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Citation: Cockton, Gilbert (2013) Diffusion of Worth Mapping: The worth of resource functions. In: CHI 2013 (ACM SIGCHI Conference on Human Factors in Computing Systems), 27 April – 2 May 2013, Paris.

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Diffusion of Worth Mapping: The Worth of Resource Functions

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ABSTRACT
This workshop paper uses a resource function vocabulary from the Working to Choose framework to analyse diffusion of the Worth Maps approach across several application domains. It explores how a resource function vocabulary can indicate aspects of design approaches and their use that favour successful diffusion.

Author Keywords
Diffusion of Design Methods; Worth Mapping; Working to Choose framework.

ACM Classification Keywords
D.2.2 Design Tools and Techniques

INTRODUCTION
Diffusion of innovation is a well understood phenomenon [9], but its insights have yet to be applied to specific interaction design and evaluation methods. This paper examines the roles of resource functions in the diffusion of Worth Mapping as an approach for interaction design, This paper applies selected insights from a companion paper for this CHI 2013 workshop, *Facilitating the Take-Up of New HCI Practices: a 'Diffusion of Innovations' Perspective*.

THE WORKING TO CHOOSE FRAMEWORK (W2C)
The Working to Choose (W2C) framework [4] is a conceptual system that: guides audit of existing approaches; identification of gaps in a design team's interaction design practices; adaptation and extension of existing approaches; and invention of new approaches. W2C analyses can focus on a single approach or an integrated group.

A design or evaluation *approach* is a group of *resources* [10] that seeds the *methods* that result from design work. Re-use of approaches requires adaptation, extension and completion to form viable methods. In this sense, methods are achievements, not premonitions. Design work can appear to be structured by methods, but the full details of methods in use cannot be known in advance, and certainly not before an approach is applied. Different approaches make different demands on design teams in terms of the work needed to make methods work, i.e., to become viable in specific work contexts.

W2C is a conceptual system for analysis of design and evaluation approaches, with three interlocking concept sets:

1. Resource functions
2. Design Choice Types
3. Meta-Principles for Designing

Recent developments have subsumed the last two concepts within the first, resulting in a simpler framework.

Resource functions

Resource *functions* are a reconceptualization of resource *types* [11]. In [11], resources within approaches were conceptualised as having distinct *types*, but it was later realised that a single resource can perform multiple types of *functions*, as well as having further attributes. The current resource functions (as named as types in [4]) are:

1. Directive
2. Harvesting
3. Expressive
4. Performative (additional to [4])
5. Scoping
6. Axiological
7. Knowledge
8. Invigorative (additional to [4])
9. Protective (additional to [4])
10. Integrative (additional to [4])

This mixes two vocabularies for resource functions, the original type vocabulary (1-3, 5-7) from [4] and an challenging vocabulary (4, 8-10) from [6], which presents further alternative vocabularies (everyday, technically neutral, poetic). Names from [4] have been used for consistency with the companion paper for this workshop. The provision of multiple vocabularies in [6] is intended to promote thought and reflection on resource functions, rather than create rapid but limited understandings through a single set of clear but incomplete definitions.

Resources can have multiple functions. For example, sketches have expressive, inquisitive, and directive functions. They not only express design ideas, but can also trigger inquiry and direct refinement. Also, sketches can have *performative* functions when shared with design

stakeholders. Sketching however is not guaranteed to have all four functions. It is always *expressive*, but must be used in particular ways to have other functions.

Three resource functions form the core of approaches: *integrative*, *scoping* and *axiological* (details below). As a shorthand, we can still write as if resource functions were types, i.e., when we call something a *scoping resource* this is to be understood as a resource with a scoping function.

Resource functions that were added since [4] recognise the complex, social, and emotional aspects of design work [6]. *Integrative* functions co-ordinate design approaches across design activities. *Performative* functions address communication beyond the design team through high quality visual presentations, careful use of language, and other presentation and communicative skills. *Invigorative* functions drive the design process forward, while *protective* ones keep it on track. Both are emotional functions.

Resource Functions Simplify and Widen Analysis

Design approaches have scopes that can be specific to technologies, user groups, application domains, or development roles or process stages. An approach's scope can also support one or more *Design Choice Types*, i.e., beneficiaries, purpose, artefacts and evaluations [4]. Making choices about beneficiaries can be a wholly human-centred activity, whereas making choices about artefacts can be creatively and/or technically focused. Making choices about evaluations can be human and/or technically focused, whereas making choices about design purpose can have a range of foci. W2C can thus be simplified by subsuming Design Choice Types into scoping functions.

W2C can be further simplified by treating Meta-Principles for Designing as evaluation criteria for resource functions [4]. For example, the quality of directive functions can be evaluated via the *tenacity* meta-principle. Directive functions are successful when they result in design options that remain valid choices due to the quality of design work that produced them. Options are not just potential features, capabilities and qualities of interactive digital artefacts, but also stakeholder considerations, design purposes and evaluation practices.

W2C's simplification subsumes two existing set of abstract concepts within ten currently identified types of functions that support a wider range of analysis. The main aim of this workshop position paper is to illustrate how a simpler W2C allows resource function analysis to be applied to an existing design approach, using *worth mapping* as an example. The use of worth mapping in six design contexts [1,2,3,7,8,9] is used to illustrate the balance between resources provided by worth maps and those that had to be sourced within specific project contexts. This exposes the role of local resources in the transfer of approaches from one design context to another, as well as demonstrating the role and value of the re-usable resources provided by design approaches. This widens analysis of the role of approaches in design work, as will now be illustrated via a resource function analysis of the worth mapping approach [3].

WORTH MAPPING

Worth Mapping as an approach creates Worth Maps, its main expressive resource, within a context of scoping and axiological functions (axiology is the study of values). We now briefly present worth maps and their use in design research settings since 2007, with published examples of use from the UK, Finland, Portugal, and Switzerland, in a wide range of sectors, including home systems, entertainment, ambient displays and mobile applications.

Worth Maps are box and arrow diagrams that represent relationships between artefacts, user experiences and design purpose. The term artefact is used here to refer to any designed product or service at any stage of realization from initial ideas to installed user bases, Boxes in worth maps either represent attributes of artefacts, episodes of interaction, or usage outcomes. Sequences of arrows between boxes can be followed from artefact attributes via interaction episodes to usage outcomes, creating *means-end chains* that represent intended, perceived or observed causal relationships between artefacts, user experiences and usage outcomes. Artefacts and experiences are means to ends, the latter correspond to worthwhile usage outcomes.

Reconstructed Applications of Early Worth Maps

First use of worth maps was based on reverse engineering from the design experiences of the author, who invented worth maps. Early versions of worth maps (W/AMs) were applied to e-commerce and educational examples [2], and to experiences from a student design exercise [3].

First Use on a Live Project

Figure 1 shows a worth map from early work within a Family Archive design research programme [7]. The inventor of worth maps was a permanent member of the research team for three months, during which time worth maps were restructured as a result of relating potential features of a family archiving system to valuable outcomes.

Consultancy Support for Two Live Projects

Worth Maps were used without direct involvement of their inventor on some case studies within the Finnish VALU project (including one on on-line gambling [8]), as well as an academic research project on ambient displays in Portugal [9]. Both projects used the revised worth map structures from the family archive project. The inventor provided advice via email, mostly on worth map element types, but this was far less significant than the local innovations within the VALU project [8]. For example, blank typed elements (e.g., for features or user experiences) were also used to good effect to indicate gaps in mean-ends chains for the current system.

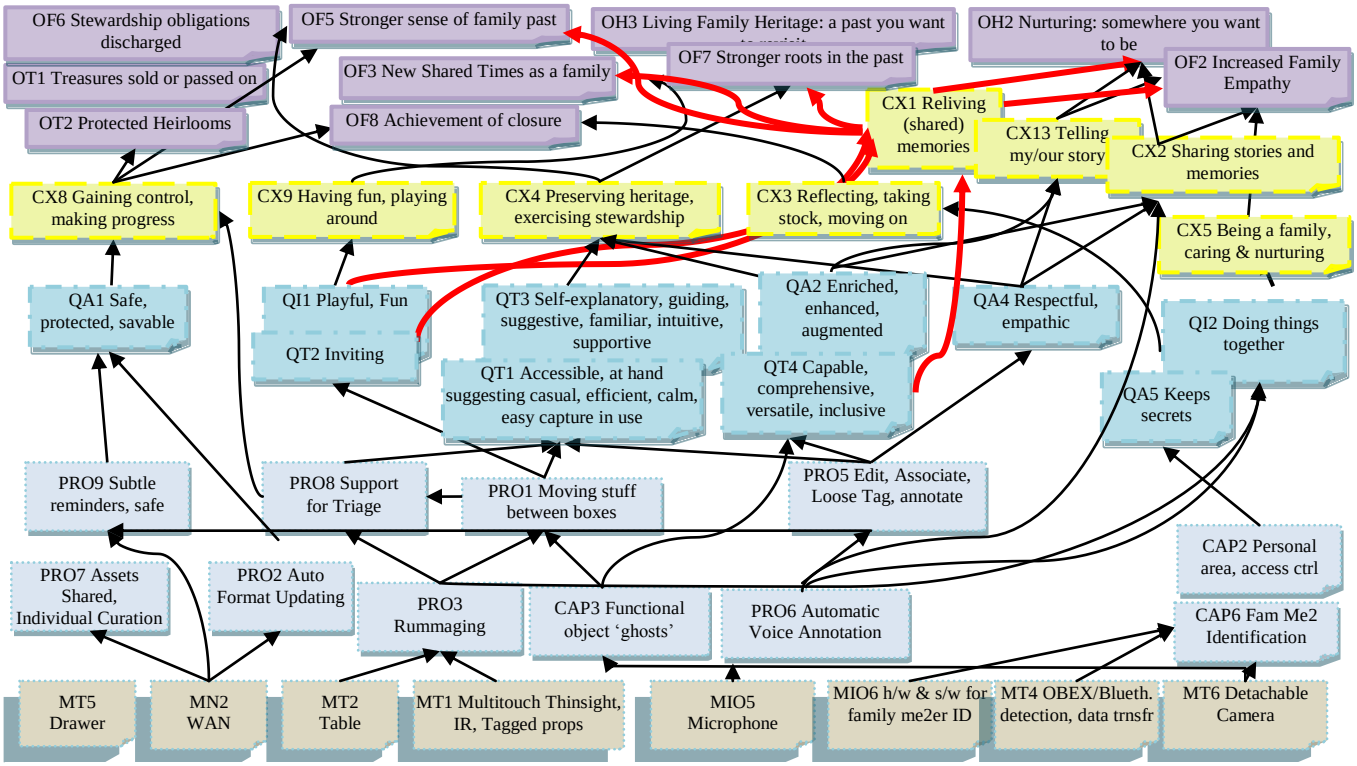

Figure 1: Example Worth Map (from [7])

Each box represents a specific type of worth map *element*. The purple boxes with O labels at the top represent *worthwhile outcomes* that were expected when organizing objects in a family archive. The green CX labelled boxes are *user experience* elements corresponding to episodes of interaction All elements below them are *artefact attributes*, separated here into *materials* (bottom M labelled layer), *features* (PRO and CAP labelled elements) and *qualities* (Q labels). Artefact features and qualities are linked to worthwhile outcomes via user experiences**,** since it is users who actually create worth through use. Bold arrows indicate such means-end chains.

Independent Use

Worth maps have most recently been used on a mobile application research project in Switzerland [1]. The inventor had no contact with this research until the completion of an associated PhD thesis [1]. Worth maps for complete design projects can become very large, and need to be modularised to manage complexity. In [1] worth maps were modularised around mobile phone elements, as this was a focus for the local mobile HCI research.

THE ROLES OF RESOURCE FUNCTIONS IN THE DIFFUSION OF WORTH MAPPING

All types of resource function have contributed to the diffusion of worth maps, but additional local project resources have been just as critical to success, e.g., the use of a diagram editor to layer worth maps in [8], and local identification of design and value elements [1,7,8,9]. This is consistent with a key position on approaches and resources, i.e., that virtually no approach has a complete set of resources prior to use. Approaches only become workable methods through local adaptation of their provided resources and local addition of additional resources. In [7], stages in the life cycle of an archived object were the basis for modularisation (a worth map for each stage), whereas in [8], worth maps were modularised around user experience, and in [1] around materials. Such variations show the role of local values and insights in adapting different structures for worth maps. The relation of local resources to those provided by worth mapping approaches is now reviewed.

Expressive Resource Functions

Worth maps are primarily *expressive* resources that compose a family of element types. These evolved rapidly during 2007, as shown in Table 1. The first set of element types for worth maps is shown in the left column. These revised the element types of previous worth/aversion maps (W/AMs [2]), which in turn were based on *hierarchical value models* (HVMs - a diagramming format with associated means-end chain and laddering theory) from marketing research. The main applications of HVMs included digital service research [2]. W/AMs revised HVM elements, in response to experiences of reverse engineering [2] and from a VALU project workshop before [8].

The key point here is that the evolution of worth maps' expressive function was not a process of linear progress, but one of contextual diversification where alternative worth map elements were adapted to different design contexts.

Table 1. Rapid Evolution of Worth Map Elements, 2007

<table>
<tr><th>Worth Maps</th><th>W/AMs</th><th>HVMs</th><th>Focus</th></tr>
<tr><td colspan="2">Worthwhile Outcome</td><td>Terminal Value</td><td rowspan="4">Design Purpose and User Experience</td></tr>
<tr><td>User Experience</td><td rowspan="3">Usage Consequences</td><td>Instrumental Value</td></tr>
<tr><td>Feeling</td><td>Psychosocial Consequence</td></tr>
<tr><td>Action</td><td>Functional Consequence</td></tr>
<tr><td>Quality</td><td colspan="2">Abstract Product Attribute</td><td rowspan="3">Artefact</td></tr>
<tr><td>Feature</td><td colspan="2" rowspan="2">Concrete Product Attribute</td></tr>
<tr><td>Material</td></tr>
</table>

The first generation of worth map elements is shown in Table 1, left column. HVM concrete product attributes were divided into materials and features. W/AM compression of three steps in HVM means-end chains into a single usage consequence was replaced with more complex causal structure, only to be replaced in the second generation of worth map elements by a single user experience element type (see [7] for rationale). Figure 1 uses this set of element types (i.e., not one in Table 1). A third generation of worth map elements was proposed [8] that merged artefact elements into a single 'product attribute', resulting in only three types of element: artefact, experience and outcome.

Worth mapping has thus used five different, but overlapping, sets of element types. Worth Sketches (boxes but no arrows [3]) are a further alternative expressive resource. Worth mapping has thus shown much expressive variation. As well as differences in structure and content, worth maps have been modularized [1,7] and layered [8] differently. Although it was not known at the time, worth maps were developed through a series of collaborative case studies as *approaches* [11], where resources were adapted to project circumstances and experiences of their use. Thus each set of elements has demonstrated different (but overlapping) benefits and challenges in specific settings.

First generation worth maps only lasted months, but the second generation (feelings and actions become parts of user experiences) achieved some successes with multi-disciplinary R&D teams including hardware and software engineers, interaction designers and human science specialists [1,7,9]. However, this simplification was not enough for a product development team that only included one technical role [8], which motivated the proposal to have only one type of artefact (product) attribute. In all cases, no-one concluded that worth mapping could not transfer to their design setting. Instead, element types were successfully adapted to better fit project contexts. The diffusion of worth maps thus depended on local adaptations and extensions that exploited the possibility of any use of physical cards or drawing tools (with/out layering) for any set of element types being valid as long as it is compatible with worth mapping's values (*axiological* functions, next).

Scoping and Axiological Resource Functions

Scoping resources limit an approach to specific abstract design situations or development process stages. The scope of worth mapping is limited to the range of choice types that design teams choose to co-ordinate via them (see *integrative* function below). Worth maps should thus transfer to any design context. Indeed, they have been found to be valuable for marketing as well as design [1,8]. No restrictions have yet emerged in terms of application domains addressed to date [1,2,3,7,8,9]) or in terms of the technologies involved (domestic controls [3], ubiquitous computing [7,9], mobile phones [1] and web-based services [2,8]). Worth maps have been used across complete development lifecycles [1] and roles involved in their use have included marketing, finance, software and hardware engineers, interaction designers and human scientists. A current case study is focused on a social network for the care circles of children with major impairments.

Despite this wide coverage across over six usage contexts, *axiological* functions inevitably limit worth mapping to project contexts where explicit links between design features and stakeholder benefits are valued. Design settings where such links can remain tacit are thus not in scope for worth mapping approaches, and thus will not transfer there. Similarly, worth maps are intended for acentric design processes, i.e., ones that have no single centre, but instead shift foci and emphases between different types of choices and their co-ordination [5]. By not privileging one type of choice, as user-centred design privileges user *beneficiaries*, *acentric* design processes must *balance* and *integrate* different design foci [5]. During design, the focus can shift between all four choice types, i.e., the artefact, beneficiaries, evaluations and purposes.

Worth maps also value expression of design purpose as intended worth in the world, but are neutral on whether this should be wholly grounded in empirical data on users' wants and needs (although it can be). This lets design teams offer unexpected value and experiences that beneficiaries do not currently know are possible. Design teams are thus allowed to be *generous*. As well as specific commitments to explicit purpose as worth, and links between this and artefact attributes, *balance*, *integration* and *generosity* are core values for worth mapping [5], which also values design process freedom where options for worth map elements can be developed in any order. Overall, the openness and freedom of worth maps has eased their diffusions as design practice innovations.

Directive, Harvesting and Integrative Functions

Directive functions guide use of an approach. Only one simple worth map construction procedure has been published by the inventor [3]. A local directive function

evolved in [7] as a combination of collaborative card based worth sketches that the inventor subsequently turned into a digital worth map. In [1,8,9], design teams used their own knowledge, experience and insights to direct worth map development. A core objective for [1] was to develop structured approaches to worth map creation, so there are now two alternative published directive resources [1,3] for worth mapping, as well as partially documented local directive resources [7,8,9]. Local creation of directive functions have thus been possible, as has creations of re-usable ones as resources for worth mapping approaches.

Worth Mapping has no *harvesting* functions to provide sources of data and inspiration, but project teams can find complementary approaches to compensate, including field research and design workshops [7], online sentence completion and existing product attributes [8], and interviews and competitor analysis [1]. As long as harvesting resources deliver design purpose elements at appropriate levels of generality, worth mapping can use any user research or design ideation approaches.

Worth maps primarily have an *integrative* function, and can co-ordinate activities focused on design purpose and artefact design, as well as activities resulting in understandings of beneficiaries (via user experience elements in worth maps) and also evaluation activities (by associating measures and targets with worth map elements). A range of scoping functions results in worth maps co-ordinating two, three or four types of design choice. Element types also have scoping functions, with the simplification to three element types in [9] motivated by a predominance of non-technical roles in the project team. While technical and creative specialists can make good use of the full range of five element types, non-design roles can find them overly complicated. Worth map element types thus have a scoping function that can adapt to the capabilities and preferences of design team members.

Performative Resource Functions

Performative resources support communication and persuasion within design settings. Physical worth sketching cards [7] can be regarded as a *performative* resource that shares a current set of worth map elements within a design research team. Layering worth maps using a drawing editor [8], limiting visible layers to those involving one or more specific user experience elements, proved to have a useful performative function when communicating worth maps to audiences who were not involved in their creation. Even so, it proved difficult to communicate completed worth maps to those who had not contributed to making them. Still, the project team in [8] was multidisciplinary, involving sales, marketing and customer relationship management, and worth mapping did improve communication between these roles. Initial difficulties did not prevent the project team from presenting insights from worth mapping to several national divisions. Additional local performative resources here were key to presenting focused insights. Such local resources may prove vital to improving diffusion in contexts where there is diverse disciplinary expertise.

Emotional Resource Functions

Emotional resources have rarely been given attention in design method research [6]. Emotional resources can have invigorative or protective functions. Resources with an *invigorative* function accelerate the progress of design towards successful completion. In [7], group use of worth sketching cards created tactile social experiences that enlivened design discussions and supported team creativity and critique that respected and exploited the expertise of each team member, creating common ground across the team (this was also achieved in [1,9]). A focus on value innovation through worthwhile outcomes accelerates progress in design workshops and generated valuable new design opportunities [1,7,9]. Users' motivations were effectively represented in a compact format (outcome elements). The final worth mapping document in [7] provided value within for at least 18 months after the initial worth mapping, and the value/outcome elements identified have guided subsequent design research. In [8], the value elements made it easier to prioritise the existing backlog in an agile development context. In [8], worth maps also provided a valuable additional high level viewpoint on evaluation of business value, but this was in part due to the involvement of product and financial managers for a live commercial service. These roles provided local invigorative resources that were vital for success.

Invigorative resources give design teams confidence that their design work is worthwhile, allowing them to focus on adding further value. In contrast, *protective* resources keep design on track, avoiding dead ends and unproductive debates, and thus reducing the costs of adverse outcomes during design. The protective function of worth maps improved as element types stabilised. Difficulties of understanding in [7,8] did not arise in [1]. Protective resources depended on the inventor in [7] and careful management of relationships beyond the project team in [8]. There was no evidence of protective resources for [1,9].

Emotional resource functions are emergent, and always due to interactions between an approach's resources and their specific configuration and use in design settings.

Knowledge Resource Functions

Knowledge resources provide underpinning knowledge, concepts and theory that enables design teams to make best use of approaches. A basic grasp of laddering, means-end theory and consumer psychology, marketing and related applications of. HVMs were achieved via different local resources across the projects. In [7], a key local resource was an evolving tutorial document written and updated for the project team by the inventor. In [8,9], it was coaching and advice by email. In [1], it was the lead researcher's interest in worth maps that motivated her to review the relevant literature on laddering, means-end theory, HVMs

and related consumer psychology and marketing concepts. The inventor's ability to respond in [7] to problems of worth map complexity depended on his familiarity with known issues with HVMs in the marketing literature [2]. Knowledge resources are vital to successful adoption and adaptation of approaches. Full competence in the use of directive and expressive resources depends on them.

DIFFUSION OF INNOVATION CONSIDERATIONS

The Diffusion of Innovation literature [10] provides many insights into why specific functions from worth mapping's resources and also local project resources combined to result in successful design work. The companion paper presents these insights systematically. A few are now presented for worth map diffusion.

The *trialability* (fourth attribute of innovation [10]) of worth maps was aided by research context values (local axiological resources) that allowed experiment, provided missing harvesting and directive resources, and even extended scoping functions to include marketing uses [1,8]. For the latter, local marketing knowledge resources [1,8] and familiarity with HVMs and consumer psychology [1] reconnected worth maps with their origins [2].

Homophily (change agent success factor: shared beliefs and team attributes [10]) let appropriate harvesting and directive resources be provided locally, with quantitative approaches used in [8], qualitative in [7], creative brainstorming in [9] and engineering requirements approaches in [1].

The minimal scoping function of worth mapping (a choice of co-ordinating 2, 3 or 4 choice types) means that only axiological mismatches at the *organisational decision making stage* [10] can put worth mapping out of scope. Local and secondary *knowledge* resources extended worth mapping's scope to marketing and communications [1,8].

As regards the *persuasion/interest stage* of innovation [10], axiological resources attracted design teams here. In [1], a strong local need advanced worth mapping to the *routinizing* stage [10] via new directive resources. In contrast, in [7,8], new local axiological resources removed the need for the expressive and integrative functions of worth maps. What diffused here instead was the worth-focused context [3] within which worth maps had been developed. After use on one project, worth maps were no longer needed to maintain a value focus, but nevertheless, the expressive functions of worth maps was a factor in the initial *agenda setting stage* [10] that persuaded design teams of a match to their needs or aspirations.

CONCLUSIONS

Overall, local resources were critical to the success of worth mapping, as predicted by [11]. Concepts from W2C may thus be combined with diffusion of innovating findings to explain the success of worth mapping across a range of project contexts. Core *expressive*, *integrative* and *axiological* functions of worth mapping resources were unchanged in [1,9], but were reduced/simplified in [7,8]. All projects [1,7,8,9] successfully added appropriate (i.e., *homophilous* [10]) *directive* and *harvesting* resources that are intentionally missing from worth mapping. Although performative functions were unintentionally omitted, all projects managed to add these locally.

Future work with worth mapping needs to pay more attention to resource functions identified since [4] (performative, invigorative, protective), perhaps adding new resources to provide more re-usable support for the social and emotional aspects of design work [6]. This would further demonstrate the worth of resource function analysis.

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