GCSM
Global Conference on Sustainable Manufacturing

12th Conference on Sustainable Manufacturing (GCSM)
Johor Bahru, Malaysia, September 22nd-24th 2014

Blue Responsibility Award:
Manufacturing for a Sustainable Terra Preta Sanitation System

Innovative equipment based on blue economy principles for daily basic needs

The GCSM 2014 "Blue Responsibility Award: Manufacturing for a Sustainable Terra Preta Sanitation System" intends to stimulate the development of new sustainable sanitation systems that enable the reuse of human excreta. The objective of the competition is to design a sanitation system that creates the maximum value from what is today considered as waste and can be implemented in urban areas of early industrialized as well as emerging countries. Submissions are to be defended and the prize shall be awarded at the 12th CIRP Global Conference on Sustainable Manufacturing, GCSM 2014, September 22nd-24th 2014, Johor Bahru, Malaysia.

Competition announcement on GCSM webpage: November 15th 2013

Final date of registration for competition: February 28th 2014

Full proposal submission deadline: July 31st 2014

1 Press release

In short: *With around 40% of the world's population currently lacking basic sanitation, the need for sustainable solutions on this issue is urgent. In order to demonstrate the broad range of applications of sustainable manufacturing, the organizers of the 12th Global Conference on Sustainable Manufacturing (GCSM) open today the competition for the "Blue Responsibility Award: Manufacturing for a Sustainable Terra Preta Sanitation System".*

According to UN Water, 2.5 billion people do not have access to basic sanitation. As a consequence, it is estimated that every 20 seconds a child dies as a result of poor sanitation. One notable cause is the large part of non-treated household wastewater that is directly returned to the environment and contributes to the development of diseases. In areas where water-based sanitation systems are broadly implemented, other issues arise: In Germany for example, each person consumes on average around 35 litres of freshwater to evacuate her/his daily production of 1 to 1.5 kg of excreta according to the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. In other words, 35 times more water than our excreta volume is used only to transport it away. Aside of water consumption, the complex infrastructures of pipes, sewers and clarification plants require significant amounts of resources. Moreover, the systematic elimination of human excretions, which are no longer returned to the soil, breaks the nutrient cycle and impoverishes the soil, ultimately leading to erosion and a higher use of chemical fertilizers.

Consequently, current available water-based sanitation systems are, on one side, insufficiently accessible by the emerging countries and, on the other side, environmentally inefficient as implemented in earlier industrialized countries. More environmentally and economically efficient solutions are called for. One of the possible approaches is the so-called Terra Preta Sanitation Systems. The basic principle of these waterless sanitation systems is to collect excreta with the help of dry toilets in order to elaborate fertile soil substrate that increases food production yields. These systems would offer users the double benefit of reducing detrimental health effects from lack of sanitation, while providing them with a natural and sustainable source of fertile soil. Although the principle of these sanitation systems is roughly specified, so far, no comprehensive market-ready solution is available for a large scale implementation.

In order to meet this challenge, the GCSM organizers, with the support of the World Toilet Organisation (WTO), launch today an international competition for Sustainable Terra Preta Sanitation System Design. The aim is to design and to prototype a comprehensive sanitation system that could create value with what is today considered as waste while requiring minimal material input e.g. infrastructure and water and therefore being implementable in urban areas of early industrialized as well as emerging countries. The award of 10 000 Euros is to be shared among the best contributions. The best contributions will be identified by an independent jury led by Prof. Gunter Pauli, founder of the Blue Economy initiative. The winners will be announced at the 12th CIRP Global Conference on Sustainable Manufacturing on September 24th 2014 in Johor Bahru, Malaysia. Hands on! We look forward to receive your applications!

Berlin, Friday, November 15th 2013.
Prof. Dr.-Ing. Günther Seliger
Chairman of the GCSM Scientific Committee

2 Competition Rules

2.1 Context and challenges

Sanitation is first a social necessity that still has to be fulfilled in some parts of the world. 40% of the world's population is still lacking basic sanitation, according to UN Water. Often combined with an incomplete treatment of waste house water, this lack of sanitation remains a significant cause of illnesses and deaths in some areas. Existing solutions implemented by early industrialized countries are still not under the reach of emerging countries. Therefore cheaper and locally accessible solutions are required to improve this situation.

But sanitation is also of environmental concern. Since humans are considered to be outside the feedstock chain, human excretions have been considered as waste rather than as valuable resources for agriculture. Sanitation systems have been designed to eliminate them rather than to use them. This leads to two major problems:

- High usage of water and energy (on average in Germany, for example, each person uses 35 litres of fresh water per day to flush their urine and faeces down the drain) and use of complex and costly infrastructures (e.g. sewages systems, treatment plants) that hamper their deployment in the poorest areas where water and energetic resources are scarce.

- Dissipation of valuable nutrients e.g. N, P, K and carbon that could be returned to the soil.

In summary, current available water-based sanitation systems are on one side insufficiently accessible by the emerging countries and on the other side environmentally inefficient in the mode as implemented in earlier industrialized countries. Innovative solutions according to economic, environmental and social criteria ought to be developed.

2.2 Objectives of the competition

The traditional Global Conference on Sustainable Manufacturing (GCSM) has evolved into a yearly meeting point of predominantly manufacturing oriented engineering researchers open for coping with global challenges of sustainability in interdisciplinary exchange of ideas, concepts and solutions with scientific and industrial partners and stakeholders. Sanitation systems are artefacts meeting basic daily needs of humanity. Each person of the more than seven billion people around the globe is affected by this issue. Huge potentials in a social and environmental perspective can be exploited in connection with excellent chances for business cases in the sense of the blue economy principles described by Gunther Pauli (see selected references in annex). Therefore, the GCSM community is on the verge to push the awareness of sanitation innovation by a respective competition among competent stakeholders.

The objective of the competition is to design a sustainable sanitation system, considering the following criteria:

- Delivery of a competitive and comprehensive solution integrating toilets, excreta storage, transportation and transformation into fertile soil enabling food generation. Decentralized closed loops in urban environment with respective logistic infrastructure, including

maintenance, repair, overhaul and related services, shall be addressed. Respective business models shall be specified.

- As it presents a greater challenge, the focus lies in urban areas. Hence, the sanitation systems should not only be implementable into separated one family houses, but also into residential buildings concentrating several households as well as community and commercial buildings. An urban area of 20 000 inhabitants can be taken as an exemplary reference.

- As sustainable sanitation is a topic of global relevance people in all areas of the globe, therefore the competition does not focus on a defined geographic area, i.e. early industrialized or emerging countries. Contributions shall find a balance between the definition of a specialized solution and its adaptability to a wide range of geographies and cultures.

One promising type of solution are the so-called Terra Preta Sanitation Systems: Based on different steps of treatments of the excretions, notably anaerobic fermentation and composting, these sanitation systems allow collecting human excretions in order to create nutrient-rich fertilizer aimed at feeding the soil back, thus leading to a closed-loop system. Further information about this approach is included hereafter.

2.3 About Terra Preta Sanitation Systems

Terra Preta is a very fertile manmade soil. The knowledge to produce these soils with very high humus content was rediscovered in the Amazon area. Terra Preta is a result of an efficient waste management system and can be produced anywhere. The main ingredients of Terra Preta are charcoal and organic waste, e.g. kitchen waste and human excrements. High soil fertility is the basis for food security and self-determined life without poverty.

Terra Preta Sanitation Systems (TPSS) intend to provide an alternative to conventional sanitation systems and organic waste management by challenging their two major disadvantages: ecological inefficiency and deployment cost. They provide a comprehensive and efficient solution to the challenges raised by sanitation and food security.

2.3.1 From food to fertile soil

The concept of TPSS implements the idea of a natural and circular system of nutrients “from food to fertile soil”. Human excreta are collected preferably using waterless toilets and are treated using lacto-fermentation, a process that ensures the highest retention of valuable nutrients while providing an odour- and pathogen-free storage. This process requires the addition of charcoal and a microbial mix to the organic wastes as well as anaerobic environment. The generated substrate can then be collected by a dedicated service and used for the creation of Terra Preta, a highly fertile and sustainable type of soil. This nutrient rich material is mixed with mineral materials to generated stable humus. This very fertile soil ultimately ensures the production of new food without mineral fertiliser, thus closing the loop of human nutrition (see the following illustration).

Closed loop of nutrients

2.3.2 Current situation

TPSS are a network of processes constituting a closed loop of materials. Up until now, several concepts, prototypal realizations or market-ready products have been proposed for each of these steps. However, a whole market-ready sanitation system that could be implemented in urban areas of early as well as late industrialized countries is still to be developed.

2.4 Acceptability and Evaluation Criteria

2.4.1 Minimal requirements

The consideration of submitted contributions requires:

- The provision of a convincing description of a comprehensive sustainable sanitation system and its functioning principles. Sustainability shall be considered in its three dimensions: economic, environmental and social. **Minimum requirements are: 1) a technical description of the designed system and 2) a business plan including an estimation of the costs and gains for manufacturing, installation and operation.** The feasibility of the submitted design can also be supported by logistical, biological, agricultural, chemical, hygienic as well as sociological considerations.

- The proposition of a fully defined solution for at least one element of the whole chain. This element must be integrated in a completely described closed loop system meeting the sustainability criteria of economic competiveness, environmental friendliness and of socially enabling for creativity and initiative. This solution shall be at least supported by a digital prototype and, if possible, a physical prototype.

- The digital prototype must be documented by complete digital representation, figures and an expressive written description. E.g. a toilet as an element should be specified by CAD files, a

bill of materials, assembly plans, definition of manufacturing techniques, as well as costs estimations including production, installation and operation.

- In order to ensure that all elements of the closed loop system will fit well together, the interfaces of the prototype, the completely specified solution respectively must be clearly described in their integration with the other elements.

- Real world implementations are welcome and encouraged.

2.4.2 Evaluation criteria

The eligible submissions will be evaluated by the criteria given in Table 1. Each parameter will be evaluated and given a note with the help of a scale 1: poor, 2: sufficient, 3: good.

Criteria
1. Technical design
a. System efficiency: minimization of the loss of carbon and nutrients (N, K, P) in the whole system, very low use and waste of carbon, nutrients and water.
b. Ease of deployment: the solution should have a reasonable total life cycle cost, including production, installation, maintenance and operation costs, and shall avoid the necessity for developing heavy infrastructures.
c. Technical adaptation to the targeted specific situations: countries, types of habitat, local materials and processes, manufacturing systems, mass production or local production.
d. Sociological adaptation to the targeted cultures: acceptability for the population, especially the feminine users; consideration of cultural differences in the use of toilets, e.g. sitting vs. squatting, water cleansing vs. toilet paper.
e. Adaptability of the system to a wide range of cultural and technical situations.
f. Robustness: minimal deviation of the operation of the proposed system to input parameter changes; can be demonstrated e.g. through a Failure Mode and Effects Analysis (FMEA).
g. Hygiene: provision of innovative answers of the challenges raised by a safe and hygienic handle of human excreta.
h. Sustainable design: e.g. cradle-to-cradle/blue economy thinking, low use of energy and materials, recyclability or remanufacturability, maintenance-ready and long-lasting solutions, social value creation.
i. Ergonomics, aesthetics: low effort of use, minimal change of the user experience compared to existing solutions, robustness, aesthetic attractiveness.
j. Consistency: Adaptation of the individual designed elements to each other, quality of the interfaces.
2. Business model
a. Value creation: maximum ratio between value creation and material losses, the understanding of value is to be interpreted and defended by the applicants. Motto: “make sustainable business out of shit”.
b. Realistic underlying business models: reasonable hypothesis, through e.g. proof of prices and costs.
c. Creation of business opportunities for local producers or service providers.
d. Sustainability of the business model, the understanding of a sustainable business model is to be defined and defended by the applicants.
3. Quality of submission

a. Innovation: Ideas that have already been developed can be used for inspiration but need further development to qualify for the prize, e.g. solutions that improve and expand existing designs especially for more robust and reliable toilets are welcome.
b. Quality of the provided overall design: feasibility, comprehensibility and methodical approach.
c. Clear description of the digital and/or physical prototype, including functionality and market-readiness of the solution, provision of documents allowing a quick industrialization, quality of the interfaces with other elements.
d. Quality of the provided documents: proficiency in the use of the English language, ease of reading, convincing argumentations, provision of clear textual and visual explanations, consistence of the used terms and definitions.
e. Quality of the performed presentation

Table 1 - Evaluation Criteria

2.5 Prizes

The reward to be distributed among the participants and corresponding to the sum of the donations of our generous sponsors is 10 000 Euro. The contribution that provides the best answers to the above listed criteria will be awarded with the main prize. Additional prizes rewarding high quality contributions on specific criteria are also to be awarded by the jury.

2.6 Participation Rules

2.6.1 Important dates

Event	Date
Official launch of the competition and publication of the present document.	November 15th 2013
Registration deadline. The registration form has to be asked for and submitted per mail to the contact information given in this document.	February 28th 2014
Deadline for full submissions. The full submission has to be sent per mail to the contact information given in this document. A requirement list for this submission is provided with the registration form.	July 31st 2014
Announcement of shortlisted contributions. On the basis of the documents provided by the competitors, the jury will evaluate the contributions under the criteria listed at section "2.4.2 Evaluation criteria", and select the contributions that will be allowed to participate in the final round.	August 31st 2014
Final round and awarding. At the 12th Global Conference on Sustainable Manufacturing (GCSM 2014) in Malaysia, the winners present their results to the scientific community (physical presence or video conference) and the jury decides on the distribution of the prizes.	GCSM 2014 (September 22nd – 24th)

2.6.2 Eligibility of participations

Submissions following the subsequent criteria will not be considered by the jury:

- copied designs

- no compliance with the given technical criteria and competition rules
- too low applicability or usefulness of the submitted designs

In case none of the submissions are selected by the jury the award will be extended to a new time period. All submissions that display specific qualities as required will get a certificate from the organizers.

2.6.3 Intellectual property rights

In order to ensure a maximal dissemination of the developed solutions, this competition adopts an open design perspective. The submitted design should be labelled under Creative Commons Licenses. The choice of the Creative Common License version is left open to the participant. The organizers reserve the right to publish the provided documents in whole or in part or use them in any way they within the limits accorded by the Creative Common License chosen by the participant. Please visit http://creativecommons.org/ for further details regarding this topic.

2.6.4 Language

The competition submission must be prepared in its entirety in English language.

2.6.5 Information exchange

Information exchange between participants is highly encouraged. A list of registered participants with the contact information of corresponding representatives will be published after the registration deadline.

2.7 Contact

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3 Annex

3.1 Selected references

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3.2 Weblinks:

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http://stoves.bioenergylists.org/files/micro_gasification_cooking_with_gas_from_biomass.pdf

http://terrapreta.bioenergylists.org/

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(DE) http://prinzessinnengarten.net/

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