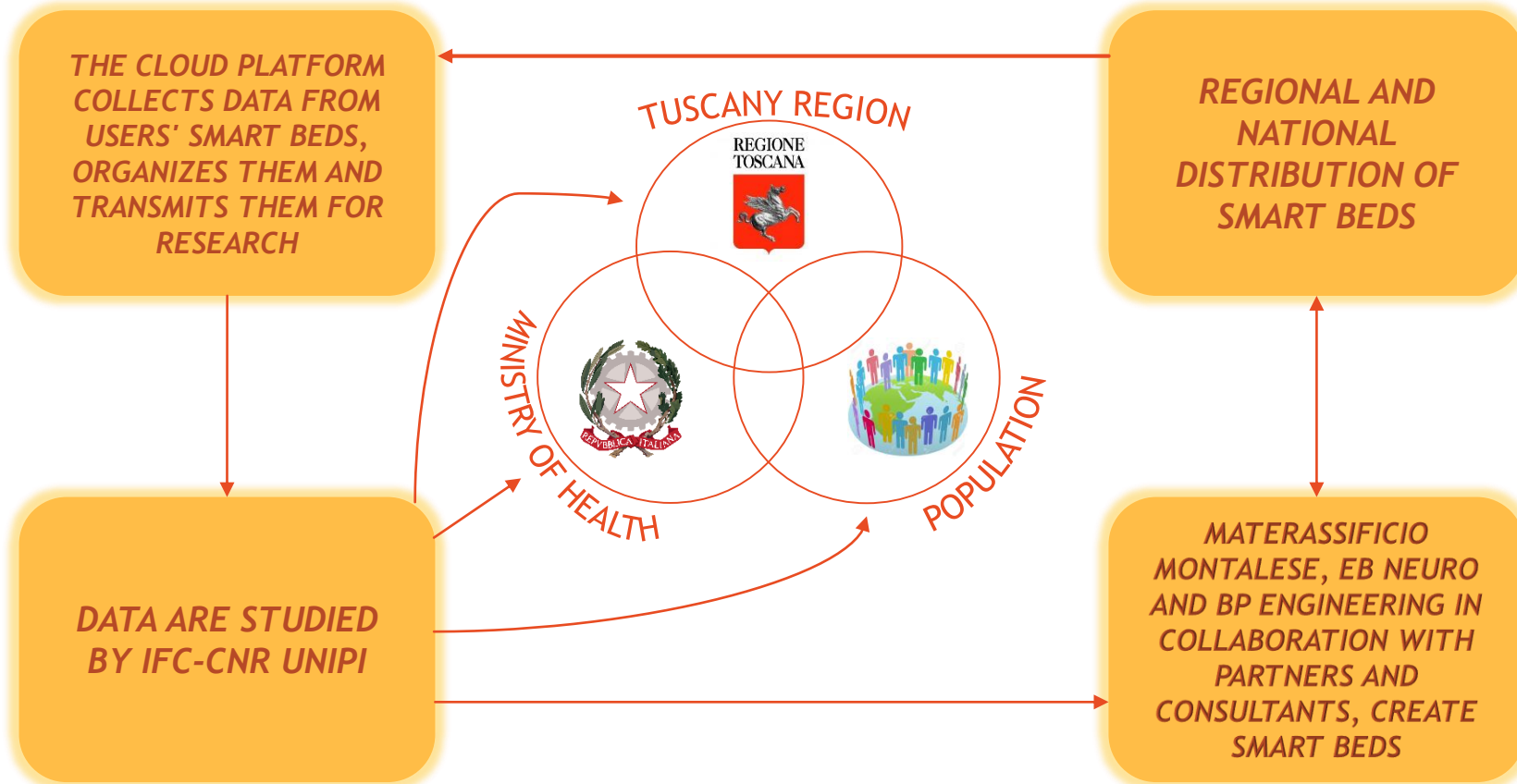
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Therefore the project will combine industrial needs, health/social needs and primarily individual well being (improving the individual approach to sleep) with collective needs (providing tools for epidemiological studies on sleep).

## SMART BED



# Behind the project - The idea

Contrary to common opinion, it has been known for over half a century that the sleeping brain is not simply a resting brain but, on the contrary, is actively involved in dynamic and metabolically complex processes. Sleep is fundamental for the survival of the organism and indispensable for its well-being. If shadows still remain on the primary function of sleep, deprivation studies show that it is essential for the survival of the organism and for the integrity of its main activities (Rechtschaffen et al., Science, 1983). In the range of hypotheses that have been put forward we find that sleep is useful in energy conservation and contributes to the conservation of homeostasis, given its active participation in the control mechanisms of thermoregulation, cardiorespiratory and immune functions (Meerlo et al., Sleep Medicine Reviews, 2008; Bryant et al., Nature Reviews Immunology, 2004). In the late several years, attention has been focused on the potential role of sleep in "energy recovery of neurons" and the mechanisms of brain plasticity related to the processes of storage and "anti-aging". Currently, the belief is being imposed that sleep is essential for the preservation of the integrity of synaptic networks (those contacts through which brain cells dialogue with each other) because it favors a periodic activation of the various neural circuits, including those not sufficiently activated during wakefulness. In this perspective, the task of sleep is to reorganize the synapses, in the framework of a "dynamic neural stabilization" (Tononi G, Cirelli C, Brain Research Bulletin, 2003). Wakefulness activities induces a strengthening of the synapses in the circuits which, homeostatically, must be regulated during sleep at slow waves. The optimization, by means of reduction, of the synaptic circuits is at the base of the beneficial effects of sleep, also of that sense of refreshment that rejoices us in the morning after a good night's sleep.

From these brief words we can see the importance of the condition of sleep, which not by chance occupies a third of our lives, on which our freshness and psychophysical wellbeing depends, as much as the stability of our mood, memories, cognitive abilities and finally the quality of our health. It becomes equally clear how its alteration can help to undermine the entire homeostatic scaffolding and adaptive functioning of the human body.

The interest of medicine towards sleep alterations has progressively increased since it was shown that a disturbed sleep can represent a risk factor for Mood (in particular for Depression) and Anxiety disorders and for some internal pathologies, in particular cardiovascular and metabolic (including obesity) and for neurodegenerative pathologies such as cognitive pathological decay (Mild Cognitive Impairment and Alzheimer's disease), as well as for early brain aging.

Some epidemiological data indicate that individual experience of inadequate or insufficient sleep is among the most common conditions in the industrialized world. Suffice it to say that a mild and sporadic form of insomnia potentially affects everyone, regardless of class, economic class, social or professional. In the Italian population, according to a survey conducted in the clinics of the general practitioner, a disturbed sleep experience, not necessarily of clinical interest, is found in almost 65% of our fellow citizens (Terzano et al., Sleep Med, 2004). Those who suffer from inadequate and unsatisfactory sleep usually complain during the day more or less intense drowsiness and a series of dysfunctional disorders both somatic and psychic. Just as daily experiences have a profound influence on sleep, determining in part its continuity and even more directly its depth and refreshment capacity, so sleep is also more or less directly at the basis of the quality of waking. It is a single cycle, in which waking and sleeping are interdependent elements. It is therefore not surprising that an altered sleep is correlated with high rates of absenteeism from work, with problems of concentration, with the reduction of performance capabilities, and even more downstream, with the number of accidents both at work and on the roads (Leger et al., Sleep, 2002).



Sleep and its disorders even in the pre-clinical or sporadic phase therefore require an attitude different from what is sometimes still observed today by society, by common thinking (eg. sleep is lost time!) or by the medical class in general, which should instead promptly worry about its protection, in the same way as it is done for cigarette smoking and hyperalimentation, or rather for the now socially and scientifically accepted risk factors for cancer, cardiovascular and metabolic diseases. Those who suffer from disturbed and unsatisfactory sleep are exposed to a series of consequences that go far beyond drowsiness and tiredness, which are sufficient to compromise the quality of life of such a large number of fellow citizens. Therefore, the constant monitoring of sleep, together with the possibility of rapidly establishing an adequate change in lifestyles, represents a "hot spot" in preventive medicine, personalized and participatory.

It is therefore easy to understand the simplicity and originality of the basic idea of this project, which is to build a "smart mattress" (SmartBed) that can record vital and environmental parameters, analyze them and, based on these, provide information on sleep quality, stress levels, and more generally on the state of well-being and quality of life of an individual. The objective is ambitious as the "non-electroencephalographic" assessment of sleep and its quality as well as well-being is an open and complex issue. In man, for example, the electrophysiological parameters of polygraphysiology are an objective and well established methodology to distinguish it from waking and analyze its architecture, or the various steps in different stages, which follow one another in a night's sleep. Sleep evaluation, based on these signals, which for now are only accessible in the laboratory, involves a deep knowledge of the analysis methodologies and the most recent developments in the study of sleep physiology. However, it is also possible to determine sleep architecture from signals of the autonomic nervous system (e.g. cardiorespiratory activity), and, from architecture onwards, many indications of sleep quality can be provided. The challenge is to monitor these signals in a "smart" way, that is fully automatic, harmless, and non-invasive, and analyze these signals based on the latest developments in physiological research and bioengineering techniques (sensors and signal analysis). The user does not have to do anything but "sleep on it", but at the same time will have a range of technologies available to obtain information useful to know and then consciously manage their health and well-being.



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The human being spends about a third of his life sleeping or trying to sleep. The first reason is that SmartBed represents an intelligent structure that, on average, could evaluate a third of our existence; the second reason is that only during sleep we can acquire, in "smart" mode, some vital parameters that, otherwise, would be altered by the behavioural activity of waking (for example, alterations related to repeated and intense movements, environmental noise, etc.). SmartBed will therefore be equipped with innovative, invisible biomedical sensors and a hardware/software platform for assessing sleep quality and well-being.

In summary, SmartBed will consist of a sensor system for non-invasive physiological monitoring of subjects during sleep and wakefulness prior to falling asleep and following morning awakening. This system of sensors will be incorporated into the mattress and connected to a dock station (which will also record environmental data) outside the mattress that will act as a central storage, processing and integration of physiological and environmental data. The heart and main innovation of the SmartBed system is the data processing software. This will be based on the latest scientific knowledge in the field of sleep and well-being and will provide users with detailed information but easy to understand on the quality of their sleep, but more generally on their well-being.

In order to make SmartBed easy for users to use, the communication and control interface of SmartBed will be realized through the development of a dedicated "App" for smart devices (smartphone/tablet) and PCs that can connect to the dock station via wireless connection. The SmartBed dock station will have the ability to interface (via wireless connection) with mobile or wearable smart devices (smartphones, smartwatches, smartbend), in order to obtain information about the activities that the user performs while awake. In this way, it will be possible to integrate sleep and wakefulness data (before falling asleep and after waking up) with those of wakefulness during the day and thus obtain more complete quality of life indices that are representative of psychophysical wellbeing.

SmartBed, in addition to being a useful aid to correctly modulate our lifestyles, can therefore provide useful guidance to doctors or psychologists. For example, we can imagine its use for a more accurate and objective assessment of the effects of hypnotic therapy or diuretic therapy or cognitive-behavioural therapy of insomnia.

The social and health impact of SmartBed would be negligible if it were limited to a niche product. A considerable part of the consortium's efforts in this project will be aimed at producing the finished product in such a way that it can be marketed at affordable prices for all families. This can only be achieved with a complete "smart" industrialization in the manufacture of SmartBeds. In this regard, the lead company Materassificio Montalese will introduce significant changes and improvements to the production process, in all its phases. The key point of the SmartBed project is the quality of the product, which will be obtained not only through the introduction in the production line of the equipment necessary to make the mattress "smart", but also through an improvement and optimization of all the steps of quality control through automatic and flexible procedures. This phase of the project also represents a pilot phase from which to extract the specifications to be implemented on 100% of the mattress factory's production, even beyond the specific line of the mattress proposed in the project, with the final result of making the entire Montalese Mattress Factory "smart", which will become a "SmartFactory". The use of new and interactive machinery and procedures will be combined with an improvement in the work itself in terms of safety and ergonomics.

The "SmartFactory" will therefore be based on the use of a system based on platforms with innovative ICT technologies. A fundamental point for quality control will be the introduction of electronic tracking, using RFID technology of the product during processing and marketing, resulting in lightening the work of management and control. The control procedures on the production line that will be made automatic will be related to the size of the line, the rigidity and density of the padding materials, residual moisture, the presence of metal residues, the operation of electronic equipment. More closely linked to the production of SmartBed will be the introduction of processes for the insertion of electronic components into the mattress. The introduction of a new raised edging line will significantly improve the quality of the work of line operators.

From a social point of view, the result of the project, beyond what is produced in terms of instruments and operating models, is the implementation of an integrated system aimed at the responsible and daily use of a general population increasingly aware and participatory with regard to their health and well-being. This component places the project in the context of a new "technological humanism" in which the contribution of partners apparently not related to each other is summarized in the realization of a project at the center of which is man and his quality of life (both the one who sleeps on the mattress but also the one who operates in its realization!), understood mainly as harmonious integration with the physical, architectural and social environment. The user of the product is not the only beneficiary of this innovation. The people taking part in the project will benefit from an innovative, interactive and flexible "SmartFactory", with a reduction of the alienation due to hard and repetitive tasks, but rather with a strong retraining, in terms of skills, of the operators involved. On this basis, the philosophy of the project can become a technological/scientific/social reference for all operators in an industrial environment, who in the future will have to benefit from a real innovative know-how, where man, his safety and health (stress-work-related and professional pathologies) are at the centre of industrial development and basic research.



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# Behind the project - State of the art

The project involves R&D and the creation of intelligent mattresses equipped with sensors to monitor the sleep of users / patients through the detection of various human parameters (movements, heart rate, breathing, sounds, body temperature, etc..) and environmental (cardinal position of the bed, temperature of the room and the mattress, humidity, noise, etc..).

The project also involves the development of an application on smartphone/tablet that acts as an interface between the user and the "dock station" where data from the mattress is stored and processed. The application will enable the user to know the "numerical indices" of his sleep quality, or know, morning after morning, how much and how well he slept at night. The application will also be able to manage the processing by the dockstation of daytime activity signals, acquired, for example, through wearable smart devices (smartwatch, smartband, etc.) and to integrate them with those of sleep, to obtain an overall index of well-being.

It will be possible, through a web connection, to store and process data in a dedicated "cloud" (ad. e.g. for epidemiological studies of sleep hygiene and population welfare, or to have the data available for medical and preventive purposes). In this perspective, the project, which foresees a "sensor equipped bed", is part of the global control approach through the Internet. The system will be able to collect data by type of user and potentially provide useful data for clinical research. Among the physiological indexes not associated with EEG that correlate with a good quality of sleep, kinematic, postural and autonomic measures (cardiorespiratory, temperature, etc.) play a significant role.

As low-cost solutions for monitoring sleep and health, Apps for smartphones are quite popular. Some of them base the operation on the presence of a bracelet and / or watch that can detect the heartbeat, movements, etc.. Among these: FitBit, Jawbone UP. Others ask the user to place the smartphone on the mattress, such as Sleep as Android, MySleepBot, SleepCycle, etc.. In the latter case, the smartphone sensors are directly used, recording not only vibrations but also sounds, etc. These systems are of low quality and present major problems of precision and reliability. In some cases, some mobile applications try to complement sleep assessment with information about food, water, alcohol, coffee consumption, sports activity or not during the day, and more. Other mobile applications add functions to facilitate sleep such as music, sounds, lights, etc., or to stimulate the interruption of snoring, generate the alarm at better times, etc..

Professional methods are based on detection tools that should be worn by the patient such as chest belts, bracelets, children's mats, EEGs, etc. These solutions are often too intrusive to be used directly at users' home and without affecting the measure itself.

There are some "smart bed" solutions available, especially in the USA. In some cases, smart beds have actuators to manage the movement of the head and the legs, to produce sounds, and/or vibrations, etc. Others have synthetic information derived from the surveys directly on smartphones or devices / remote controls. The solutions proposed, which have different types of precision, are sometimes very costly

We would like to point out the following links to the most complete solutions, in our opinion, available today on the American market and/or on the EU market:

- ▶ <http://bamlabs.com/> (see also [www.dailymail.co.uk/sciencetech/article-2535859/Solving-insomnia-21st-century-5-000-smart-bed-monitors-movement-breathing-heart-rate-perfect-nights-sleep.html](http://www.dailymail.co.uk/sciencetech/article-2535859/Solving-insomnia-21st-century-5-000-smart-bed-monitors-movement-breathing-heart-rate-perfect-nights-sleep.html))

The "sleep numbers" line, equipped with "sleep IQ" software from bamlabs, offers integrated bed solutions or simple mattresses that cannot be used with any type of bed. This is the consequence of the technology used, which makes use of a variable number (with the price) of air chambers that act both as sensors and actuators for greater or lesser local rigidity. A disadvantage of this technology is the need for soundproofing of the pumps and space for insertion into the mattresses. The mattresses have a thickness of more than 30 cm, with problems for the insertion in many beds or the use of common sheets with corners or mattress covers. It is not clear whether the air chamber system can be positioned on slatted frames, which is the standard in Italy and many European countries (the US standard provides a base with a smooth top surface, called "springbox"). A further disadvantage is the energy required by the actuator/sensors (pumps), which require connection to the electricity grid.

- ▶ <http://www.smartmattress.nl/> is an air mattress that uses similar technologies, but is placed under the mattress for clinical use. It is effective for monitoring movements, it does not seem capable of ensuring a monitoring of autonomic and environmental parameters.
- ▶ <http://lunasleep.com/> is a US project in the crowdfunding phase. It is a mattress cover that regulates the temperature (heating and cooling) through a matrix of resistive elements, also capable of monitoring the local pressure. A band of conductors placed close to where the chest is supposed, allows you to extract the heartbeat. In this case, too, the connection to the electricity grid is necessary.



In addition to the above mentioned technologies, based on pressure gauges, at patent level there are several that describe "smart bed" or "smart mattress" or "smart mattress covers", with different technologies capable of performing the measurements we propose. It is generally a matter of providing grids of accelerometers and/or inclinometers, or piezoelectric sensors, or elastic conductors woven into fabrics like Lycra. The scope of these patents ranges from clinical monitoring to the prevention of white deaths, up to purposes that can be superimposed on those of the current project. We do not have any patents for using magnetic sensors or fibre optic bending sensors in such systems.

In terms of company technology, Materassificio Montalese has a technology called Ergo Check which, by analysing the pressure exerted by the various parts of the body (with 648 sensors) on the various areas of the mattress, makes it possible to optimise its support capacity.

At present there is no device on the market that evaluates the quality of sleep in an objective and scientifically correct way, integrating all the measurements that can be performed daily in a fully automatic, non-invasive, without the need for the user to perform any type of intervention. The University of Pisa has developed methods for integrating sleep parameters that are the basis of a synthetic index of sleep quality. The project aims at absolute innovation by integrating the above results of medical/scientific research into a mass industrial product.

# Behind the project - Objectives

The aim is to create a highly innovative mattress: no longer a merely passive object, but an active device that through the analysis of our behavior during sleep-time can lead to useful indications for our well-being and health. The mattress is the object with which we are most in contact, so the idea of using the hours of sleep to assess one's well-being opens the field to a range of possible beneficial effects. In addition, the intelligent mattress will be the ICT technology basis for future clinical research studies on sleep hygiene and well being in general. An R&D path will be undertaken to develop the new product and adapt the production process to it.



The project will mainly concern the study, design and implementation of:

- ▶ Sensors (inside the mattress) and electronics (inside and outside the mattress) for the detection of various parameters, body and environment (humidity, temperature, pressure, heart rate, position, etc.) during sleep and wake before and after sleep.
- ▶ Wireless/bluetooth transmissions between mattress and smartphone/tablet/smartband.
- ▶ new power supply and recharging system to guarantee maximum safety for the users of the mattress.
- ▶ Development of the local dock station software to collect and process data from the users, to provide aggregated data to the users. The software will provide synthetic indices of both sleep quality and user well-being.
- ▶ Application for smart devices (smartphones, tablets, PCs), which will be the user interface to display the quality indices of sleep and well-being, and to allow the management of data stored in the "dock station" and possibly send them to a dedicated "cloud" platform. At the user's request, the application will be able to collect the user's daily activity data, so that they can be integrated with the user's sleep data.
- ▶ new mattress processing (e.g. new edge-banding lines) to insert the electronic circuits inside the mattress.
- ▶ Process and product traceability system using RFID tag technology.
- ▶ Validation of process and product conformity

The above points will be detailed in the description of the Operational Objectives and Activities, and all duly validated. The technologies introduced, thanks to the contribution of research institutions, will ensure that the sector will undergo a real technological revolution.

It is clear that the described innovation remains an end in itself if not accompanied by an industrial process that guarantees the possibility of production and diffusion in large numbers. For this reason, the company's objective is to develop a new industrial production line, which at the end of the project will be able to produce what is illustrated by applying the most advanced concepts of the smart factory.

The innovative process aims to maximize product quality by introducing equipment, procedures and quality standards that have never been used before in such a widespread way in the same production sector: given the complexity of the smart bed mattress, in fact, only the absolute quality of the processing, the accuracy of the controls and the reliable identification of each phase and component can guarantee the functionality of the finished product and its success on the market.

A poorly controlled production process, free of the controls provided for within this project, could only lead to an unacceptable level of quality of the final product and to the commercial failure of the project.

The product to be developed, at the highest level of innovation and technical solutions, has the ambition to be competitive and to be a global reference, and certainly represents a unique solution of its own kind for the national market. This should strengthen the position of the leading company in its sector, with a strong impact on the other involved companies, in terms of ongoing collaboration and business relationships (consulting, supplies, etc.).

Just as the product sector will benefit greatly from the interaction with the University and the CNR, these entities will also benefit from the interaction, as the product can be configured as the new gold standard for clinical and basic research and population on well-being in general and sleep in particular.

Finally, as a result of the above two objectives, it will be possible, on the basis of the project, to continue the collaboration between research institutions and the involved companies in order to optimize the SmartBed for routine applications in the clinical field. This would open up to the consortium the market for the supply of electromedical mattresses for the healthcare sector.

The future must necessarily combine the skills acquired in ICT-photonics-nanotechnology of materials in order to have a mattress that is intelligent, adaptive, speaking and affordable.

# ACTIVITY FLOWS

