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《产业生态学报》
2003 年冬，第 7 卷第 2 期，13–32 页

题目：产业生态学与生态工程学：学科融合机会之研究

作者：David R. Tilley

关键字：生物学类比，人工湿地，生态学类比，能源，再循环，可持续技术

摘要：生态工程(EE)与产业生态学(IE)尽管是独立发展起来的两个学科，但二者都致力于平衡人类活动与自然界的关系，并解决当今复杂的环境问题，具有共同的目标、理论基础和理念。当然，两个学科之间还有很多差异，有必要研究两者的异同并寻求两者之间的合作。为此，本文(1)对比了生态工程与产业生态学这两个学科，研究了它们协作融合的可能性；(2)进一步指出了三个可能连接 EE 与 IE 的关键跨学科研究领域。

第一个领域是回收利用副产品的生态系统工程，致力于设计、创造和管理可吸收利用工业系统副产物的自然生态系统(如森林、湿地等)。这一领域的实践包括利用人工湿地吸收铅污染，利用植物开采镍尾矿等。第二个领域可以称作“产业生态学的生态系统类比”，它基于产业生态系统效仿自然生态系统提高其能量效率与物质循环的理念，研究自然界千百万年来的大量资源有效利用的实例，并将其复制到产业生态系统中去。第三个领域为“生态系统信息工程”，人类需要理解自然生态系统中复杂而有效的知识系统与信息机制，并籍以解决当今社会的信息爆炸问题。此外人类正在由工业社会向信息社会转变，有必要采用全面的模型研究维持各类信息生态系统，如服务业的有效运作所需的物质与能源需求。

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Industrial Ecology and Ecological Engineering: Opportunities for Symbiosis

David R. Tilley

KEYWORDS:
biological analogy, constructed wetlands, ecological analogies, energy, recycling, sustainable technology

SUMMARY:
Ecological engineering (EE) and industrial ecology (IE) strive to balance humanity’s activities with nature. The disciplines have emerged separately but share theoretical foundations and philosophies on how to address today’s complex environmental issues. Although EE and IE share motive, goals, theories, and philosophies, there are many differences. These similarities and differences may make for a strong symbiotic relationship between the two fields. The goals of this article are (1) to compare and contrast the two fields to identify opportunities for collaboration and integration and (2) to suggest three crossdisciplinary focal areas that bridge EE and IE.

The first symbiotic area, ecosystem engineering for byproduct recovery, is defined as the design, creation, and management of living ecosystems (e.g., forests, wetlands) that utilize the by-products of industrial systems. Examples of this exist, including constructed wetlands for lead recovery and phyto-mining of nickel tailings. The second symbiotic focus is entitled “ecosystem analogues for industrial ecology,” which fits with a founding principle of IE to strive to have industry emulate the energy efficiencies and material cycles of natural ecosystems. This focal area quantifies the ecological analogy and exploits the tremendous library of design alternatives that nature has developed over thousands of years to deal with varied resource situations. The third focal area is termed “ecosystem information engineering.” The means by which living ecosystems have created robust knowledge systems and information cycles should be understood in terms useful for managing current society’s information explosion. As industrial society evolves toward the information society, holistic models are needed that account for the available energy and material resources required to operate effective information ecosystems, such as service industries.

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题目：自然生态系统与产业生态系统的产品和生产过程的比较研究

作者：Stephen H. Levine

关键字：生物学类比，系统比较分析，生态学类比，生态系统建模，隐喻，增加值

摘要：自然生态系统与产业生态系统具有很多共性：系统组成部分之间都存在物质与能量流动，都利用能量来转化物质，都存在物流与能流支配的互利共生或相互竞争等作用。产业生态学的中心原则是这些共性的集中反映：“产业系统是一种特殊的生态系统”。然而，自然生态系统与产业生态系统之间也存在重要差别。商品即具有一定价值的产品或服务，但在自然生态系统中却基本不存在。由产品的相异性出发可发现自然生态系统与产业生态系统尚有诸多不同，自然生态并非产业生态的一种想当然模型。

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Comparing Products and Production in Ecological and Industrial Systems

Stephen H. Levine

KEYWORDS:
biological analogy, comparative systems analysis, ecological analogy, ecosystem modeling, metaphor, value-added

SUMMARY:
Ecological systems and industrial systems have much in common. Both systems are characterized by flows of material and energy between components, both contain components that use energy to transform materials, and both contain energy and material flow-regulating interactions such as competition and mutualism. These shared traits are reflected in the metaphor “an industrial system is an ecological system” that is central to industrial ecology. At the same time, critical differences exist between the two systems. Products, that is, goods and services exchanged for something of value, are characteristic of industrial systems, but relatively rare in ecological systems. This prevalence of products leads to a number of other interesting differences between the two systems, some of which might limit the value of ecological systems as prescriptive models for industrial systems.

《产业生态学报》

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题目：经济系统物流分析法与评价指标的原理及解释

作者：Stefan Bringezu, Helmut Schmütz, Stephan Moll

关键字：材料直接输入(DMI)，环境指标，材料流分析(MFA)，实物经济，可持续性，材料总需求(TMR)

摘要：本文提出了经济系统材料流分析方法及其相关分析指标，用来监测和评价一个经济系统的内部物流及其与外界环境或其它经济系统之间的物流代谢水平。分析指标用来衡量生产和消费过程的材料消耗，如材料直接输入(DMI)和材料直接消耗(DMC)。国内隐流(HF)表示资源开采的副产品；国外隐流则表示进口产品所包含的上游材料开采副产品。其中材料直接输入(DMI)、国内隐流和国外隐流(HF)三者之和构成一个经济体的材料总需求(TMR)。材料总需求减去出口和出口隐流则为该经济体的总材料消耗(TMC)。

DMI 和 TMR 可用于分析经济增长与资源消耗之间的关系，因而提供了一个反映资源利用效率的指标。对 TMR 进行核算可以用来分析一个经济系统内的资源需求从内部向外部转移。材料存量净增量(NAS)反映了经济体的实物增长情况，为该经济体的材料流输入与输出之差。这是衡量一个经济系统代谢地可持续性和成熟度的基本指标。

基于材料流方法的分析指标还可用于评估一个经济系统的环境影响。为此，我们必须考虑不同材料流在不同规模上的环境影响，并合理地区分一般环境影响的总量指标和具体环境压力的影响指标。例如，TMR 和 TMC 是一般环境影响指标，无法用于评价某一具体环境影响。本文从材料流总量和组成两方面探讨了工业国家的 TMR 是否可持续。

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Rationale for and Interpretation of Economy-Wide Materials Flow Analysis and Derived Indicators

Stefan Bringezu, Helmut Schmütz and Stephan Moll

KEYWORDS:
direct material input (DMI), environmental indicators, material flow analysis (MFA), physical economy, sustainability, total material requirement (TMR)

SUMMARY:
Economy-wide material flow analysis (MFA) and derived indicators have been developed to monitor and assess the metabolic performance of economies, that is, with respect to the internal economic flows and the exchange of materials with the environment and with other economies. Indicators such as direct material input (DMI) and direct material consumption (DMC) measure material use related to either production or consumption. Domestic hidden flows (HF) account for unused domestic extraction, and foreign HF represent the upstream primary resource requirements of the imports. DMI and domestic and foreign HF account for the total material requirement (TMR) of an economy. Subtracting the exports and their HF provides the total material consumption (TMC).

DMI and TMR are used to measure the (de-)coupling of resource use and economic growth, providing the basis for resource efficiency indicators. Accounting for TMR allows detection of shifts from domestic to foreign resource requirements. Net addition to stock (NAS) measures the physical growth of an economy. It indicates the distance from flow equilibrium of inputs and outputs that may be regarded as a necessary condition of a sustainable mature metabolism.

We discuss the extent to which MFA-based indicators can also be used to assess the environmental performance. For that purpose we consider different impacts of material flows, and different scales and perspectives of the analysis, and distinguish between turnover-based indicators of generic environmental pressure and impact-based indicators of specific environmental pressure. Indicators such as TMR and TMC are regarded as generic pressure indicators that may not be used to indicate specific environmental impacts. The TMR of industrial countries is discussed with respect to the question of whether volume and composition may be regarded as unsustainable.

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题目：再利用还是用得更多？旧货市场对商品需求与非物质化的影响

作者：Valerie Thomas

关键字：消费，产品耐用性，产品寿命，处理成本，旧货，废物

摘要：本文利用了 Anderson 和 Ginsburgh 所开发的经济学模型中的一个变量，研究了经济系统中的物料使用情况，分析了二手货市场的存在对新产品需求总量的影响。在处理费用降低及产品寿命增长的情况下，模型中的旧货市场得以发展。如果废旧用品能够顺利进入市场，旧货市场的发展确实可以减少人们对新产品的需求。反之，如果缺乏迅速稳定的废旧产品供应渠道，旧货市场的增长反而会增加人们对新产品的需求并促进物料消费。此外，即使二手货的销售减少了对新品的需求，二者之间也不是一一对应的关系。二手货究竟能在多大程度上替代新产品，取决于二者的相对价值。

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Demand and Dematerialization Impacts of Second-Hand Markets: Reuse or More Use?

Valerie Thomas

KEYWORDS:
consumption, product durability, product lifetime, transaction costs, used goods, waste

SUMMARY:
The potential for second-hand markets to reduce demand for new goods is investigated. Using a variant of an economic model originally developed by Anderson and Ginsburgh, the physical implications for material use are explored. The second-hand market grows if transaction costs decrease or if product lifetime increases. In this model, growth of the secondhand market reduces demand for new goods if there are waste used goods that can be brought into the market. But if there is not a ready supply of waste used goods, growth of the second-hand market can increase demand for new goods, thereby increasing material consumption. Moreover, even when second-hand sales reduce demand for new goods, it is typically not on a one-for-one basis. The extent to which the purchase of used goods replaces the purchase of new goods is shown to be an explicit function of the relative value provided by used versus new goods.

《产业生态学报》
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题目：用户所需与所想：关于一个生命周期工具的用户调查

作者：Patrick Hofstetter, Thomas Mettier

关键字：BEES 2.0，偏差，决策支持，生命周期评价(LCA)，软件，加权

摘要：越来越多的软件工具可以帮助设计者和决策者开展设计、生产和采购决策。某些软件甚至提供有关产品环境影响的定量信息，如生命周期各阶段的气候变化、生理毒性和资源消耗等等。然而，人们对用户的真实需求以及软件的具体使用情况往往知之甚少，也不清楚用户是否按照软件开发者想象的方式使用相应的信息。作者对某一类工具软件的用户作了调查。调查结果显示，尽管用户要求更大的软件透明度，仍有半数用户侧重于软件的易用性并接受模型所内含的假设。此外，大多数用户希望软件的环境影响模型能够超越环境压力层次，能够兼顾潜在的环境影响以及可能的危害。虽然很多用户希望得到关于环境影响和环境成本的总量信息，但多数人仍对这种集成信息的合理性存在疑虑，认为需要对不同的环境影响进行一定的折衷。环境影响的权重因时因地而异，本文以每一类环境影响的时间及空间规模为自变量，以环境影响的权重为因变量作了回归分析。分析结果说明，如果事先设定环境影响权重，则时空因素仅能解释环境影响的权重偏差(R^2)的 6%；反之，如果先由用户指定环境影响的时空规模然后再设定影响的权重，则时空因素能解释权重偏差的 24%。上述发现有助于开发者深入思考软件的一些预先设定，而且还引出了其它许多有待研究的问题。

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What Users Want and May Need: Insights from a Survey of Users of a Life-Cycle Tool

Patrick Hofstetter and Thomas Mettier

KEYWORDS:
BEES 2.0, bias, decision support, life-cycle assessment (LCA), software, weighting

SUMMARY:
An increasing number of software tools support designers and other decision makers in making design, production, and purchasing decisions. Some of these tools provide quantitative information on environmental impacts such as climate change, human toxicity, or resource use during the life cycle of these products. Very little is known, however, about how these tools are actually used, what kind of modeling and presentation approaches users really want, or whether the information provided is likely to be used the way the developers intended. A survey of users of one such software tool revealed that although users want more transparency, about half also want an easy-to-use tool and would accept built-in assumptions; that most users prefer modeling of environmental impacts beyond the stressor level, and the largest group of respondents wants results simultaneously on the stressor, impact potential, and damage level; and that although many users look for aggregated information on impacts and costs, a majority do not trust that such an aggregation is valid or believe that there are tradeoffs among impacts. Further, our results show that the temporal and spatial scales of single impact categories explain only about 6% of the variation in the weights between impact categories set by respondents if the weights are set first. If the weights are set after respondents specify temporal and spatial scales, however, these scales explain about 24% of the variation. These results not only help method and tool developers to reconsider some previous assumptions, but also suggest a number of research questions that may need to be addressed in a more focused investigation.

《产业生态学报》
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题目：砷化镓半导体废物处置的环境影响：移动电话案例研究

作者：Tsutomu Uryu, Jun Yoshinaga, Yukio Yanagisawa

关键字：砷，焚烧，元素分析，渗滤，生命周期清单，S 型曲线

摘要：本文介绍了对一个移动电话中砷化镓半导体(GaAs)废物处理处置的环境影响定量评价方法。本文采用日本的数据。

移动电话产品使用寿命较短，相关的回收体系目前还不健全，因此很多废旧手机只是简单地焚烧或填埋处置，导致镓和砷元素释放到大气和水体当中。本文提出的方法首先估计废旧手机的累计数量，认为其符合 S 型增长曲线。然后通过实验分析和热力学模拟计算了镓和砷的环境释放量。研究表明，到 2010 年，日本需处理总计达 6.1 亿只废旧手机。焚烧处理时废气、沥滤液以及不溶残渣(添埋的焚化灰)中镓的比例分别为 0.042%、0.158%及 99.8%，砷的比例分别为 0.20%、19.5%和 80.3%。直接填埋处理时镓和砷元素则几乎全部存在于固体废物中。具体就日本而言，我们认为废旧手机的填埋处置将优于焚烧，镓和砷的环境释放较少。本文介绍的方法还可用于其它类似产品的废物处理评价。

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Environmental Fate of Gallium Arsenide Semiconductor Disposal: A Case Study of Mobile Phones

Tsutomu Uryu, Jun Yoshinaga and Yukio Yanagisawa

KEYWORDS:
arsenic, incineration, elemental analysis, leaching, life-cycle inventory (LCI), logistic curve

SUMMARY:
This article describes a methodology for the quantitative assessment of the environmental fate of gallium and arsenic from the disposal of mobile phones containing gallium arsenide (GaAs) semiconductors, using data from Japan.

The product lifetime of mobile phones is short, and the recycling systems for such phones are currently underdeveloped. As a result, many mobile phones are disposed of via incineration and landfilling. The disposal of GaAs semiconductors could lead to some releases of gallium and arsenic to air and water. The methodology presented here begins with an estimation of the cumulative number of disposed mobile phones, using a logistic curve. Then, thermodynamic simulation and laboratory experiments are carried out to assess how much gallium and arsenic may be released into the environment. Using this method, the cumulative number of mobile phones disposed of in Japan is calculated to be 610 million by 2010. Distribution among air emissions, the leachate, and the insoluble residue (in landfilled incinerator ash) was determined to be 4.20 x 10−2%, 1.58 x 10−1%, and 99.8% for gallium, and 2.00 x 10−1%, 19.5%, and 80.3% for arsenic, respectively. For phones that are disposed of directly in landfills, it is estimated that nearly 100% of the gallium and arsenic exists as the insoluble residue. We suggest that, in the conditions present in Japan, disposal of mobile phones directly into the landfill is preferable to the incineration with subsequent landfill of ash with respect to gallium and arsenic emissions into the environment. The proposed methodology may be adapted for the assessment of the environmental fate of problematic substances from the disposal of similar products.

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题目：废物生成之必然性与效率的热力学分析

作者： Stefan Baumgartner, Jakob de Swaan Arons

关键字：效率，熵，㶲，工业代谢，联合生产，热力学

摘要：本文利用热力学定律对社会代谢开展物流与能流分析。研究表明，工业生产在提供人类所需物品的同时，将不可避免地产生废物。尽管生成废物是工业生产过程的基本特点之一，但废物数量还取决于具体生产过程的热力学效率。文中进一步分析了哪一部分废物是热力学定律的必然结果以及哪一部分废物是由生产过程的低效率造成的。

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Necessity and Inefficiency in the Generation of Waste: A Thermodynamic Analysis

Stefan Baumgartner and Jakob de Swaan Arons

KEYWORDS:
efficiency, entropy, exergy, industrial metabolism, joint production, thermodynamics

SUMMARY:
The laws of thermodynamics are employed as an analytical framework within which results about society's metabolism may be rigorously deduced in energetic and material terms. We demonstrate that the occurrence of waste is an unavoidable necessity in the industrial production of desired goods. Although waste is thus an essential qualitative element of industrial production, the quantitative extent to which waste occurs may vary within certain limits according to the degree of thermodynamic (in)efficiency with which these processes are operated. We discuss the question of which proportion of the amount of waste currently generated is due to thermodynamic necessity and which proportion is due to thermodynamic inefficiency.