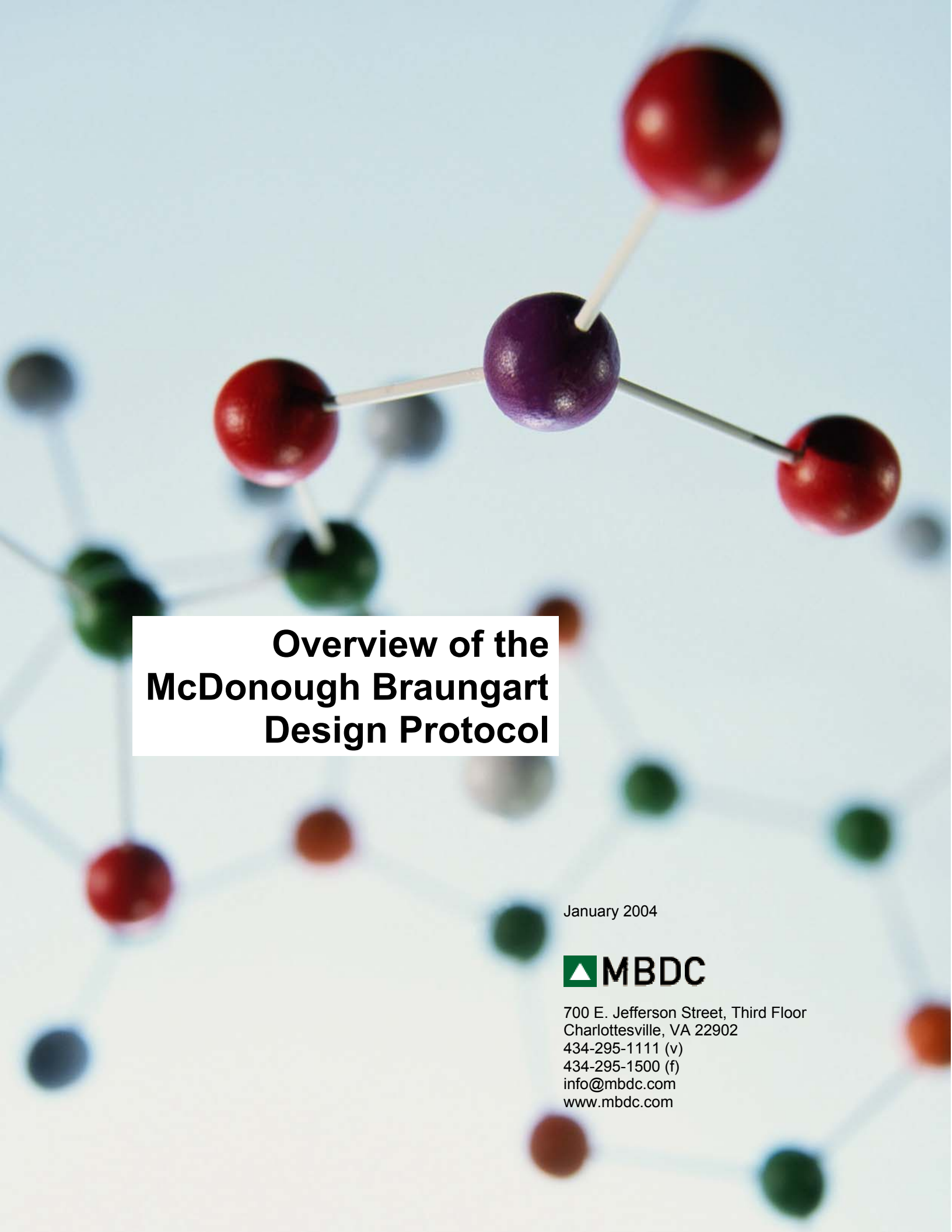

Overview of the McDonough Braungart Design Protocol

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Introduction

The McDonough Braungart Design Protocol is a set of activities that leads to improved product quality. Materials are assessed in order to encourage product transparency and the conscious selection of materials that have the most positive impact on human and environmental health. An expanded definition of quality—that includes human and environmental health—allows a manufacturer to fully understand its product and specific shortcomings, and empowers the manufacturer to improve product quality for these properties. Intelligent questions about the human and environmental health characteristics of all inputs along the supply chain can stimulate industry dialogue about the use of a more comprehensive definition of quality and the realization of associated business value.

MBDC does not conduct full life cycle analyses on materials or products under review. However, “life cycle thinking” serves as a useful framework for scientific inquiry and informs the assessment process. Observing how a material or final product flows through any of its various life cycle stages (e.g., raw material extraction and processing; manufacturing; use; recovery/reutilization) allows for the identification of impacts to human health and the environment at each stage or collectively. This "contextual filter" allows the assessor to quickly identify and acknowledge potential issues of concern that may negatively impact human and/or environmental health.

Assessment Process

The MBDC assessment process is an information gathering and evaluation process that informs and guides material selection decisions, with the goal of choosing the most environmentally intelligent materials available. There are three levels of evaluation—basic chemical substances (identified by unique Chemical Abstract Service numbers), materials and finished products. The assessment process includes the following components that build upon one another:

1) Assessment Criteria	The set of human and environmental health attributes researched for a specific chemical and used to rate it based on its inherent properties.
2) Chemical Profile	Evaluation of a basic chemical and its performance with respect to the assessment criteria.
3) In-Situation Chemical Assessment	Assessment of a chemical within a specific material, based on its chemical profile, routes of exposure, concentration and life cycle.
4) Material Assessment	Determination of a material’s cradle-to-cradle performance, from combining the in-situation chemical assessments of all ingredients.
5) Product Assessment	Assessment of a finished product, from combining the assessments of all materials.

Assessment Criteria

Human Health Criteria	*Environmental Health Criteria*
Carcinogenicity* Teratogenicity* Reproductive Toxicity* Mutagenicity* Endocrine Disruption* Acute Toxicity Chronic Toxicity Irritation of Skin/Mucous Membranes Sensitization Other (e.g., skin penetration potential; flammability) *Priority criteria; must be positively identified for a substance to be acceptable for use.	Algae Toxicity Daphnia Toxicity Fish Toxicity Persistence/Biodegradation Bioaccumulation Climatic Relevance (e.g., global warming potential; ozone depletion potential) Content of Halogenated Organic Compounds Heavy Metal Content Other (e.g., water danger list; toxicity to soil organisms)
Evaluate safety for customers, workers and the surrounding community during production, use and recycling/disposal.	Evaluate safety for the air, soil, water, climate, exposed organisms and successive generations, and the ecosystem as a whole.

Profile of Individual Criteria
The following scale is used to denote a chemical's properties for each criterion:

GREEN	Little or no hazard associated with the chemical
YELLOW	Low to moderate hazard
ORANGE	Incomplete data
RED	High hazard

Chemical Assessment

Chemical Profile
Research on individual chemicals begins using the priority criteria: Carcinogencity, Disruption of Endocrine System, Mutagenicity, Reproductive Toxicity, and Teratogenicity. If any of these criteria is assessed as Red, research stops and the chemical is given a rating of Red. If data is not available for any of the priority criteria, then that criterion is given an Orange rating.

If the chemical meets the priority criteria, then all of the remaining criteria are profiled. In most cases, the chemical's rating is equal to the lowest rated criterion. Thus, if acute toxicity data for a chemical is profiled as Red, then the chemical's overall profile is Red. However, the profile process requires scientific judgment. The heuristic guidelines for determination of potential hazard and risk should be based on sound precautionary judgment. For example, there are some instances when a chemical with a Red rating for a non-priority criterion or an Orange rating for any of the criteria is given an overall rating of Yellow or Green.

In-Situation Chemical Assessment
An in-situation chemical assessment is based on the chemical profile, as well as the routes of exposure, concentration and life cycle considerations for the chemical within a specific material application. For example, chemicals that are assessed Red as raw substances may be present within a product formulation in very small concentrations. Specifically, if a Red chemical is present at a concentration of less than 100 parts per million (ppm), it will not be considered in the material evaluation.

Material Assessment

The material assessment combines the in-situation chemical assessments of all ingredients. When conducting a material assessment, the assessor needs to determine if there are any known chemical interactions that might alter a Yellow assessment result to Red. Using the “weakest link" method, the material is assigned a color value rating similar to the colors used for individual chemical assessments listed in the second column. This means that the material evaluation will be the same as the lowest color designation for any component present in that material.

Assessment of Material Properties
The following rating scale is used to denote a material’s cradle-to-cradle characteristics:

GREEN	Preferred material; positively identified; healthy, safe and non-problematic.
YELLOW	Presents low to moderate hazard and/or risk, so it cannot be classified as Green, but it also does not have any characteristics to classify it as Red. Recommended for continued use, until Green substitutes can be found.
ORANGE	Insufficient information is available to adequately assess its human and environmental health characteristics. Two potential options are available (strategy selection is based on the need to use the material, and the time and budget available to conclusively assess the material): • Phase out its use. • Perform testing to fill data gaps with respect to human and environmental health characteristics.
RED	Phase-out its use. Known human and environmental health hazards exist, or the risk is too great to continue using it. Explore alternative materials, redesign the current material formulation, or, at a minimum, implement a strategy for minimizing the risks (i.e., a technical solution).

Product Assessment

The main steps to assess a finished product are the following:

1) Compile/summarize material assessments based on a “weakest link” perspective
2) Evaluate the manufacturing process, including energy use and emissions to air, soil and water
3) Evaluate the product life cycle for the potential to recover and truly recycle ingredient materials
4) Evaluate whether opportunities to cycle technical and/or biological nutrients are being actualized
5) Identify areas for optimization
6) Generate Product Benchmarking Report

Companies have different preferences for the determination and reporting of their product-related assessment criteria and weighting of those criteria. The following are example criteria for evaluating finished products.

Bill of Materials
A product's Bill of Materials (BOM) is developed showing part numbers, quantities, descriptions, materials, and weights. Some components must be broken down into their base materials and finishes, such as painted steel or plastics containing colorants.

HH/ECO Tox Score
The HH/ECO Tox assessment is reviewed for each material within the finished product and an HH/ECO Tox Percent Credit is assigned based on where the material falls on the color rating scale (e.g., Green materials are given higher Percent Credit percentage than Yellow materials). The HH/ECO Tox Score for the finished product is determined by multiplying the HH/ECO Tox Percent Credit value for each material by some factor (e.g., material weight, as percent of finished product).

Recyclability Score
Each material within the finished product is given a Recyclability Percent Credit based on its relative ability to be truly recycled. The Recyclability Score for the finished product is determined by multiplying the Recyclability Percent Credit value for each material by some factor.

Recycled / Renewable Content Score
The Recycled / Renewable Content Score takes into account the values for Post Industrial Recycled Content, Post Consumer Recycled Content, and Renewable Content provided by a material supplier. The Recycled / Renewable Content Score for the finished product is determined by multiplying the Recycled / Renewable Content Percent Credit value for each material by some factor.

Disassembly Score
Each material within the finished product is given a Disassembly Percent Credit based on its relative ability to be separated from other materials following the product's use. The following questions represent potential ways to evaluate a material's Disassembly Percent Credit:

1) Can the component be separated with no dissimilar materials attached?
2) Can common disassembly tools be used (e.g., pry-bar; hammer; screwdriver; utility knife; pliers)?
3) Can one person disassemble the component in 30 seconds or less?
4) Can the material type be identified through markings, magnets or other mechanisms?

The Disassembly Score for the finished product is determined by multiplying the Disassembly Percent Credit value for each material by some factor.

Design for Environment (DfE) Score
The overall DfE Score for the finished product combines the scores for the individual product criteria, such as the HH/ECO Tox Score, Recyclability Score, Recycled / Renewable Content Score, and Disassembly Score, along with some weighting factors to reflect the priority that the company places on each product characteristic.