Social Sustainability and Manufacturing Simulation

Defining Social Criteria for a Holistic Sustainability Simulation Approach in Manufacturing Companies

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***Abstract* — This paper presents the concept and prototype of a plugin, as part of a software suite (MILAN), aimed to provide technical analysts with the means to simulate various sustainability criteria in manufacturing companies. The plugin is intended to enable analyst to freely define relevant social influence indicators, as well as influence functions and combine them with the existing environmental and economic modeling approach. Various social indicators are, on the one hand still fuzzy, as well as disputed, and on the other hand, dependent on the company's structure. In this regard, the free definition aims to give the modeler the needed flexibility to create a model of his choosing, while also providing him with a structural guideline on how the integration of social criteria is best realized in a holistic sustainability approach. This paper thus addresses the key challenges of the integration of a social perspective in manufacturing simulation and gives an overview over a first implementation of a software that is able to integrate the economic, environmental and social dimension in a single model.**

Keywords – sustainability; discrete event simulation (DES); material flow analysis (MFA); life cycle analysis (LCA); social life cycle analysis (SLCA).

I. Introduction

From the very start of the modern sustainability debate the idea always included the call for the third pillar of sustainability, i.e., the social pillar, resulting in the term of the triple bottom line [1]. While the classical usages of simulation considering the economical perspective of manufacturing systems and its rather output oriented point of view have already been discussed in much detail [2], the social perspective is, to this day, underrepresented in modern simulation tools. That is, even though many Occupational Health and Safety (OHS) factors, such as ergonomic criteria, or influences through material exposure play an important role in the planning of new and legal compliance of existing entities [3].

Aside from the obvious still debated definition problem of social sustainability [4] the integration of such a perspective is facing other problems, for example the fact that the correlations between humans and their environment are highly dependent on both, which makes a general handling of human resources in a software very difficult and scientifically challenging [5]. Furthermore, the quantification between the relation of the output and the way humans interact with existing production processes may need a great variety of different physical, organizational and psychological algorithms, which indicates a very high modeling effort. This high effort combined with the fact that simulation studies are usually carried out in order to find (economic) optimization potential is contributing to the disregard of social and environmental inclusion. Consequently, in order to promote a more holistic perception, the questions this paper is focusing on are:

- what are possible abstract formulations of social criteria relevant in manufacturing companies,
- how can these criteria be modeled in a way that pays tribute to the great differences between humans and their possible reactions to different strains,
- and how can the modeling effort itself be reduced in order to promote such an integration.

These are the problems this paper addresses and will answer by:

- present the main problems with the integration and related work for this approach (Section II)
- identifying the most relevant aspects of social criteria in producing companies (Section III A),
- categorizing the accorded impacts and deducing criteria for the simulation (Section III B and III C),
- presenting a simulation software for environmental and economic evaluation (Section IV A),
- elaborating the concept and the implementation of a software prototype purposed to integrate the social perspective into the existing simulation software (Section IV B),
- highlight possible results and briefly state strengths and weaknesses of the approach (Section V).

Lastly, an outlook will be given in Section VI.

II. The Problem in More Detail

A. Motivation

To understand the driving force behind this paper and the problem with social criteria integration one has to question how producing companies are motivated to produce in a more sustainable way. Aside from intrinsic motivations of

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given deciders, the two main concepts are legal compliance and the demand of customers, representing top down and bottom up tendencies. Both of these tendencies have inherent difficulties. The main problem with the top down tendency is that regional and international frameworks, as basis for policy decisions, pay tribute to the different regional necessities, hence reflecting the needs and situation of the people in the region. Ultimately the given diversification results in a different prioritization of criteria, which leads to different compliance criteria for the resident entities. These differences allow for a distortion of competition and consequently to a higher prioritization of the economic orientation in order to keep up with the globalized market.

For the bottom up tendency consider that, while time is limited, if a consumer wants to buy a product that is environmentally viable and socially friendly without having to spend too much money, the necessity for an elaborate research develops, in order to find a fitting product. While it is fairly easy to assess the economic value behind the chosen product, when it comes to environmental and social identifying values, it is a difficult task. With regard to firms, and particularly manufacturing companies, reports on the sustainability of their operations rarely include the social dimension. Many companies are issuing corporate reports which stress governance aspects and environmental practices, but tend to overlook the role of the employees or workforce [6][7]. Normally, a detailed analysis of products is impossible to find and thus, in order to make a decision, consumers relay, for example, on brand identification combined with rather current information on how environmental and social friendly the company is or displays itself to be. In other words and from a capitalistic perspective, the steering of the capital by the consumer is not based on the actual environmental and social impacts of the product, but by the little information they can gather about its manufacturing processes and the company itself. The data to assess the environmental and social friendliness of the product itself is not at the consumer's disposition [6]. Naturally a choice regarding the price comes easier than basing the decision on facts that the consumer can hardly evaluate. In order to address the information gap different (modeling and simulation) approaches can be noted, which will be presented in the following.

B. Related Work

Over the last decade the environmental perspective has become more prominent, examples for the focus on the environmental sustainability of production systems can be found in Seliger [8], Andersson [9] and Reinhard et al. [10]. In Thiede [11], one can find a list of simulation tools with a status overview of their features considering sustainability aspects, which gives a broad overview even though the feature list for most tools has already changed. Furthermore, material and energy flow data are under observation in Thiede et al. [12], which can become relevant when considering interaction of human and material, i.e., exposure. The software solutions described were used as references for the meaningful combination of different perspectives.

Most existing simulation software is however not integrating the life cycle approach. It seems that the perception of the system borders of the simulation approach, which logically inhibits the gate to gate focus, is hindering the other. In order to change that and integrate upstream data, two strategies can be observed: on the one hand, through the integration of Life Cycle Analysis (LCA) data (for used material) at least the environmental and some social aspects of the upstream can be integrated, examples can be found in Andersson [9] and Kellens et al. [13], while on the other hand different simulation techniques (for example Discrete Event Simulation (DES) and System Dynamics (SD) and or Agent Based Simulation (ABS)) are combined in order to model and integrate different parts of the life cycle in appropriate and possible detail/granulation. These will logically be integrated once the simulation has finished; see for example Andersson et al. [14]. The combination of these different models is however usually happening via interfaces or meta-models and not integrated in one combined modeling approach, which was the intention when designing the different prototypes of MILAN. In that regard, Widok et al. [15][16] and the elaborations in the following depict the integration of LCA, DES and MFA in a combined modeling approach, where only one model has to be created.

Social criteria are only very rarely elaborated when considering the sustainability of manufacturing system in general [7][17] and when it comes to simulation and or software solutions for these, even less. In Heilala et al. [18], ergonomic criteria are, as part of a social domain, integrated in one simulation approach; Lind et al. [19] displays the findings of the research paper in more detail. The general approach and findings of [18][19] were carefully reviewed for input considering the scope of a possible social domain. The approach defined in Section IV is however intended to go beyond the depicted ergonomic criteria and hence had to be designed more flexible considering very different influences and their respective algorithms. In Makhbul et al. [20] stress at the workplace is analyzed and ergonomic workstation factors categorized. These factors were important for the general handling and served as one reference for the design of the calculation methodology. Implications towards the work performance of following measures can also be found in Yahaya et al. [21]; in the future, it may be possible to integrate the described ideas, even though they only served as reference for the design phase. Detailed analysis of occupational musculoskeletal and mental health with specific focus on production systems can be found in Westgaard and Winkel [3]. They also show an overview over relevant studies and highlight the significance of their findings. The European Agency for Safety and Health at Work Report 2013 is also highlighting OSH risk and trends [22]. A detailed analysis of historic occupational safety measures and trends can be found in Luczak et al. [23]. Examples and guidelines for shift-management and workplace fatigue can be found in [24]. The more general sources [22][23][24] were used as basis for the domain development, while [3] served as guideline for the integration of specific indicators, i.e., which indicator integration was worthwhile and could possibly lead to meaningful results. Furthermore, Sharma [25] presents a case study about a conceptual framework for the improvement of business performance with lean manufacturing and human factors interventions, which served as idea for the post-simulation framework development, i.e., for result interpretation. In addition, a new guideline by the association of German engineers has been published in 2013, depicting the representation and physical strains on humans in virtually modeled manufacturing halls, an analysis is described by Zülch [26] (in German), while it did not influence the development, adaptation in the future may be oriented in order to comply with the formulated standards. Lastly, Zaeh and Prasch [27] are making suggestions for systematic workplace/assembly redesign for aging workforces, which was always considered for future uses of the domain, especially when with regard to the fatigue, ergonomics, skillset and possible differentiations of work performance.

More holistic approaches (needed for the combination of the perspectives) are presented by Omann and Spangenberg [4]. The capital approach for sustainability evaluation is explained in chapter V of the UN report [28], which is also relevant for framework compositions and hence contributed, as Sharma [25] did to the post-simulation framework design for result evaluation. Social capital in relation to quality of life is discussed by Grünberger and Omann [29] and in relation to productivity Reagans and Zuckermann [30], both of these are relevant general evaluation strategies. When trying to incorporate the idea of holistic sustainability approaches one should furthermore consider Gasparatos et al. [31], where the authors list important arguments against the reductionist approach and also directs the attention to possible struggles and problems with their integration. A supplementary holistic design approach is discussed by Spangenberg et al. [32], where most of the already described problems are addressed. While Schneider [17] is giving a specific example for breaking down criteria from a macro management oriented (OECD – Sustainable Development) perspective, to social criteria in firms (see also the OECD report [6] for that matter); this was very important for the general design of the framework composition. Further extensive reviews of social sustainability can be found in Schneider [33] and an extensive literature review of social sustainability assessment methodologies has been published by Benoît and Vickery-Niederman [34]. These papers are also very valuable considering LCA integration and possible SLCA adaptations in the future. Considering SLCA integration further extensive summaries were made by author Jørgensen [35][36], which's findings will be at the basis for further component development in the SLCA segment.

To sum up, one can note various modeling approaches for social sustainability, but very few actual software implementations when it comes to manufacturing simulation. Furthermore, combinations with different perspectives and focus on holistic perception of social criteria are usually intended for reporting, after careful aggregation of various different sources. Actual implementations are usually conducted with a single focus (for example ergonomic criteria). With this in mind, the following sections will describe what specifically had to be taken into account for the definition of a more holistic oriented implementation of a social domain in the described simulation software.

III. SOCIAL SUSTAINABILITY IN THE MANUFACTURING INDUSTRY

A. Understanding Social Sustainability on Company Level, definitions, challenges

The definition of social sustainability and the deduction of relevant criteria are both far from new; in the last decades various entities have made great efforts to give deciders a stronger foundation on what social sustainability implies. Starting with the World Bank's sponsored Social Capital Initiative at the beginning of the millennium [37] many international and regional organizations have since created a variety of international policy/reporting guidelines, such as the G4 guidelines of the Global Reporting Initiative (GRI) [7] /monitoring/auditing frameworks and other instruments, such as value chain analysis, social impact assessments and other that all aim for a broad perception and integration of social criteria in sustainability assessment.

When considering these framework approaches and social criteria, the problem arises, that different social criteria will be relevant to different regions, companies and different people. Furthermore, as the sustainability concept has an inherent function to be able to shift in time [16], potential sustainability criteria have to have their qualification flexible in those regards (hinting the change of the model used for their qualification, i.e., iterations of simulations to pay tribute to the change of normative values at the basis of the qualification). In addition to those modeling challenges, Omann and Spangenberg formulated four major challenges on how to assess social sustainability, namely:

- the lack of conceptual clarity (emphasizing definitions to be dependent on countries and entities),
- the complexity (questioning if the concept is even manageable with current organizational and technical means),
- the "bad experience" from the past (1960's) considering the formulation of normative goals, in order to place social values in relation to economic and environmental goals (see also Colantonio [38]),
- the fact that a stronger integration of social values may question the very foundations of current development models [4], reducing the likeliness of acceptance/introduction.

Many other authors [33][38][39] argue in similar directions, yet the first argument should not be understood as lack of conceptual clarity; this is because the regional/organizational shift of relevant criteria is explainable. If we consider social criteria to be in direct relation to human beings, similar to any human need categorization, regional social sustainability frameworks will represent the state of the needs of the people in that region. This does not necessarily influence the validity of existing frameworks, but only reduces their comparability.

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Summarizing one can observe two functions that influence the definition of social sustainability criteria in companies:

- The first differentiation needs to be made considering the people and organizations that are at the basis of the question of what is sustainable (i.e., sustainable for whom, for what, for how long). The definition is thus dependent and pays tribute to the different states of the people and organizations in question.
- The second variance is in relation to manufacturing companies. It is necessary to make a difference between the social impact manufacturing processes have on the people directly involved in them (i.e., the people working for example at a workstation) and the social influences emitted by the production itself.

In addition to these differences, the technology choice needs to be discussed. Consequently confronted with a variety of possible input factors the question poses itself, what are the relevant criteria and how could they be integrated.

B. Categorization of social sustainability aspects on company level

This categorization of social sustainability aspects is oriented on Porter and Kramer's depiction of social impacts of the value chain of companies [40][41]. Extending their description of different criteria and placing them in a manufacturing company perspective (their elaborations are more general), we can note that the main value creating activities for manufacturing companies are operations, inbound and outbound logistics, as well as procurement, while the logistics, procurement and human resource management enable and facilitate the operations in the same way as the firm infrastructure and marketing/sales enable the function of the firm itself.

Given these main branches of the company (including also technology development) it is possible to make a differentiation between:

- the infrastructure, marketing and after sales – being categorized as mainly socio-economic with some socio-institutional aspects,
- the operations, inbound-, outbound logistics, as well as procurement – being categorized as mainly socio-environmental, with natural socio-economic (especially if we consider efficiency) and some social orientation,
- and the human resource management, as well as technology development – being categorized as mainly social orientation with some socio-environmental (due to new technologies).

The according social criteria can be derived from these main categories, as for example energy, water and material usage, emissions and waste, worker safety and labor regulations, hazardous material usage and general ecological impacts, for the operation category. The same derivation (for the other main aspects of the value chain) has already been done a few times and can be reviewed for example in Porter [40]. The idea behind this division is one can now understand where existing simulation approaches have high correlations.

C. Definition of social criteria relevant to the simulation of manufacturing companies

The main thesis that was described in Section III B is that many of the social impacts at operation's level and generally in the primary value creating activities of manufacturing companies (mainly operations, but also inbound/outbound logistics, procurement) have high correlations with existing DES and ABS modeling approaches. This is because the social impacts are almost directly linked to either the materials in usage (socio-environmental orientation and socio-economic if we consider efficiency aspects) or the people working and facilitating the functioning of the workstations (social orientation, OHS aspects). One can thus note, that a limited integration of a social perspective in existing economic, environmental orientated manufacturing simulation models is possible without having to change the model itself drastically, opening the possibility for an integrated holistic modeling approach. In that regard the choice for a first set of resulting criteria was based on the described social impact criteria from these aspects. Also note, that the indicated social impacts are not complete, further elaborations of social impacts at midpoint level can be found in [35]; the given lists were simply intended to demonstrate examples and their general categorization. Furthermore, as social impact criteria have been categorized as socio-environmental, basically representing the original sustainability perception of conservation, and as socio-economic, the correlations between the pillars of sustainability become even more apparent.

While this only considers a limited view on social impacts (reducing the perception to the manufacturing processes), it is important to note, that the life cycle approach can consequently be incorporated through the integration of social life cycle assessment (SLCA) data for the materials in usage and general upstream input data. To clarify this, consider a classical manufacturing model, which depicts the system borders at the in- and output flows before and after the existing manufacturing processes. This model has and produces little life cycle knowledge but only considers the manufacturing aspects (which depending on the used materials make more or less of the overall impact). It is however possible to have a combination of classical DES/ABS manufacturing approaches in combination with life cycle assessment (LCA) upstream data (and possibly even downstream data, depending on the modeling approach), as has been demonstrated among others by Kellens et al. [13], Andersson et al. [14] and Widok et al. [16] for the environmental LCA (ELCA) part. Taking SLCA parallel to ELCA, it can thus potentially be used for two different overall purposes, already discussed in 1997:

- to compare the social impacts of two comparable products or services (or compare a product or service against a standard – which is what we want to achieve in the future),
- to identify hot spots or improvement potentials in the life cycle of the product or service [34].

There are different approaches, which use different simulation techniques in order to model and simulate the bigger picture (apart from the LCA integration), i.e., changes in customer demand (due to marketing for example) or the abstract term of innovation (tech. dev.) can be modeled and simulated using system dynamics, examples can be found in Georgiadis and Besiou [42], as well as, Venkateswaran and Son [43] and then combinations of these can be found in Andersson [9], Rabelo et al. [44] and Jain et al. [45] using also LCA.

Since the integration of social issues into LCA, SLCA methodology now advanced to the point where it is left with many of the same unresolved issues as ELCA (see also Jørgensen [36]). These include:

- the challenges of tracking down site-specific data,
- the challenges of integrating location sensitive information,
- the challenges of integrating information collected at different scale (from general sectors to specific unit processes),
- developing characterization methods [34].

Yet, even though the data situation is always a problem to be taken seriously, the concept of integrating social impacts for the production processes in the simulation model, as was already done for environmental criteria, while integrating social impacts for the different other life cycle stages through SLCA data, was found worthwhile and is at the basis of the depicted prototype that will be elaborated in the following.

IV. Integration of Social Criteria in the DES/MFA/LCA Simulatior

A. *The basics of the simulation software MILAN*

The software MILAN has its origin in 2001, when the conviction began, that the combination of material flow analysis (MFA) with existing simulation approaches was worthwhile [46].

The concept of combining discrete event simulation and material flow analysis in a component-based approach was then presented in 2006 [47] and its re-implementation on .NET basis was elaborated in 2009 [48]. The integration of DES with the material flow perspective of MFA within a single integrated modeling approach was made possible in order to strengthen the perception of correlations between environmental and economic questions. Based on the dynamic, tactic and strategic character of the simulation approach itself, the perception of material and energy flows, which was at that point not part of the operative level, was intended to be given a more strategic, proactive tendency.

In 2011, a capital measurement approach for a more holistic sustainability perspective was presented, hinting the beginning of the integration of the life cycle approach [15].

In 2012, the ELCA integration was elaborated and the integration of the social perspective was discussed in the outlook [16]. Since then the simulation software has constantly been enhanced with new features and has been used for case studies with companies in Germany and Switzerland (under a different scope with a MILAN core). The most basic components of the software are:

- a simulation core (central simulation service, interfaces and abstract base classes for models),
- a bundle for discrete event simulation (specific for DES, with scheduler, timing aspects, etc.),
- stochastic distributions (e.g., Bernoulli, Exponential, etc., to generate streams of numbers),
- a graph editor (enabling the visual representation and manipulation of models),
- property editors (facilitating the parameterization of model entities and given metadata),
- a reporting suite (creating the simulation results and preparing charts depending on the scope),
- the material management (for the creation, management of materials, batches, bills of materials),
- the material accounting (by its means it is possible to show, save and manage material and energy bookkeeping resulting from the simulation. The bookkeeping is realized using accounting rules, which can be added to all discrete events in combination with relevant model components),
- a LCA browser, which enables an easy, string-based search and the subsequently integration of LCA material data, enabling life cycle inventory (LCI) and LCA in the simulation and the results.

For more information about the technical aspects of the simulation software, see Jahr et al. [48].

B. *The social perspective prototype*

The main components of the social domain are visualized in Figure 1 below. The first two lines represent the social domain layer, the two lines below that represent sustainability related components, the elements in the fifth line from the top represent DES relevant components, while the last two stand for technical features facilitating the general functioning of the software.

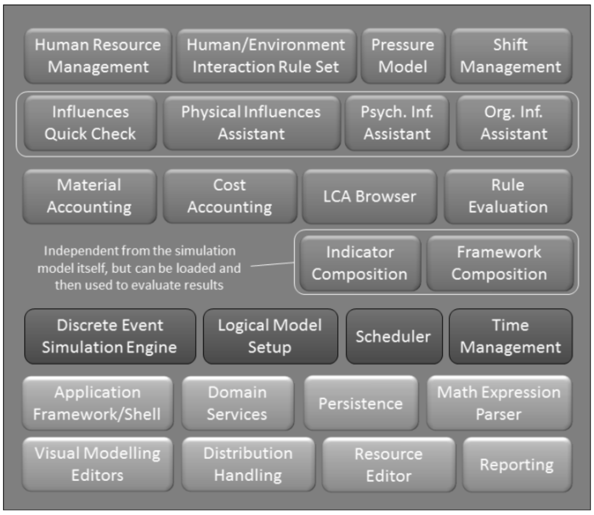

Figure 1. Abstracted overview of the main components of and needed for the social domain

When the social prototype was first conceptualized the two attributes considered to be the most important were:

The component architecture: aside from normal component-development reasons, such as high reusability and the easier understanding of the code, through clear, small packages, this also means that the usage of the social perspective is not enforced, i.e., it is possible to model social aspects through the software, but one does not have to. The software also allows to only build DES simulation models and not integrating MFA or LCA, but if the data is existing and the intention is to have a strong, holistic model, one can use the different techniques combined in one modeling approach and only a single model has to be created, incorporating the methodologies.

The free definition of influences: this is based on the conviction that social criteria, as well as their measurement, are still disputed. Based on this, it was decided that an open definition of different influences would be made possible, with different editors for the most common influences (physical, organizational, psychological), incorporating current knowledge considering the measurement of such criteria and their impact on human resources over time. These impacts however are not validated by the tool itself, i.e., the reasonableness of the defined influences and their impact lays currently with the modeler (except for logically excluding behavior).

The main features of the social component will be elaborated in the following (see Figure 1 for reference).

Human resource management/editor: based on normal resource management approaches a functionality was created to split existing resources into three different resource types, 1) human resources, 2) tools and 3) usable resources. Each of these resource types has a different editor, facilitating for the human resources possibilities to adjust for skill set, integration of distributions considering illness or weaknesses (also usable for the modeling of elderly workers and adjustment of strengths in the following) and many others. Furthermore, a new pooling mechanism was created based on a list of categories attributable to the existing resources, for example one could attribute a human resource different locations, workplaces and others (also at different time steps). The categorization/pooling then manages for example the availability of the resource.

Shift management module: the shift management is basically a standard shift planning tool, which is used for both, the workstations, i.e., one can define if production processes are continuously or with breaks for a period of time. This is of course relevant for the warm up phases and different states of the workstations. Furthermore, the shift management is used to attribute different human resources to their respective work-related entities. These could be different workplaces (although a workplace editor is yet to be integrated). For the moment, these are the respective workstations (i.e., the rather classic DES workstations model entities). In that regard a classical resource usage over time can be calculated and attributed to locations, as well as workstations and other categories that were defined in the resource categorization. In addition, the possibility is given to attribute a type of influence on the resource over time. These possible strains can be either physical, or otherwise, depending on the modeled influences through the different influence editors and the following choice of the modeler.

Social influence layer: in this layer, different editors for different types of influences were developed, the main differentiation is between physical, psychological and organizational influences, where the physical editor guides the definition of a physical influence through possible input choices (strong relation to German OHS guidelines, as in strains for lifting, crouching, carrying, but also general, as in workload dependent, biological interaction, noise, etc.) all of the possible choices are backed up with known formulas for the development of the influence (such as the physical basics of noise development or basics for the development of particulate matter in production processes), as well as known limit values considering the strain on an average human being. The psychological editor does currently have a completely free definition of influences, while different types are suggested, no choices of formulas is, but rather the definition of a type is mandatory, which can subsequently be used in the rule set editor. The same procedure is implemented for the organizational influences. Even though many studies were incorporated in a knowledge basis for these components (a systematic review of occupational musculoskeletal and mental health studies for production systems can be found in [3]), the definition of the non-physical influences was implemented without structural restriction.

Human environmental influences rule set component: this is the second key element for the integration of the social criteria. In this element one can choose from the previously defined social influences and by the usage of a math expression parser and the existing model of shifts and or the production system (i.e., the workstations), combine time with influences to create an impact over time. Different dose concepts were evaluated in that regard, which are also integrated in a knowledge base and selectable (note: the tool is only making a basic validation for reasonable combination choices). Once an influence is attributed to a shift or a workstation, the simulation is then calculating an impact of the indicated influence over time.

V. POSSIBLE RESULTS AND BRIEF DISCUSSION OF STRENGTHS AND WEAKNESSES

The social component is currently being tested in two use cases, respectively in one plastic processing company and one company that manufactures technical boilers. Aside from the classic results, such as new information on resource usage, failure times, etc. new information considering workload and strains on human resources are expected as results. Different scenarios are still under evaluation (noise, repetition, material exposure influences). What can however be observed, is that the bringing into focus of social aspects, already created ripple effects, considering the perception and the management of social impacts.

In light of the current feedback, we argue that the main weaknesses/challenges of this approach (bad data situation, privacy issues, fear of abuse, wrong evaluations) are manageable and that it is similar as with the environmental sustainability assessment in the past, i.e., that the best way to address the complexity is by making one step at a time, without losing focus of the needed flexibility and adaptability of further models, simulations and their result qualification. This approach is intending to do just that. While others have shown that different social aspects can be integrated in DES manufacturing approaches, it is our intention to create the scientific basis for the step by step integration of new impact criteria, by delivering results of successful integration and evaluation of social criteria through the depicted method in the future. The concept for a worthwhile integration of SLCA criteria is currently being worked on.

VI. CONCLUSION AND OUTLOOK

Last year's Amnesty International Report [49], titled "the dark side of migration" was discussing the exploitation of humans as workforce under inhuman conditions. While this very terrifying problem is less occurring in western countries, it is common sense, that as long we cannot track and measure the social impacts of production processes, it is less likely that consumers will be empowered to choose social friendly created products, and hence not be able to steer their capital accordingly.

Even though we agree with the conclusion of Gasparatos et al. [31], considering methodological pluralism (very simplified: more is not necessarily better), the key idea of the approach in this paper is the attempt of the integration and ability to put different perspectives in correlation. It is clear that the social aspects have yet to mature in their scientific provability, yet potentials can clearly already be indicated. This is what the tool already delivers as result, potentials compared to limit values (i.e., elevated by x%, without qualifying beyond stating that it is a positive or negative tendency and putting it into context).

The main arguments against the integration of social criteria are usually their fuzziness and the fact that every human is different. These points are valid, however the main aspects of human beings are not so different, as a variety of studies suggest (see Westgaard and Winkel [3]). Of course, it is complicated to derive exact numbers, but that is where the free definition of influences comes into play, by allowing for the modeling of workers, as well as the impact on different levels. So while the presented approach is far from scientifically established, its purpose is more to promote the re-integration of social values in existing manufacturing processes. Human development author and activist Max-Neef mentioned in his keynote at Zermatt Summit 2012 that sustainability has been misused to promote rather economical concepts than actually bringing the essence of what sustainability incorporates into prominence, hence it is the intention of this paper to clarify that the deficit of social integration in these regards can be overcome.

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