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European Network for Additive Manufacturing in Industrial Design for Ukrainian Context

AMAZE

INDUSTRIAL DESIGN – VECTOR FOR PRODUCT MEANING

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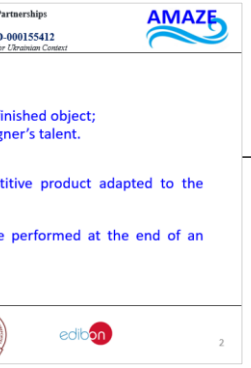
The general public and design novices believe that:

- product development is a linear process from idea to finished object;
- much of the development activities are based on designer's talent.

It is ***not*** the case.

Professionals know that in order to obtain a competitive product adapted to the requirements of the market segment:

- some stages should be iterative,
- an assessment phase of the stage results should be performed at the end of an iteration.




What is really (to) design?
design
user
information
application
usability
also
one page
data
text
view pages
controls
using
dashboard
menus
display
screen
wizard
xero
make
online
program
forms
navigation
table
familiar
important
need
cmsbox
manager
creating
function
since
way
main
good
supersaas
customers
sql
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many
time
applications
development
options
buttons
management
available
changes
used
functions
key
common
company
form
use
server
possible
rather
several
get
although
button
look
level
just
campaign
sugarsync
help
menu
system
specific
including
computer
like
create
dialog
less
color
large
interaction
fotoflexer
software
experience
multiple
mobile
much
within
list
well
include
files
set
photo
want
see
document
performance
ribbon
quickly
clicking
task
new
provides
tasks
visual
feedback
feature
first
even
simple
allows
easy
working
wufoo
pane
hale
order
file

Examples of definitions from scientific literature:

Design = to organise resources in order to achieve an objective
Design = to generate the concept of a system, product or service
Design = to create, execute, or construct according to a plan for a given purpose

Possible arguments between specialists:
Is a plan (methodology) really needed?
- **YES**, the followers of structured thinking will say.
- **NO**, very creative people will say.

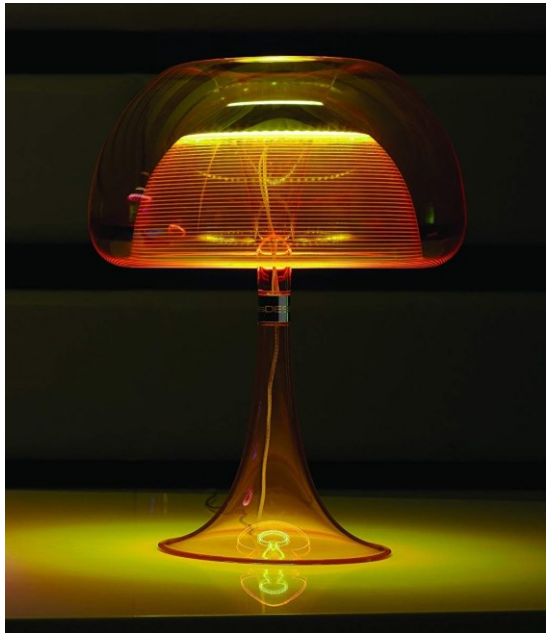
There are many **myths** regarding design and especially the design of successful products. One such myth was built around a product with an iconic design: **Juicy Salif**.

Squid

Juicy Salif

"Stained" napkin

From an etymological point of view, the word **design** comes from the Latin **designare**, respectively assigning the character of a sign to something. From this perspective, the name "industrial design" for product aesthetics is correct, because it conveys meanings.



Aurelia Lamp:

- luxurious
- high quality
- mysterious

Approaches in designing / solving practical problems:

- **everyday design / design-by-use / non-intentional design**

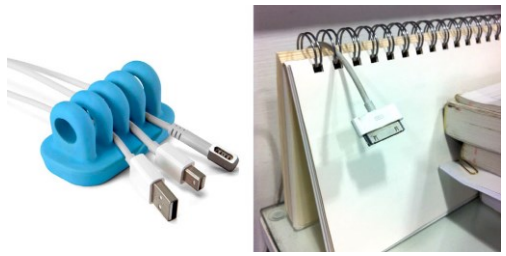
  discovering simple solutions to design problems using resources at hand

- **silent design**

  it is specific to newly established companies, which have not yet hired a professional designer, and design decisions are taken by employees from other fields

- **professional design**

  the result of the activity of a designer or design team that covers every aspect of product development



Well-known rules, but which should still be mentioned:

- Representatives of **all relevant departments** participate in product design.
- The design process covers **simultaneously** (more or less) **all aspects** of the product (mechanical, electrical, ergonomics, aesthetics, etc.) and absolutely not sequentially (for example, first the mechanical part, then the electrical part...).
- The design starts with the **functional core** and then expands to the "outside".
- **Materials** and (operational and manufacturing) **technologies** should be used with maximum efficiency.

A product development framework should necessarily include the following aspects:

- Understanding the company's **objective**, overcoming the **ill-defined problems** and formulating the **design task**
- Correct **identification of the market segment** that will purchase the product
- In-depth understanding of the **needs, desires and expectations** of the considered market segment
- Formulation of the **value proposition** (vital and customer-aware problem that the proposed product / service solves)
- **Analysis of the competition** for an effective differentiation of product on the market
- Elaboration of the **product design specification**
- (Iteratively) generation and sorting of **concepts**
- **Concept selection** and embodiment design (for very complex products)
- **Detailed design**
- **Prototype testing** (including user appropriation)

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Models	Establishing a need phase	Analysis of task phase	Conceptual design phase	Embodiment design phase	Detailed design phase	Implementation phase
Booz et al. (1967)	X	New product strategy development	Idea generation / Screening & evaluation	Business analysis	Development / Testing	Commercialisation
Archer (1968)	X	Programming / data collection	Analysis / Synthesis	Development	Communication	X
Svensson (1974)	Need	X	Concepts	Verification / Decisions	X	Manufacture
Wilson (1980)	Societal need	Recognize & formalize / FR's & constraints	Ideate and create	Analyze and/or test	Product, prototype, process	X
Urban and Hauser (1980)	Opportunity identification	Design		Testing		Introduction (launch) / Life cycle management
VDI-2222 (1982)	X	Planning	Conceptual design	Embodiment design	Detail design	X
Hubka and Eder (1982)	X	X	Conceptual design	Lay-out design	Detail design	X
Crawford (1984)	X	Strategic planning	Concept generation	Pre-technical evaluation	Technical development	Commercialisation
Pahl and Beitz (1984)	Task	Clarification of task	Conceptual design	Embodiment design	Detailed design	X
French (1985)	Need	Analysis of problem	Conceptual design	Embodiment of schemes	Detailing	X
Ray (1985)	Recognise problem	Exploration of problem / Define problem	Search for alternative proposals	Predict outcome / Test for feasible alternatives	Judge feasible alternatives / Specify solution	Implement
Cooper (1986)	Ideation	Preliminary investigation	Detailed investigation	Development / Testing & Validation	X	Full production & market launch
Andreasen and Hein (1987)	Recognition of need	Investigation of need	Product principle	Product design	Production preparation	Execution
Pugh (1991)	Market	Specification	Concept design		Detail design	Manufacture / Sell
Hales (1993)	Idea, need, proposal, brief	Task clarification	Conceptual design	Embodiment design	Detail design	X
Baxter (1995)	Assess innovation opportunity	Possible products	Possible concepts	Possible embodiments	Possible details	New product
Ulrich and Eppinger (1995)	X	Strategic planning	Concept development	System-level design	Detail design	Testing & refinement / Production ramp-up
Ullman (1997)	Identify needs / Plan for the design process	Develop engineering specifications	Develop concept	Develop product		X
BS7000 (1997)	Concept / Feasibility		Implementation (or realisation)			Termination
Black (1999)	Brief/concept	Review of 'state of the art'	Synthesis / Inspiration	Experimentation / Analysis / reflect	Synthesis / Decisions to constraints / Output	X
Cross (2000)	X	Exploration	Generation	Evaluation	Communication	X
Design Council (2006)	Discover	Define	Develop		Deliver	X
Industrial Innovation Process 2006	Mission statement	Market research	Ideas phase	Concept phase	Feasibility Phase	Pre production

Design Phases

[Howard, T. J., Culley, S. J., & Dekoninck, E. (2008). *Describing the creative design process by the integration of engineering design and cognitive psychology literature*. Design studies, 29(2), 160-180]

Models	Analysis phase	Generation phase	Evaluation phase	Communication / implementation phase
Helmholtz (1826)	Saturation	Incubation / Illumination	X	X
Dewey (1910)	A felt difficulty / Definition and location of difficulty	Develop some possible solutions	Implications of solutions through reasoning	Experience collaboration of conjectural solution
Wallas (1926)	Preparation	Incubation / Illumination	Verification	X
Kris (1952)	X	Inspiration	Elaboration	Communication
Polya (1957)	Understanding the problem / Devising a plan	Carrying out the plan	Looking Back	X
Guilford (1957)	X	Divergence	Convergence	X
Buhl (1960)	Recognition / Definition / Preparation / Analysis	Synthesis	Evaluation	Presentation
Osborn (1963)	Fact-finding	Idea-finding	Solution-finding	X
Parnes (1967)	Problem, challenge, opportunity / Fact-finding / Problem-finding	Idea-finding	Solution-finding	Acceptance-finding / Action
Jones (1970)	Divergent: Search for data / Understand the problem	Transformation: Pattern finding / Flashes of insight	Convergent: Judgement	X
Stein (1974)	X Fact-finding	Hypothesis formulation	Hypothesis testing	Communication of results
Parnes (1981)	Mess finding / Problem-finding	Idea-finding	Solution-finding	Acceptance-finding
Amabile (1983)	Problem or task presentation / Preparation	Response generation	Response validation	Outcome
Barron and Harrington (1981)	X	Conception / Gestation / Parturition	X	Bring up the baby
Isaksen et al. (1994)	Constructing opportunities / Exploring data / Framing problem	Generating ideas	Developing solutions	Building acceptance / Appraising tasks / Designing process
Couger et al. (1993)	Opportunity, delineation, problem definition / Compiling information	Generating ideas	Evaluating, prioritising ideas	Developing an implementation plan
Shneiderman (2000)	Collect	Create / Relate		Donate (communicate)
Basadur et al. (2000)	Problem finding / Fact finding / Problem defn.	Idea finding	Evaluate and select	Plan / Acceptance / Action
		Diverge – converge at each stage		
Kryssanov et al. (2001)	Functional requirements / Structural requirements	Functional solutions / Analogies, metaphors	Reinterpretation	X

Creative Phases

[Howard, T. J., Culley, S. J., & Dekoninck, E. (2008). *Describing the creative design process by the integration of engineering design and cognitive psychology literature*. Design studies, 29(2), 160-180]

But it should be emphasized once again that **the process is not linear,** and each stage should be treated in-depth. It can be said that there are specialized methods and techniques that are suitable for each stage. Thus, someone can **classify** the design methods and techniques into four broad categories:

- documentation methods
- methods for increasing creativity
- auxiliary design methods
- actual design methods

Documentation methods and techniques:

- competition analysis
- historical research
- collecting information from consumers (observing the product in use; questionnaire; interview; focus group; drawing / prototyping the ideal product)
- anthropological research
- sentence completion test
- user perceived value
- empathy diagram
- bio-mimicry (bionics)

Methods to increase creativity:

- TRIZ
- brainstorming
- synectic method
- bisociation
- 6 thinking hats
- creative break
- creative challenge
- alternatives method
- layers method

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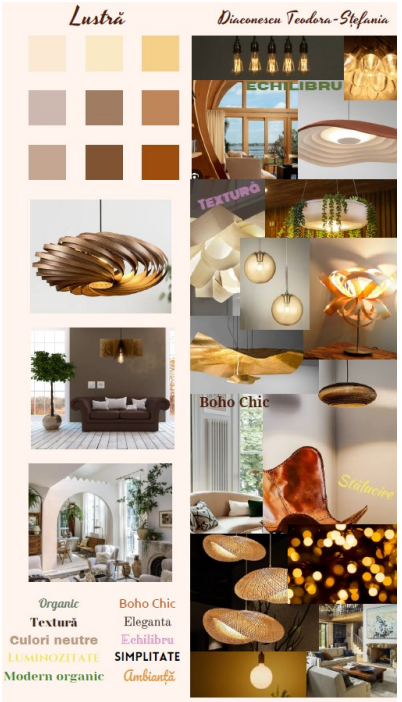
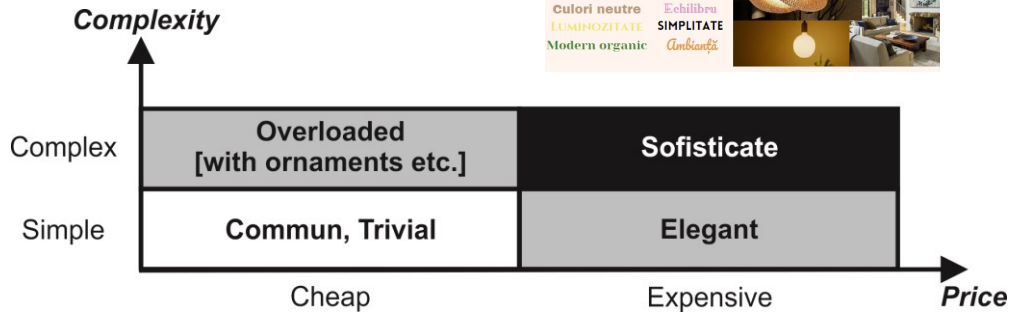
Auxiliary design methods and techniques:

- customer journey mapping
- character profiling
- scenario method
- mind map
- 9 windows technique
- cultural matrix
- mood board

	Past	Present	Future
Road			
Automotive			
Car body			





Actual design methods:

- Design Thinking
- User Experience Design / Interaction Design
- Participatory Design (CoDesign)
- Design for Behavioural Change
- Material Driven Design
- Design for Emotion

Methods oriented to product aesthetics:

- Kansei method
- Morphological diagram
- Grammar of forms
- Designing product significance
- Product metaphor generation
- Design for product personality

Design Thinking:

Stages:

1. Understanding the problem / empathy with consumer
2. Definition
3. Ideation
4. Prototyping
5. Testing

Characteristics:

- iterative experimentation;
- searching for a better and not necessarily perfect solution;
- allows finding revolutionary solutions, not just incrementally superior to others;
- search for novelty;
- ignoring the status quo;
- seeing and doing approach;
- focus on action.

User Experience Design / Interaction Design

User Experience Design (UX Design) is the process of developing products that offer users a meaningful and relevant experience through the whole interaction involving observing, acquiring, using and appropriation.

Key Characteristics of User Experience Design:

- Empathy
- Strategy
- Usability
- Inclusivity
- Validation

Participatory Design (CoDesign)

Participatory design is a design approach that:

- involves future users in all design stages, not only in the market research.
- imposes the consultation of all stakeholders associated to the product.
- requires the careful selection of the participants to the design process.
- ensure that all participants to the design process have a real say.
- all critical decisions are transparent.
- the whole design process is democratic.

Design for Behavioural Change

This method philosophy is that the products, through the way or the context of use, determine the change in the consumers' attitude regarding harmful habits.

Harmful habits:

- driving on any occasion, even for short distances
- sedentary lifestyle
- food excess
- obtaining coffee from the machine in a single-use cup
- use of disposable glasses, cups, plates, cutlery made of any material (especially plastic)
- using a maximum and continuous flow of water when washing hands or teeth
- surfing the internet for hours out of boredom

Design for Behavioural Change

In order to provide a pleasant conflicting feedback, a product should meet the following requirements:

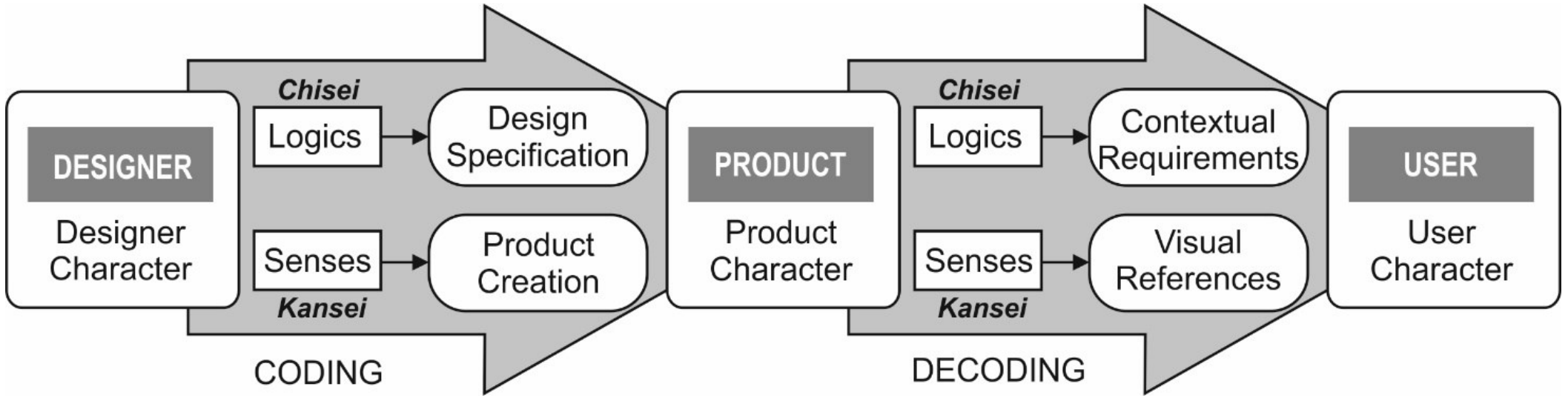
- to be linked to an impulsive or automatic habit;
- to offer a much better alternative;
- to be used at the right time for attitude change;
- to disturb the user in some way so that he starts thinking.

Material Driven Design

The materials-centred design methodology includes the following stages:

- understanding the material: technical, perceptual and semiotic characteristics
- creating a vision of the experience of using the material
- manifestation of material experience models
- designing with the material

Kansei



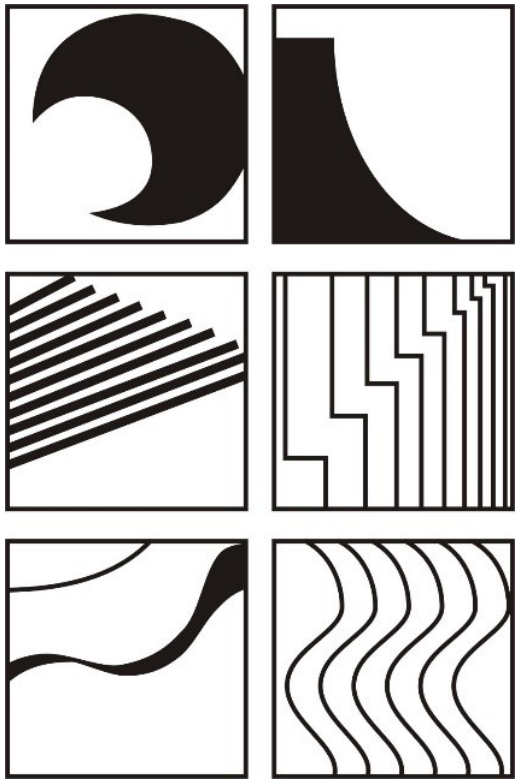
Chisei means intellectual knowledge.

Kansei represents sensory knowledge.

Kansei

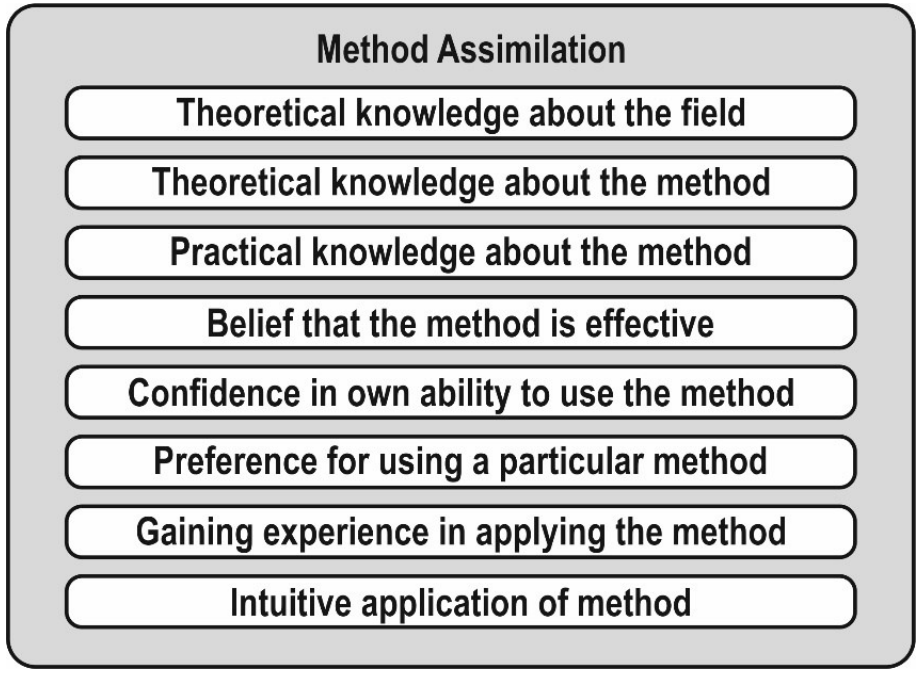
Kansei Stages:

- collecting product images
- aesthetic transfiguration of product images into icon images
- establishing Kansei adjectives
- sorting icon images and Kansei adjectives
- establishing links between the icon images and Kansei adjectives
- analysis and decomposition of the shape
- synthesizing new shapes
- selection of the final shape



Method Assimilation

Except for some simple techniques, the methods are not easy to apply and the designer needs to assimilate the method.



Prototypes

A comprehensive classification is the following:

- **conceptual model** – simple expression of the idea of operation;
- **model for testing the principle of operation** – a model that only tests the basic idea of functioning;
- **non-functional model** ("visual") - model that only has the role of the designer and others to observe how the product will look in the end;
- **virtual model** – model made with a computer-aided design programme, and which can be tested virtually in different ways;
- **working prototype** – prototype that allows testing the functioning of the product;
- **ergonomic prototype** – prototype that allows testing how the user can use the product;
- **final prototype** – prototype that is almost identical to the final product in all respects.

Prototypes

Iterative prototyping implies that a large part of the product development activities is dedicated to the development of prototypes and their testing. This strategy requires attention to application from two points of view:

- costs that can become high in the case of complex products
- need to design a system for assessment the contribution made by each prototype to the understanding, development and improvement of the product.

Parallel prototyping involves different teams (or individual designers) developing a prototype separately.

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Thank you for your kind attention!

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