Development of Randomly Mixed Perennial Plantings and Application Approaches for Planting Design

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1 Introduction

The planning of diverse and species rich perennial plantings is very time consuming. To increase the efficiency of the planning process the concept of randomly mixed plantings was developed in a series of trials at Anhalt University of Applied Sciences, Bernburg, Germany. Compared with plantings based on a graphically depicted planting plan the visual quality of a mixed model was assessed equally ranking.

1.1 Planning of Perennial Plantings – Common Approaches of Planning Perennial Plantings

Monoplanting: One simple and popular strategy in public green spaces is planting with a single species. Among the typical perennials used in monoplantings are competitive species of *Geranium, Salvia, Lavandula*, etc. Monoplantings are less cost intensive to planning, construction of the planting and maintenance as long as hardy and long lived perennials are used. Monoplantings are monotonous, since blooming occurs only for a certain period or even not at all. Evergreen shrubs such as *Cotoneaster* and *Lonicera pileata* do not show the seasonal changes typical to perennials and deciduous trees and shrubs.

Planting in groups or blocks (Fig. 1), usually of more than two different species, are another way of creating public green spaces. Block planting is essentially a more complex version of the above and is perhaps the most common approach to landscape planting (DUNNETT, KIRCHER & KINGSBURY 2004, p. 246).

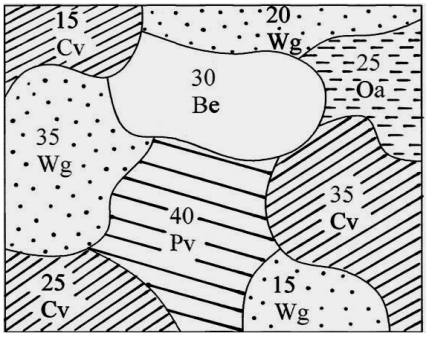

Fig. 1: Planting Plan arranged in groups

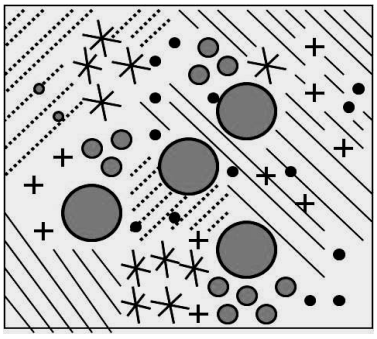

Fig. 2: Planting Plan arranged according to sociability levels

Block plantings consist of several different species planted for effect in groups of three to five or even more than one hundred. Block plantings can be subdivided into so-called drifts, which are strips, usually linear and at tendentially right angles to the observer, in order to provide perspective. Drifts contain groups of plants arranged in extremely narrow rows running more or less parallel to the main direction of the bed. This arrangement enhances the depth effect, but is more expensive to plan and maintain. Drift planting was used with great skill by Gertrude Jekyll in herbaceous and mixed borders. As a big advantage of this method ROBINSON (1998) mentions that the narrow groups would look best at their peak but also that they would not detract from the border after fading.

Planting according to sociability levels (Fig. 2): A very naturalistic approach is to arrange plants according to sociability levels I to V (according to HANSEN & STAHL 1993). This planting strategy is applicable to perennials with a more "wildlife" effect. Plants of low sociability levels (groups I and II) are set individually or in small groups of three to nine. Plants of higher sociability levels (groups III to V) are set in groups of 10 to 20 or more and arranged loosely around those of groups I and II (HANSEN & STAHL 1993).

1.2 Randomly Mixed Planting

This approach aims to completely abstain from a drawn planting plan. Species and variety are carefully selected according to their habitat, competitiveness, flowering, height, and reproductive behaviour. The amount of each type of plant to be used is recorded according to these criteria in a list. By laying out the plants are distributed as evenly as possible over the entire area, starting with the species present in the lowest amounts. The exact position of every plant is not predetermined in a planting plan, but determined by chance. This planting strategy gives a natural effect. The idea behind this strategy is to create a plant community in an ecologically sound, competitive balance, comprising the ideal type of vegetation for public green spaces. Ideally, species showing various striking aspects, forms, heights and propagation strategies complement each other to form a self-regulating system. Within this dynamic model the survival of the entire planting under extensive maintenance is more important than survival of individual plants. The conditions at individual sites result in different competitive conditions and vegetation patterns despite identical plant components. Moreover, there are possibilities for introducing structure such as dominant visual elements or rather theme plants (especially "dominant species" – see table 1; definition following BORCHARDT, 2006, complemented)

The term "Staudenmischpflanzung" (mixed perennial planting) was coined in 1994 by KOLB and KIRCHER at the Institute "Landesanstalt für Weinbau und Gartenbau" (LWG), Veitshöchheim, Germany. They were seeking to develop a simplified version of the concept of sociability levels (HANSEN & STAHL 1993), which would be practically applicable by inexperienced workers, who had never before worked with herbaceous perennial plantings. It is not necessary to have a planting plan with a list of the prescribed numbers of the plants to be used (KIRCHER 2000). In times of limited public funding the concept of mixed herbaceous perennial planting is a reasonable way nevertheless to provide public green spaces as an alternative to costlier approaches with intricate planting plans or rather seasonal bedding.

2 Material and Methods

2.1 The Research Project "Mixed Herbaceous Perennial Planting" at Anhalt University, Bernburg

Experiments to create suitable perennial mixtures as well as establishing and maintaining methods are carried out since 1999 at Anhalt University of Applied Sciences in Bernburg. This dry region provides an annual precipitation of only 470 mm in average. The trials were supported by the German Federal Ministry for Education and Research (BMBF), the German Perennial Nurseries Association (BdS), and the German Research Foundation (DFG). Till 2010 around 30 mixtures have been developed; fifteen have been optimized on the basis of knowledge and assessments gained in the project and are now published as recommendations (http://www.prof-kircher.de; FENZL & KIRCHER 2009). Methods and results from the assessments are recorded by MESSER (2008), who elaborated many aspects of the research project in his PhD-Thesis, assumed by the University of Sheffield.

2.2 Perennial Mixtures from Further Research Institutions

Additionally to the research at Anhalt University a remarkable amount of mixtures with promotional "trade names" were tested, assessed and optimized since the end of the 1990's especially by these institutions:

- Bayerische Landesanstalt für Weinbau und Gartenbau (LWG), Veitshöchheim (P. SCHÖNFELD)
- Schau- und Sichtungsgarten Hermannshof, Weinheim (C. SCHMIDT)
- Lehr- und Versuchsanstalt für Gartenbau/Fachhochschule, Erfurt (C. PACALEI, W. BORCHARDT)
- Zürcher Hochschule für Angewandte Wissenschaften Institut Umwelt und Natürliche Ressourcen, Wädenswil, Switzerland (D. TAUSENDPFUND, A. HEINRICH)

Together with Anhalt University these protagonists currently are publishing 29 recommended plant mixtures in http://www.stauden.de/cms/staudenverwendung/mischpflanzungen/mischungen_alphabetisch.php?navid=87.

The most widespread planting is "Silbersommer", a concept of 36 taxa, created by the Arbeitskreis Pflanzenverwendung (Committee of Planting Design; see http://www.stauden.de/cms/staudenverwendung/mischpflanzungen/forschung/ak_verwendung.php?navid=93).

2.3 Creating Applications of Randomly Mixed Perennial Plantings

Small plots can be designed aesthetically satisfying with pure randomly mixtures. On bigger areas more predictability of the resulting planting is desired. Thus at Anhalt University some variants of mixed plantings were developed to enhance the quality of the designed vegetation's appearance. Nevertheless they should not effect significantly more time consumption than working with the pure randomly mixing strategy. FENZL & KIRCHER (2009) published six application variants for practitioners. In chapter 3 these variants shall be introduced and explained by their theoretical background.

3 Results

3.1 Preconditions for Well Performing Mixed Plantings

Plant species have to be selected and arranged by taking into account the following trait (MESSER 2008):

- Choice of suitable site/habitat conforming (HANSEN & STAHL 1993)
- Thematic focus of the planting (i.e. blue-yellow contrast)
- Growth rhythm (short-term dynamics, annual aspects, height in various seasons, long-term dynamics)
- Life expectancy of the plants (biennials, short- and long-lived perennials)
- Plant sociability (according to HANSEN & STAHL 1993)
- Reproduction and rate of propagation
- Population biological strategies (runners, rhizomes) (GRIME, HODGSON & HUNT 1986)
- Aesthetic criteria (layering, color combinations, texture)

To guarantee a visually pleasing and sustainable relief within the planting, it is recommended to distinguish between 5 different plant categories according to height and long and short term space requirements (table 1).

The diversity of most mixtures is guided by around 12 to 20 species/cultivars per theme for sunny habitats. "Silbersommer" is the richest mixture with 36 taxa. Under shady conditions it is better to reduce the diversity appropriately. Concrete recommendations for mixtures in woodland habitats are currently investigated by tests of the Committee of Planting Design.

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Category	Definition	Recommended proportion of plants
Dominant species: structure plants, framework plants	Forming the structural framework of the planting, e.g. grasses (*Miscanthus sinensis, Cortaderia selloana*), large-leaved perennials (e.g. *Rodgersia*) or upright plants (e.g. *Veronica longifolia*); mainly C-, C-S or S-Strategists	5 – 15%
Companion plants	Recurring, stabilizing elements (e.g. *Salvia nemorosa, Hemerocallis lilioasphodelus)* which define the visual character of the planting and emphasize the structure plants. Long lived plants; mainly C-, C-S or S-Strategists	30 – 40%
Ground cover plants	Usually small perennials of up to 30 cm height which must be used in larger numbers, usually as a carpet between gaps between plants of the first two categories, i.e. *Geranium x cantabrigense, Omphalodes verna, Waldsteinia geoides;* mainly C-, C-S or S- Strategists	≥ 50%
Filler plants	Short lived plants, responsible for a quick cover and visual display in the first one to three years. Quick in growth and spreading generatively, but weak in competition, declining whilst substituted by the dominant, companion and ground cover plants (e.g. *Linum perenne, Aquilegia canadensis, Digitalis purpurea);* R-, R-S, or C-R-Strategists	5 – 10%
Scattered plants	Plants with a short growth period that do not require much space. However, these are very showy and dominant when in bloom, such as flowering bulbs (e.g. *Allium sphaerocephalon, Anemone blanda, Narcissus* 'Hawera') or very slim perennials (e.g., *Codonopsis clematidea, Campanula persicifolia*)	added additionally in great amounts: 20 to 50 bulbs/m²

Table 1: Classification of perennials (MESSER 2008, definitions following BORCHARDT 1998, supplemented by FENZL & KIRCHER 2009; C-, R-, S- Strategy see GRIME, HODGSON & HUNT 1986

3.2 Applications of Randomly Mixed Perennial Plantings

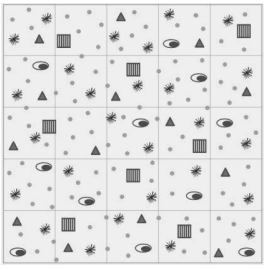
The planning strategy of mixed perennial plantings can be recommended for small to medium sized beds in public and private green spaces, if a natural display is desired. Considering the proportions and amounts of plant- categories recommended in table 1 is essential for an attractive relief as mentioned above. Bigger scaled planting areas can be arranged in a meadowy style, allowing more intricate and intertwining plant structures: the proportions of taller species may be increased. Also combinations between sown vegetation and planted perennials are conceivable (see Fig. 8/Variant 6).

Suitable for tenders with mixed plantings are for example the following themes:

- Planted meadows, eventually in combination with sowing
- Planted prairies
- Mille-Fleur-plantings (seasonal bedding with small inflorescences, in well balanced color combinations)
- Woodland underplanting (mixes with lower diversity in species)
- Marginal plantings in ponds (reed forming plants shall be combined with only filler plants or rather shade tolerant ground coverers)
- Traffic islands and roundabouts as well as small plots between asphalt sealed surfaces
- Narrow beds along fences, walls and buildings
- Rock gardens and dry stone walls (plant lists divided into differentiated habitats like „sunny gaps“, „shady gaps“, “mural crown” etc.)
- Extensive roof gardens
- Plantings between pavement crevices

Particularly on bigger planting beds it might be beneficial not to dedicate the complete plant distribution to chance. Six adaptation possibilities are introduced hereafter.

Fig. 3:
Variant 1 – Pure mixed planting list with names and quantities of plants (species, genus, variety, cultivars). Plants are arranged in similar distances to each other. The image on the right hand shows a randomly planted plot of “Bernburger Blütenschleier”.

plant list example	**planting plan example**	**distribution pattern on the plot**
30 *Aster amellus* `Rudolf Goethe´ 25 *Buphthalmum salicifolium* 50 *Carex Montana* 100 *Thymus serpyllum* `Album´ etc.	no depicted plan is necessary	

Variant 2 – List with names and quantities of plants plus additional remarks about positioning or grouping
The grouping of certain species allows to include areas providing a calming appeal. Groups in rows or streams are effective for grasses or vertically growing perennials like *ampanula persicifolia* or *Verbascum* spp. “Filler plants” do not leave an ugly hole after vanishing if

arranged in narrow groups. It is also possible to prevent tall plants (dominant species) from being placed nearby the bed's edge by only adding an appropriate written remark into the plant list. On vast areas the observer's eye is assisted by a consistent use of all species in small groups, causing a "zooming" effect communicating with the extension of the complete planting bed's size.

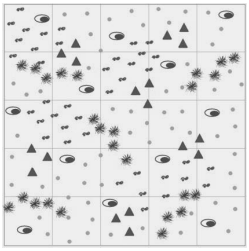
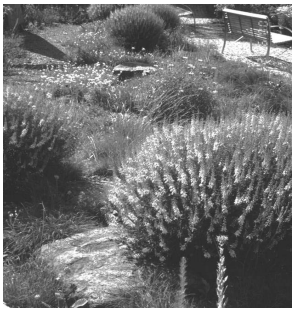
plant list example	**planting plan example**	**distribution pattern on the plot**
30 *Aster amellus* `Rudolf Goethe´ in small groups of 3 25 *Buphthalmum salicifolium* randomly distributed 50 *Carex Montana* In linear streams of 5 100 *Thymus serpyllum* `Album´ in groups of 10 etc.	no depicted plan is necessary	

Fig. 4:
Variant 3 – Illustration of tall, dominant plants in the plan, accompanied by randomly mixed lower perennials
On middle and bigger sized areas it can be necessary to include taller Plants into the vegetation pattern to provide visual leading. This can be realized by adequate perennials, subshrubs or even shrubs arranged in sufficient distances to each other. To create naturalistic distribution patterns these species should be depicted into a graphical plan or sketch. The shallower species can be added randomly as in variant 1 or added by additional remarks about positioning or grouping as in variant 2.



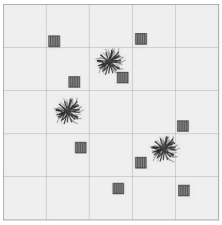
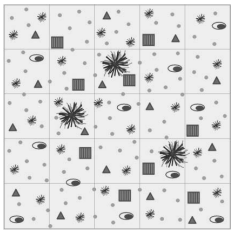
plant list example	**planting plan example**	**distribution pattern on the plot**
 3 *Dictamnus albus*  8 *Stipa gigantean* in mixture: 30 *Aster amellus* `Rudolf Goethe´ 25 *Buphthalmum salicifolium* 50 *Carex Montana* 100 *Thymus serpyllum* `Album´ etc.		

Fig. 5:
Variant 4 – Illustration of clear defined recurring core groups accompanied by additional perennials in randomly mixture

Core group planting = "Kerngruppenpflanzung" is defined by BORCHARDT (2006). To be sure that desired combinations of particular partners will be realized within the planting clearly specified groups can be depicted detailed (left alternative in box below). The same effect will result by using one symbol as placeholder for the specific species combination per core group. The rest of the designated perennials can be added randomly as in variant 1 or 2.The planting on the right hand shows repeated combinations of *Gypsophila* 'Rosenschleier' and Iris Barbata-Media, the former covering reliably the unpleasant summer appeal of the faded latter ones.

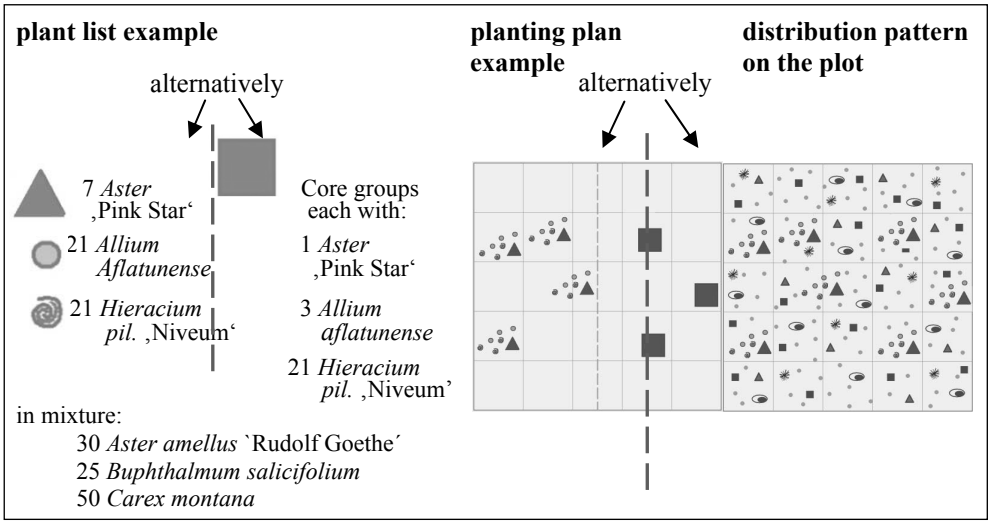


Fig. 6:
Variant 5 – subdividing the planting bed into smaller parts with different mixtures or with the same mixture in different multitudes per species
Extensive planting areas, for example several hundred square meters, may look too uniform if covered consistently with one mixture only. If partitioning into dequate sized plots it should be paid attention to form transitions from plot to plot or rather to refrain from colliding completely different plant combinations against each other. Neighbouring plots should contain similar ranges of species but arranged in different amounts respectively proportions. Of course this approach can be combined with all variants mentioned above inside of one single plot. The image shows a "Garigue" planting at the Botanical Garden of Würzburg: Different mixtures can be recognized, but some species such as *Asphodeline lutea* are skipping over the borders.

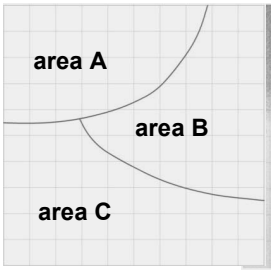
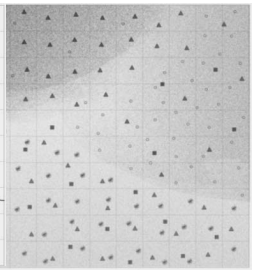
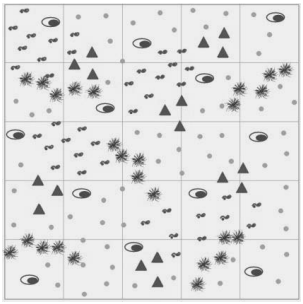
plant list example	**planting plan example**	**distribution pattern on the plot**
area A: 100 *Aster amellus* `Rudolf Goethe´ 50 *Allium sphaerocephalon* 60 *Asphodeline lutea* etc. area B: 30 *Aster amellus* `Rudolf Goethe´ 300 *Allium sphaerocephalon* 24 *Dictamnus albus* etc. area C: 100 *Allium sphaerocephalon* 30 *Asphodeline lutea* 8 *Festuca gigantea*		

Fig. 7:
Variant 6 – Combination of mixed plantings with seeding or rather spontaneous vegetation

The most naturalistic approach is to combine existing vegetation or seed mixes with a mixed perennial planting. To include pot plants or young plants from trays is rewarding for vegetatively propagated perennials (i.e. *Hemerocallis* cv.) as well as for species with a weak or unreliable germination (*Salvia* species). Also plants with a very slow development (*Dictamnus albus*) are worth to be planted as bigger specimen.

plant list example	**planting plan example**	**distribution pattern on the plot**
30 *Iris* `Libellula´ 20 *Salvia officinalis* 15 *Verbascum olympicum* etc. plus sowing mixture (1g/m²): 5 % *Festuca pallens* 2 % *Dianthus carthusianorum* 1 % *Linum perenne* etc. or scattered between existing spontaneous vegetation	no depicted plan isnecessary	

4 Conclusions and Outlook

4.1 Contemporary Strategies Related to Mixed Perennial Plantings

Precursors of the mixed planting strategy were already performed in artificial prairie plantings such as the first prairie restoration project, the Curtis Prairie, in Madison, Wisconsin, USA. A combination of sowing, planting and transplanting sod (DIECKELMANN & SCHUSTER 2002; WASOWSKI 2002) was distributed in mixture. The "Matrix Planting" approach of Peter Thompson (THOMPSON 1997) is also based on mixed plantings. Oudolf combines a few mainly tall growing species in drifts or blocks which are neighboured to each other in borders, as can be seen at his famous "Wisley Border" in RHS Wisley Gardens (GERRITSEN & OUDOLF 2000). The latter project can be characterized as an ornamental type of "variant 5" (Fig 7). Further examples of planting methods referring to the randomly mixed strategy see in MESSER (2008).

Fig. 8: Piet Oudolf's Border at RHS Wisley Gardens is a combination of diagonally running streams with mixed tall perennials

4.2 Mixed Plantings in Academic Education

It is to be discussed which level of knowledge and skills shall be taught in academic landscape architecture courses based on four steps of intricacy:

Step 1: Coming to know only the mixed strategy as one possibility beside monoplanting, planting in groups and habitat planting with sociability figures. To experience a synoptic view on existing mixtures from diverse research institutions and their implementation into the planning process.
This step should be a fundamental target in undergraduate Landscape Architecture courses.

Step 2: Understanding basically principles of functioning sustainable combinations such as habitat-conformance, well balanced strategy types and heights as well as a precise aesthetical concept.
At least undergraduate students with emphasis in planting design should reach this level.

Step 3: Ability to change existing mixtures in case of differing site conditions or aesthetical demands by substituting particular species according to their individual role within the planting. For this step it is important to mediate a deeper insight into plant traits concerning ecological as well as aesthetical features. Postgraduate courses should target at least this step.

Step 4: Ability to create individual mixtures. Profound plant knowledge is necessary as well as a grounded understanding of ecological traits and site demands of plants. Design skills and a well developed know how in aesthetical enhanced plant composition are to be educated intensively. This can be aimed in specific postgraduate courses focusing on planting design

4.3 Applications of Mixed Perennial Plantings in Academic Education

Undergraduate courses should include at least variant 1 – 4 (see 3.2 Fig. 3-6) of mixed plantings to implement these methods into planning for public as well as for private gardens. Variant 5 (subdividing the planting bed into smaller parts with different mixtures or with the same mixture in different multitudes per species) demands more skills from the

planner: to guarantee fluent transitions between neighbored plots mixtures have to be carefully changed in their species ranges (Step 3 in 2.2). Also a combination between mixed planting and sown or spontaneous vegetation (variant 6; Fig 8) requires this skills. So variants 5 and 6 can be targets for postgraduate courses for an adequate insight into site analyses, aesthetical and ecological principles are necessary as well as an adequate knowledge of plant ranges.

Table 2 summarizes 7 levels combining the application variants from chapter 3.2 and the intricacy steps from the above chapter 2.2.

Variant	Step of intricacy	Required knowledge				Proposed for academic course	Time demand in planning
		Knowledge in Site analysis	Knowledge in aesthetic & design	Knowledge in vegetati-on ecology	Knowledge in species		
1	1	low	low	–	–	Undergraduate	very low
1	2	low	middle	low	low	Undergraduate*	low
2	1 – 2	middle	middle	low	low	Undergraduate	low
3/4	1 – 2	middle	middle	low	low	Undergraduate	middle
1 – 4	3	high	middle	middle	middle	Postgraduate	high
5/6	3	high	high	high	middle	Postgraduate	high
1 – 6	4	high	high	very high	high	Postgraduate*	very high

Table 2: Matrix for estimated required knowledge/skills, proposed level in academic Landscape Architecture courses and predicted time demand in the planning process. Knowledge levels: – = no knowledge required; low = basic knowledge; middle = advanced knowledge; high = professional knowledge; * = for specific courses or studios focussing planting design.

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